-MIZORAM UNIVERSITY

NEP (UG- Geology) 2020

GEOLOGY COURSE STRUCTURE AND PAER DISTRIBUTION FOR UG CERTIFICATE, DIPLOMA, AND BACHELOR DEGREE (INCLUDING HONOURS AND RESEARCH) WITH MULTIPLE ENTRY AND EXIT OPTIONS

CURRICULUM AND CREDIT FRAMEWORKFOR UNDERGRADUATE PROGRAMMES

Geology course structure and paper distribution for UG certificate, Diploma, and Bachelor degree (including honors and research) with multiple entry and exit options

SEMESTER	CATEGORY	COURSE CODE	COURSE NAME	CREDIT
I	Major	*GEOL 100*	Earth Surface Processes	4
		*GEOL 101**	General Geology (*Indicates paper which can be opted for minor)	4
	Minor		Offered by other departments	4
	Multidisciplinary	*GEOL 110*	Elements of Geology	3
	Language (AEC)	150	English/Mizo/Hindi	3
	Value added course	VAC100	Universal Human Values	2
			Total credits	**20**
II	Major	*GEOL 160*	Oceanography & Climatology	4
		*GEOL 161**	Environmental Geology & Geohazards	4
	Minor		Offered by other Departments	4
	Multidisciplinary	*GEOL 120*	Petrology, Structural Geology and Geological Hazards	3
	Skill Enhancement Course	SEC160		3
	Value added course	VAC120	Understanding India	2
			Total credits	**20**
Students exiting after securing 40 credits will be awarded UG Certificate in relevant Discipline/Subject provided they secure additional 4 credits in work based vocational course(s) offered during summer term along with entry option to third semester				
III	Major	*GEOL 200*	Crystallography, Mineralogy & Optical mineralogy	3
		GEOL 200P	Crystallography, Mineralogy & Optical mineralogy (Practical)	1
		GEOL 201	Petrology and Structural geology	4
	Minor		Offered by other departments	4

	Multidisciplinary	*GEOL 210*	Remote Sensing and GIS	3
	SEC	*SEC270*		3
	Value added course	VAC230	Environmental Science	2
		VAC231	Digital and Technological Solution	
			Total credits	**20**
IV	Major	*GEOL 260*	Economic Geology	3
		GEOL 260P	Economic Geology & Paleontology (Practical)	1
		GEOL 261 Major/minor	Paleontology & Stratigraphy	4
	Minor			4
	Language (AEC)			3
	SEC			3
	Value added course			2
			Total credits	**20**
Students exiting the programme after securing 80 credits will be awarded UG Diploma in the relevant Discipline/Subject provided they secure additional 4 credits in skill based vocational course(s) offered during first year or second year summer term with entry option to fifth semester				
V	*Major*	*GEOL 300*	Engineering Geology, Remote sensing & GIS	3
		GEOL 300P	Engineering Geology, & GIS (Practical)	1
		GEOL 301	Mining and Exploration Geology	3
		GEOL 301P	Exploration & Hydrogeology (Practical)	1
		GEOL 302 Major/minor	Hydrogeology & Groundwater Exploration	4
	Minor		Offered by other Departments	4
	Language (AEC)			2
	IAF 300		Internship/Apprenticeship / Field Projects	2
			Total credits	**20**
	Major	*GEOL 360*	Sedimentology	3
		GEOL 360P	Sedimentology Practical	1
		GEOL 361	Igneous and Metamorphic petrology	3
		GEOL 361P	Igneous and Metamorphic petrology Practical	1

VI		*GEOL 362*	Structural Geology	3
		GEOL 362P	Structural Geology (Practical)	1
		GEOL 363	Geochemistry and Geodynamics	4
	Minor		Offered by other departments	4
			Total credits	**20**
Students who want to exit with 3 Year UG Programme will be awarded UG Degree in the relevant Discipline/Subject after securing 120 credits with entry option to 4 Year Bachelor's Degree Programmes for those students obtaining a minimum CGPA of 7.5 in the 3 Year UG Programme				
VII	Major	*GEOL 400*	Surveying, Field Geology and Morphotectonics	4
		GEOL 401	Fuel & Exploration Geology	4
		GEOL 402	Practical field and surveying	4
	Minor	*GEOL 703*	Surveying, Field Geology and Morphotectonics	4
		GEOL 704	Fuel & Exploration Geology	4
			Total credits	**20**
Award of Bachelor's Degree (Honours with Research) after securing 160 Credits with Research				
VIII	Major	*GEOL 800*	Research Methodology	4
		GEOL 801	Geology of North East India	4
	Research Project/ Dissertation			12
			Total credits	**20**
Award of Bachelor's Degree (Honours with Research) after securing 160 Credits with Research				
VIII	*Major*	*GEOL 460*	Research Methodology	4
		GEOL 461	Geology of North East India	4
		GEOL 462	Dynamics of the Earth	4
		GEOL 463	Paleontology and Stratigraphy - II	4
		GEOL 464	Geodynamics, Paleontology and stratigraphy (Practical)	4
			Total credits	**20**
Award of Bachelor's Degree (Honours) after securing 160 credits without Research				

SEMESTER 1

GEOL 100

(4 Credits)

EARTH'S SURFACE PROCESSES

Objective of the Paper

This course is designed to give a comprehensive introduction to physical aspects of geology, including rocks and minerals, plate tectonics, earthquakes, volcanoes, glaciation, groundwater, streams, coasts, mass wasting, climate change, planetary geology, and much more. It has a strong emphasis on examples from India.

Unit 1

Principles of Geomorphology. Geological processes: endogenous and exogenous processes, weathering, and erosion. Davisian cycle of erosion.

Unit 2

Orogeny and Isostacy. Geological work; erosion, transportation, deposition, erosional and depositional landforms of rivers.

Unit 3

Geological work; erosion, transportation, deposition, erosional and depositional landforms of winds and oceans.

Unit 4

Geological work; erosion, transportation, deposition, erosional and depositional landforms of Glacier and underground water.

Course outcome: *This course will give comprehensive knowledge on the processes that led to the formation of present landforms and the ongoing processes sculpting Earth's surface.*

BOOKS RECOMMENDED

1. G.B Mahapatra: Textbook of physical Geology
2. Holmes, Arthur (1992): Principles of Physical Geology, Vol. 1, Chapman and Hall,London.
3. Leet, L.D. and Judson, S. (1969): Physical Geology, Prentice Hall.
4. Ruhe, R.V. (1975): Geomorphology, Houghton Miffin Co., Boston.
5. Sparks (1960): Geomorphology, Longmans, London.

SEMESTER 1

GEOL 101*

(4 Credits)

GENERAL GEOLOGY

Objective of the Paper

This course is designed to provide knowledge of the development of the Earth's crust, its minerals, rocks, volcanoes, glaciers, mountains, and continents.

Unit 1

Introduction to Geology, branches, and relationship with other branches of science. Origin of the universe; Big Bang theory. Originof the solar system; Nebular, tidal and planetesimal hypotheses.

Unit 2

Earth; size, shape, mass, density, rotational, and revolution parameters. Kepler's law of planetary motion. Rock Cycle. Types of Rocks and their Formations.

Unit 3

The internal constitution of the earth; core, mantle and crust. Elementary ideas on continental drift, seafloor spreading and plate tectonics. Mantle convection, earth's magnetic field, Mid-Oceanic ridges and trenches.

Unit 4

Earthquakes; epicenter, and focus elastic rebound theory, causes, measurement. Effects of earthquakes, world distribution of earthquake belts. Types of Seismic waves

Course outcome: *This course provides an understanding of the natural and physical processes of the planet Earth and an appreciation for the impact geology has on everyday life.*

BOOKS RECOMMENDED

1. Holmes, Arthur (1992): Principles of Physical Geology, Vol. 1, Chapman and Hall,London.
2. Leet, L.D. and Judson, S. (1969): Physical Geology, Prentice Hall.
3. Condie, K.C. (1997): Plate Tectonics, 4th Edition, Elsevier
4. Kearey, P. (1990): Global Tectonics, 3rd Edition, Wiley
5. Shearer, P.M. (2019): Introduction to Seismology 3rd Ed., Cambridge
6. Udías, A. & Buforn, E. (1999): Principles of Seismology, Cambridge University Press
7. Clague, J.J. (2012): Landslides: Types, Mechanisms and Modeling, Cambridge
8. Werner, E.D. & Friedman, H.P. (2010): Landslides: Causes, Types & Effects, NovaScience Publishers Inc;

SEMESTER 1

GEOL 110

(3-Credits)

Multidisciplinary

ELEMENTS OF GEOLOGY

Objective of the Paper

This course aims to introduce students to geology subject and its allied courses. This course will highlight a very brief idea about the earth`s surface processes, structural elements and major hazards on the earth`s surface.

Unit 1: Introduction to Geology

Introduction to Geology, branches and relationship with other branches of science. The internal constitution of the earth, core, mantle and crust. Earth; size, shape, mass, density, rotational and revolution parameters. Introduction to rocks.

Unit 2: Earth's surface processes

Exogenic and endogenic processes and types. Weathering and erosion, transportation and deposition of sediments.

Unit 3: Astrogeology

Origin of the universe; Big Bang theory. Origin of the solar system. Celestial bodies of our solar system. Kepler's laws of Planetary motion. Basic idea on comets and meteors. Indian space mission; Chandrayaan and Mangalyaan.

Course outcome: *Students opting this course will have a brief understanding of our Earth, the universe, celestial bodies within our solar system and surface processes responsible for the evolution of topography.*

BOOKS RECOMMENDED

1. Holmes, Arthur (1992): Principles of Physical Geology, Vol. 1, Chapman and Hall,London.
2. Mahapatra G.B (1994); Text book of Physical Geology, CBS Publisher.
3. Bhangar K.M (2021): Principles of Engineering Geology, Standard Publisher Distributors.
4. Billings, M.P. (1972): Structural Geology, Prentice Hall.

SEMESTER 2

GEOL 160

(4 Credits)

OCEANOGRAPHY& CLIMATOLOGY

Objective of the Paper

This course has been introduced in this syllabus to learn some of the basic concepts in marine geology and oceanography. It covers the geological evolution of the ocean basins andthe methods currently employed to investigate the superficial and deep structural features of the sea bed.

UNIT -I

Hypsography of the continents and ocean floor –continental shelf, slope, rise, and abyssal plains. Physical and chemical properties of seawater, Salinity and temperature distribution of sea water. Residence times of elements in seawater.

UNIT -II

Ocean currents, waves and tides, Currents of Indian, Atlantic, and Pacific Oceans, Thermohaline circulation, Ekman Spiral, Major water masses of the world's oceans.

UNIT -III

Insolation, Earth's Heat Balance, Cloud forms and classification. Tides; origin, types. Milankovitch cycle. Global Climatic changes.

UNIT -IV

Land-Sea and Air Interaction. Origin of Indian monsoon, El Nino and La Nina, Impact of El Nino and La Nina on Global Climate.

Course outcome: *From these courses, we can explore the driving forces behind, consequences, and importance of sea-level changes in the geological record as well as the mineral resources*

BOOKS RECOMMENDED

1. Trujillo, Alan P. (2011): Essentials of Oceanography, 10th Edition, Prentice Hall
2. Garrison, Tom (2009): Essentials of Oceanography, 5th Edition, Brooks/Cole
3. Barale, Vittorio (2010): Oceanography from Space, 1st Edition, Springer
4. Pinet, P.R. (1996): Invitation to Oceanography 8th Ed., Jones & Bartlett Learning
5. Hidore, J., Snow, R., Snow, M., Oliver, J.E. (2009): Climatology: An AtmosphericScience, Perasons
6. Bhattacharya, T. (2015): A Textbook of Climatology, Wisdom Press
7. Schmittner, A. (2018): Introduction to Climate Science, Oregon State University

SEMESTER 2

GEOL 161*

(4 Credits)

ENVIRONMENTAL GEOLOGY & GEOHAZARDS

Objective of the Paper

This paper is to introduce the fundamental understanding of the Earth's dynamic and changing environment comprising one of the most compelling and exciting areas of study. Now is a particularly interesting time to study the environment from a geologic perspective because, as the human population increase and the use of resources grows, we may be on a collision course with the natural support systems that provide water, air, soil, and other resources we depend on.

UNIT -I

Fundamental concepts of Environmental Geology. General idea about structure and composition of different environmental domains such as atmosphere, hydrosphere and biosphere.

UNIT -II

Types of environmental pollution; Environmental consideration in Industrialization (EIA). Soil and Environment; Soil formation, soil profile, physical and chemical properties.

UNIT -III

Volcanos: types of volcanic eruption, the effect of volcanos & Volcaniclandforms. Landslide: classification, causes, and remedial measures.

UNIT -IV

Cyclone and anticyclones; naming, types and formation, cyclone in India. Cyclone management. Tsunami; causes and effects. Flooding; causes, management.

Course outcome: *This course will give a basic understanding of our Earth's unique and fragile components and will give awareness on the consequences of uncontrolled exploitation of our environment.*

BOOKS RECOMMENDED

1. K.S Valdiya: Environmental Geology (Ecology, Resource and Hazard management.
2. Keller Edward A., (2013): Environmental Geology, 9th Edition, Prentice Hall
3. Reichard James S., (2011): Environmental Geology, 1st Edition, McGraw Hills
4. Montgomery Carla W., (2011): Environmental Geology, 9th Edition, McGraw-Hill

SEMESTER 2

GEOL 120

(3-Credits)

Multidisciplinary

PETROLOGY, STRUCTURAL GEOLOGY AND GEOLOGICAL HAZARDS

Objective of the Paper

This course is designed to introduce students to different rock types, composition, and their formation on the earth. Students will have a better understanding of primary and secondary rocks, their origin, and their distribution in the crust mantle, and core of the earth.

Unit 1

Petrology: Definition of petrography and petrogenesis; Rock cycle. Distribution of rock associations in time & space. Types of rocks and their formations.

Unit 2

Outcrop, Dip and strike, Folds- parts of the fold, Faults - parts of faults, types of faults. Joints and Unconformity.

Unit 3

Earthquakes; causes, epicenter, and focus. Volcanos; types of volcanic eruption, Landslides; types, causes, and remedial measures. Cyclone and Tsunami

Course outcome: *This multidisciplinary course will enlighten students on the basics of Geology in the field of petrology and structure which will give them a better understanding on different natural hazards covered within the course.*

BOOKS RECOMMENDED

1. Best, Myron G.(2002): Igneous and Metamorphic Petrology, Blackwell Science.
2. Blatt, H. and Tracy, R.J. (1996): Petrology (Igneous, Sedimentary, Metamorphic), W.H. Freeman and Co., New York.
3. Tucker, M.E. (2011): Sedimentary Petrology, 3rd Ed., Wiley
4. Leeder, M.R. (2011): Sedimentology and Sedimentary Basins, 2nd Ed., Wiley

SEMESTER 3

GEOL 200

(3 Credits)

CRYSTALLOGRAPHY, MINERALOGY AND OPTICAL MINERALOGY

Objective of the Paper

The course introduces fundamentals of crystallography and mineralogy to enable students to understand and acquires basic knowledge in this respect. Students will understand and learn the nature and characteristics of various rock-forming minerals and native minerals. The course is also designed to enable students to acquire knowledge of the principles and application of various analytical techniques.

Unit 1: Crystallography

Crystal, elementary idea of crystal structure; Parts of crystal - face, edge, apex, solid angle, and interfacial angle; Crystallographic axes and angles; Parameters and indices; Contact Goniometry, Angular measurement, Common crystal forms - dome, prism, pyramid, and pinacoid; Elements of crystal symmetry; Introduction to different crystals systems. Study of Normal (Holosymmetric) Class of each crystal system.

Unit 2: Mineralogy

Chemical bonding and compound formation. Minerals, definition, and classification (Silicates and Sulphides, Sulphates, Oxides, Carbonates, Nitrates &Native Elements); A brief introduction of common mineral groups: Feldspar, Silica, Olivine, Pyroxene, mica and amphibole. Common physical properties of minerals (form and shape, color, streak, luster, cleavage, fracture, hardness, tenacity, transparency, specific gravity, magnetic nature).

Unit 3: Optical Mineralogy1

Properties of Light, Polarizing microscope, its parts and functioning; Birefringence and double refraction, Optically isotropic and anisotropic substances; Ordinary and polarized lights; Uniaxial and Biaxial minerals.

Unit 4: Optical Mineralogy 2

Common optical properties of minerals observed under plane-polarized light (colour, form, relief, cleavage, habit, pleochroism) and cross-polarized light (Interference colour, extinction, twinning, exsolution); Optical properties of the following common rock-forming minerals: Quartz, Plagioclase, Orthoclase, Microcline, Biotite, Muscovite, Hornblende, Hypersthene, Augite, Garnet, Olivine, Calcite& Tourmaline.

Course outcome*: This course enables students to understand the building foundations*

of different minerals and help identify the internal structure that give rise to different minerals and contrasting physical and optical properties.

BOOKS RECOMMENDED

1. Berry, L.G., Mason, B. and Dietrich, R.V. (1982): Mineralogy, CBS Pub.
2. Dana, E.S. and Ford, W.E. (2002): A textbook of Mineralogy (Reprints).
3. Nesse, D.W. (1986): Optical Mineralogy, McGraw Hill.
4. Phillips, F.C (1971): Introduction to Crystallography, Longman Group Pub.
5. Read, H.H. (1968): Rutley's Element of Mineralogy (Rev. Ed.), Thomas Murphy and Co.
6. Correns, C.W. (1969): Introduction to Mineralogy: Crystallography and Petrology,Springer
7. Okrusch, M. (2000): Mineralogy: An Introduction to Minerals, Rocks, and MineralDeposits, Springer
8. Kerr, P.F. (1977): Optical Mineralogy, McGraw-Hill Inc.

SEMESTER 3

GEOL 200P

CRYSTALLOGRAPHY, MINERALOGY AND OPTICAL MINERALOGY

PRACTICAL

- Identification of minerals based on chemical composition and diagnostic physical properties of the following:
  quartz, orthoclase, microcline, Plagioclase, nepheline, muscovite, biotite, augite, hypersthene, hornblende, olivine, talc, chlorite, apatite, calcite, dolomite, garnet, kyanite, Sillimanite, Gypsum, corundum

- Identification of optical properties of some common rock-forming minerals (Quartz, Plagioclase, Orthoclase, Microcline, Biotite, Muscovite, Hornblende, Hypersthene, Augite, Garnet, Olivine, Calcite & Tourmaline).

Course Outcome: *This course will give a hands-on understanding and analysis on the building blocks of minerals and their properties.*

BOOKS RECOMMENDED

9. Berry, L.G., Mason, B. and Dietrich, R.V. (1982): Mineralogy, CBS Pub.
10. Dana, E.S. and Ford, W.E. (2002): A textbook of Mineralogy (Reprints).
11. Nesse, D.W. (1986): Optical Mineralogy, McGraw Hill.
12. Phillips, F.C (1971): Introduction to Crystallography, Longman Group Pub.
13. Read, H.H. (1968): Rutley's Element of Mineralogy (Rev. Ed.), Thomas Murphy and Co.
14. Correns, C.W. (1969): Introduction to Mineralogy: Crystallography and Petrology,Springer
15. Okrusch, M. (2000): Mineralogy: An Introduction to Minerals, Rocks, and MineralDeposits, Springer
16. Kerr, P.F. (1977): Optical Mineralogy, McGraw-Hill Inc.

SEMESTER 3

GEOL 201*

(4 Credits)

PETROLOGY & STRUCTURAL GEOLOGY

Objective of the Paper

All the topics of the course have been very meticulously arranged into four units to help a student explore the various petrologic dimensions of igneous, metamorphic and sedimentary rocks. The main objective of this course is to give the student a comprehensive account of knowledge on the origin and evolution of magmatic rocks. The course gives due importance to the petrogenesis of igneous rocks. Comprehensive coverage of modern concepts, principles and conceptual data that are highly rewarding to understanding the process of metamorphic evolution. This course deals with the modern concepts of metamorphism, metamorphic facies, petrogenetic grids, and various methods to estimate the P-T conditions ofmetamorphism. Metamorphic rocks are formed due to metamorphic reaction which is stable at certain P-T conditions during equilibrium. Moreover, importance is also given to the geological structures and their mechanics and their relation with the tectonics will also be discussed.

Unit 1: Igneous petrology

Petrology: Definition of Petrography and Petrogenesis; Composition and types of Magma. Bowen's Reaction Series; Mode of Occurrence of the Igneous Rocks; Texture & Structure of Igneous Rocks; Classification of Igneous Rocks based on Silica content; Petrographic description of common igneous rocks (granite, diorite, syenite, gabbro, dolerite, basalt, rhyolite, trachyte, peridotite)

Unit 2: Sedimentary petrology

Origin of clastic and non-clastic sediments and sedimentary rocks; Primary sedimentary structures;Elementary idea about texture and mineral composition of clastic and non-clastic sedimentary rocks; Pettijohn’s classification of sedimentary rock; Descriptive petrography of common sedimentary rocks: Sandstone, Shale, Conglomerate, Breccia & Limestone.

Unit 3: Metamorphic petrology

Definition, agents of metamorphism; Types of metamorphism, Classification of metamorphic rocks; Metamorphic textures and structures; Metamorphic zones and elementary ideas about metamorphic facies. Study of Common metamorphic rocks as given below:
Slate, phyllite, schist, gneiss, hornfels, marble, quartzite.

Unit 4: Structural Geology

Topography and its representation; contour maps and their interpretation, toposheet numbering (IAC), map scale (statement scale and representative fraction (RF). Dip and strike; Outcrop, Instruments used in the field study. Brunton compass and their use. Folds, parts of the fold, geometric classification of folds. Faults - parts of faults, types of faults; Joints- their geometric classification; Unconformity, its kinds, and significance; Overlap; Outlier and Inlier.

Course outcome: *This course will help understand the geological behavior of the rocks and mechanics of different types of geological structures concerning their genetic characters, which on the contrary reflects the physical nature of the geological features*

BOOKS RECOMMENDED

1. Best, Myron G.(2002): Igneous and Metamorphic Petrology, Blackwell Science.
2. Blatt, H. and Tracy, R.J. (1996): Petrology (Igneous, Sedimentary, Metamorphic), W.H. Freeman and Co., New York.
3. Ehlers, E.G. & Blatt, H (1982): Igneous, Sedimentary and Metamorphic Petrology,CBS Publ.
4. Huang: (1962): Petrology, McGraw Hill Book Co.
5. Nockold, Knox and Chinner (1978): Petrology for students, Cambridge Univ. Press.
6. Winkler, H. G.F. (1967): Petrogenesis of Metamorphic Rocks, Springer–Verlag.
7. Wilson, M. (1989): Igneous Petrogenesis A Global Tectonic Approach, Springer
8. Faure, G. (2001): Origin of Igneous Rocks, Springer
9. Frost, B.R. (2013): Essentials of Igneous and Metamorphic Petrology, CambridgeUniversity Press
10. Winter, J.D. (2013): Principles of Igneous and Metamorphic Petrology, 2nd Ed., Pearson
11. Tucker, M.E. (2011): Sedimentary Petrology, 3rd Ed., Wiley
12. Leeder, M.R. (2011): Sedimentology and Sedimentary Basins, 2nd Ed., Wiley
13. Bucher, K. (1994): Petrogenesis of Metamorphic Rocks, 8th Ed., Springer
14. Billings, M.P. (1972): Structural Geology, Prentice Hall.
15. Dennis, J.G. (1972): Structural Geology, Ronald Press Company, New York.
16. Hills, E.S. (1963): Elements of Structural Geology, Farrold and Sons, London.
17. Leet, L.D. and Judson, S. (1969): Physical Geology, Prentice Hall.
18. Ramsay, J.G. and Huber, M.I. (2000): Techniques of Modern Structural Geology,Vol. III, Academic Press.
19. Singh, R. P. (1995): Structural Geology, A Practical Approach, Ganga Kaver

SEMESTER- III

GEOL 210

(3-Credits)

Multidisciplinary

REMOTE SENSING AND GIS

The objective of the Paper

With the rapid advancement in technology, this Couse covers the growing knowledge within the field of Remote sensing and its various applications in Geosciences.

UNIT -I

Introduction, basic principles, types (geodetic and plane surveying) and methods (triangulation and traversing) of surveying. Topographic maps and interpretation of contour maps

UNIT -II

Basic principles of Remote Sensing. Electromagnetic spectrum. Basic idea about platforms & Sensors. Satellites orbits

UNIT -III

Principles of Geographic Information System (GIS). Hardware and software components. GIS data (Raster and vector). Basic concept of Global Positioning System (GPS).

Course outcome: *Students who are foreign to the field of technological application in scientific studies will develop a good understanding on the concept of remote sensing and its application in everyday life.*

BOOKS RECOMMENDED

1. Johnson, R.B. and DeGraf, J.V. (1988): Principles of Engineering Geology, JohnWiley.
2. Banger, K. M. (2009): Principals of Engineering Geology, Standard Publishers
3. Singh Parbin (2012): Engineering and General Geology, S. K. Kataria and SonsPublishers
4. Punmia, B. C. (2005): Surveying (Volume – 1&2), Laxmi Publication Ltd.
5. Lahee, F.H. (2005): Field Geology, 6th Edition, CBS Publishers & Distributors
6. Gokhale, N.W. (2011): A Guide to Field Geology, CBS Publishers & Distributors
7. Coe, Angela L. (2010): Geological Field Techniques, A John Wiley & Sons, Ltd.

SEMESTER 4

GEOL 260

(3 Credits)

ECONOMIC GEOLOGY

Objective of the Paper

The main objective of the paper is to introduce the principles and fundamental understandingof the genesis and localization of ore deposits.

UNIT -I

Concept of ore, ore minerals and gangue in economic geology; Tenor of ores; Ore forming minerals – metallic and non-metallic; Common forms and structures of ore deposits; Paragenesis, paragenetic sequence and zoning in metallic ore deposits. Concept of Metallogenic epoch and Metallogenic Provinces

UNIT -II

Processes of formation of ore deposits; Magmatic, Sedimentary and metamorphic deposits. Factors controlling the availability of Economic minerals.

UNIT -III

Occurrence, origin, and Indian Distribution of important Mineral Deposits like Iron,Manganese, Chromium, Copper, Lead, zinc, Gold, and Aluminum

UNIT -IV

Occurrence, origin, and Indian Distribution of important non-metallic deposits like Graphite, Diamond, Mica, Coal and Petroleum.

Course outcome: *The content of the course is very thoughtfully designed to equip a post-graduate student in requisite knowledge of ore deposits and their localization, ore-forming systems, ore deposition related to various Plate tectonic set-ups, andhow to mine out the ores using contemporary mining methods.*

BOOKS RECOMMENDED

1. Gokhale, K.V.G.K. and Rao, T.C. (1983): Ore Deposits of India, East West Press Pvt.Ltd.
2. Jense, M.L., Bateman, and A.M. (1981): Economic Mineral Deposits, John Wiley andSons.
3. Krishnaswamy, S. (1979): India's Minerals Resources, Oxford and IBH Publ.
4. Mookherjee, A. (2000): Ore Genesis-A Holistic Approach, Allied Publisher.
5. Pramod, O. Alexander (2009): A Handbook of Minerals, Crystals, Rocks and Ores,New India Publishing Agency New Delhi.
6. Sharma, N.L. and Ram, K.V.S. (1972): Introduction to India's Economic Minerals,Dhanbad
7. Evans, A.M. (2011): Ore Geology and Industrial Minerals: An Introduction, ELBS.

SEMESTER 4

GEOL 260P

ECONOMIC GEOLOGY & PALEONTOLOGY

PRACTICAL

Objective of the Paper

This course will cover the practical works and hands on analysis and identification of different ore minerals from Geol 400 course.

- Study of ore and economic minerals in hand specimen as detailed in the theory syllabus.
- Preparation of maps showing the distribution of important metallic and non-metallic depositsand important coal and oil fields in India.
- Representation of Important mineral deposits on the map of India
- Study of fossils showing various modes of preservation
- Study of morphological characters and identification of phylum Mollusca, Brachiopoda & Gastropoda.

Course outcome: *The course will give students the necessary knowledge and practical understanding of ores which will be helpful in careers related to industrial settings.*

SEMESTER 4

GEOL 261

(4 Credits)

PALEONTOLOGY AND STRATIGRAPHY

Objective of the Paper

Paleontology forms an important tool for the classification and correlation of stratigraphic sequences based on the evolutionary trends of organisms. The fossils preserved in the rock record leave signatures on the evolution, depositional environment, paleoecology, and paleogeography. These signatures have to be identified and interpreted to extract the above information. The recent trend is to view stratigraphic sequence in terms of its genesis vis-à- vis global tectonic processes and design model for basin evolution. The course on paleontology is so designed to meet the above objectives.

The thick stratigraphic sequences need to be classified and correlated using basic principles of stratigraphy. This requires information on the origin of the sequences with respect to global changes in the past. The boundaries between rock records of different geological periods need to be delineated. Besides, the Precambrian and Phanerozoic stratigraphy of India needs to be understood by the student in terms of its chrono-, litho-, bio-, sequences- andseismic stratigraphy, and mineral resources.

UNIT-1

Fossils, definition, characters, kinds (body and trace fossils); Conditions of fossilization. Systematic classification of organisms. Evolution of man and horse. Extinction of dinosaurs.

UNIT-2

A detailed study of the morphology and geological distribution and significance of the following classes/orders - Trilobites, Bivalves, gastropods, brachiopods, echinoids, and corals. Elementary concepts on palynology.

UNIT-3

Stratigraphy: Definition& scope; Principles of stratigraphy; Geological time scale; Elements of Duel Stratigraphic classification; Litho-stratigraphic unit, Chronostratigraphic unit, Bio- stratigraphic unit; Stratigraphic Correlation, Facies concept in Stratigraphy.

UNIT-4

Study of the following tectonic domains with reference to classification, lithology, and economic significance: Dharwar Supergroup, Precambrian of Central India (Sakoli), Precambrian of North East India (Mikir Massiff and Shillong Group), Cuddapah Supergroup, Kurnool Group, and Vindhyan Supergroup, Siwalik Supergroup, Deccan Trap, Gondwana Supergroup, Tertiary of NE India & Stratigraphy of Mizoram.

Course outcome: *This course will give proper knowledge on the fossil assemblages as well as the bio-stratigraphic horizons of the stratigraphic framework of an area which will be a crucial tool for dating, paleoenvironmental analysis and stratigraphic correlation.*

BOOKS RECOMMENDED

1. Black, R.M. (1988): The Elements of Palaeontology, Cambridge Univ.
2. Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.
3. Jain, P.C. and Anantharaman, M.S. (1983): Palaeontology: Evolution and AnimalDistribution, Vishal Publ.
4. Kumar, R. (1985): Historical Geology and Stratigraphy of India, Wiley Eastern Ltd.
5. Moore, R.C., Lalicker, C.G. and Fischer, A.G. (1997): Invertebrate Fossils, CBS Publ.
6. Nield, E.W. and Tucker, V.C.T. (1985): Palaeontology: An Introduction, PergamonPress.
7. Prothero, D.R. (2004): Bringing Fossil to Life – An Introduction to Paleontology (2ndEd.), McGraw Hill.
8. Shrock, R.R. and Twenhoffel, W.H. (1952): Principles of Invertebrate Paleontology,CBS Publ.
9. Weller, J.M. (1960): Stratigraphic Principles and Practices, Universal Book.
10. Woods, H. (1985): Palaeontology Invertebrate, CBS Publ.
11. Ramakrishnan, M & Vaidyanadhan, R. (2010): Geology of India (Vol. 1 & 2), Geological Society of India

SEMESTER 5

GEOL 300

(3 Credits)

ENGINEERING GEOLOGY, REMOTE SENSING AND GIS

The objective of the Paper

With the rapid industrial expansion and the necessity of civil engineering constructions related to hydropower generation, surface transportation, etc. the applied aspects and techniques of Engineering geology are gaining importance. This course has been thoughtfully designed to equip a student with the requisite knowledge of various techniques of engineering geology. All the civil engineering projects like dams, reservoirs, tunnels, roads, bridges, buildings, etc.are constructed on rocks or soil.

UNIT -I

Engineering properties of rocks. Classification & engineering properties of soil. Geological Considerations and survey methods for the construction of Dam & Reservoir, Bridge, Tunnel and Roads.

UNIT -II

Introduction, basic principles, types (geodetic and plane surveying) and methods (triangulation and traversing) of surveying. Surveying methods; plane table, theodolite. Topographic maps and interpretation of contour maps.

UNIT -III

Basic principles of Remote Sensing. Electromagnetic spectrum. Remote Sensing Platform: Basic idea about platforms & Sensors. Basic idea of Radar Image. Remote sensing Satellites with a special reference to LANDSAT, SPOT, IRS Series.

UNIT -IV

Principles of Geographic Information System (GIS). Hardware and software components. GIS data (Raster and vector); topology, spaghetti, DEM. Software used in GIS (ArcGIS& QGIS). Application of GIS in Geology

Course outcome: *The course covering is designed to provide knowledge on the selection of the site for various geo-engineering projects.*

BOOKS RECOMMENDED

1. Johnson, R.B. and DeGraf, J.V. (1988): Principles of Engineering Geology, JohnWiley.
2. Banger, K. M. (2009): Principals of Engineering Geology, Standard Publishers
3. Punmia, B. C. (2005): Surveying (Volume – 1&2), Laxmi Publication Ltd.
4. Gokhale, N.W. (2011): A Guide to Field Geology, CBS Publishers & Distributors
5. Theory & Practice -Geographic Information system –Rao & Shariff-EBH
6. Pandey SN – Principles and Application of Photogeology –Wiley Eastern Limited
7. Krynin, D.P. and Judd W.R. 1957. Principles of Engineering Geology and Geotechnique, McGrawHill (CBS Publ).
8. Johnson, R.B. and DeGraf, J.V. 1988. Principles of Engineering Geology, JohnWiley.
9. Miller, Victor, C. 1961. Photogeology. McGraw Hill Book Co., New York.

10. Gupta R.P. 2003. Remote Sensing Geology. 2nd Ed., Springer-Verlag,Heidelberg, Germany.
11. Bhatta, B., 2008. Remote Sensing and GIS. Oxford, New Delhi.
12. Parbin Singh: Engineering & General Geology,SK Kataria & Sons,New Delhi

SEMESTER 5

GEOL 300P

(1 Credit)

ENGINEERING GEOLOGY AND GIS (PRACTICAL)

Objective of the Paper

This paper will focus on practical and experimental works including field-based study to enhance students' understanding of the topics

UNIT -I

- Fieldwork. Local and regional geological field work.
- Preparation of lithologs; digitizing lithologs using software.
- Geotechnical analysis of Rock and Soil samples
- Field visit to landslide affected areas.

UNIT -II

- Plane table/Theodolite/ Total station survey
- Interpretation of Ariel Photographs; Working with Stereoscopes
- Preparation of location map using GIS software
- Preparation of DEM map and contour map using GIS software

Course outcome: *Practical course will give practical and field experience for research and jobs.*

BOOKS RECOMMENDED

1. Todd, D.K., (2005): Groundwater Hydrology, 3rd Edition, John Wiley & Sons
2. Fetter, C.W., (2009): Applied Hydrology, 4th Edition, Prentice Hall
3. Raghunath, H.M. (2006): Hydrology: Principles, Analysis, Design, 2nd Edition, NewAge International (P) Ltd.
4. Davies, S. N. and De Wiest, R. J. N. (1966): Hydrogeology, John Wiley and Sons.
5. Karanth, K. R. (1989): Hydrogeology, Tata McGraw Hill Publ.
6. Karimi, H. (2016): Hydrogeology/Hydraulic Conductivity, Intech Publishers
7. Hölting, B. (2019): Hydrogeology, Springer
8. Alain, D. (2019): Hydrogeology: Groundwater Science and Engineering, CRC Press

SEMESTER 5

GEOL 301

(3 Credits)

Mining and Exploration Geology

Objective of the Paper

This paper covers the basics of mining geology as a part of the interaction of geology with mining engineering. Methods, terminologies and exploration techniques from other branches of science in relationship with geology.

UNIT -1

Introduction and scope of mining geology. Mineral resources and reserves. Duties of geologists in a mining enterprise. Exploratory mining terminologies: Adit, drifts, Stope, draw point, inclined and vertical shafts, crosscuts, winse and raise. Mining methods: Open pit mining, strip mining, alluvial mining, underground mining methods.

UNIT -2

Microfossils-definition and types; study of morphology, geological distributions and ecology of calcareous, siliceous, phosphatic and organic microfossils. Application of microfossils in petroleum exploration

UNIT -3

Principles and methods of important geological exploration techniques. Basic ideas about geophysical exploration techniques: Electrical, Seismic, gravity and magnetic methods.

UNIT -4

Geochemical sampling methods, Assay maps, isograde map and anomaly maps. Geochemical profile generations. Geobotanical and geo zoological indicators.

Course outcome: *Students will gain knowledge on safe mining methods and field practices which will prepare them for field-based research and exploration related career in mining industries.*

BOOKS RECOMMENDED

1. Arogyaswamy, R.N.P. (1973): Courses in Mining Geology, Oxford and IBH Publ.
2. Bryant, E. (1985): Natural Hazards, Cambridge Univ. Press.
3. Chaussier, Jean – Bernard and Morer, J. (1987): Mineral Prospecting Manual., North Oxford Academic.
4. Dobrin, M. B., and Savit, C. H., (1988): Introduction to Geophysical Prospecting, McGraw-Hill Book Co.
5. Rajendran S. et al (2007) : Mineral Exploration : Recent Stratégies.
6. T.S. Ramakrishna (2006) :Geophysical Practice in Mineral Exploration and Mapping,Memoir -62,Geological Society of India,Banglore.
7. Telford, W.M., Geldart, L.P, Sheriff, R.E. and Keys, D.A. (1990): Applied Geophysics, Cambridge Univ. Press.
8. Exploration and Mining Geology - William C. Peters
9. Geological Methods in Mineral Exploration and Mining
10. Applied Mining Geology 2018 Edition by Marat Abzalov

SEMESTER 5

GEOL 301P

(1Credits)

EXPLORATION & HYDROGEOLOGY (PRACTICAL)

Objective of the Paper

This paper will focus on practical and experimental works including field-based study to enhance students' understanding of the topics

UNIT -I

- Preparation of maps showing distribution of Petroleum and Coal deposits of India.
- Preparation of Assay and Isograde maps.
- Interpretation of Seismic, Electrical and Gravity survey data
- Interpretation of Geophysical Logs

UNIT -II

- Exercises on the plotting of Ocean Currents on the world outline map
- Preparation of water table contour map and their interpretation.
- Graphical representation and interpretation of water quality data.
- Preparation of flood zonation maps of India.

Course outcome: *Practical course will give practical and field experience for research and jobs.*

BOOKS RECOMMENDED

1. Todd, D.K., (2005): Groundwater Hydrology, 3rd Edition, John Wiley & Sons
2. Fetter, C.W., (2009): Applied Hydrology, 4th Edition, Prentice Hall
3. Raghunath, H.M. (2006): Hydrology: Principles, Analysis, Design, 2nd Edition, NewAge International (P) Ltd.
4. Davies, S. N. and De Wiest, R. J. N. (1966): Hydrogeology, John Wiley and Sons.
5. Karanth, K. R. (1989): Hydrogeology, Tata McGraw Hill Publ.
6. Karimi, H. (2016): Hydrogeology/Hydraulic Conductivity, Intech Publishers
7. Hölting, B. (2019): Hydrogeology, Springer
8. Alain, D. (2019): Hydrogeology: Groundwater Science and Engineering, CRC Press

SEMESTER 5

GEOL 302

(4 Credits)

HYDROGEOLOGY AND GROUNDWATER EXPLORATION

Objective of the Paper

This course deals with the original types of surface and subsurface water and the hydrologic properties of rocks. It also includes the techniques of groundwater explorations.

UNIT -I

Definition of hydrogeology; Hydrological cycle and groundwater in the hydrological cycle; Hydrological parameters - Precipitation, evaporation, transpiration, and infiltration; Origin and age of groundwater; Vertical distribution of groundwater; Types of aquifers.

UNIT -II

Water bearing properties of rocks - Porosity and Permeability; Retention of water in rocks and yield of water from rocks; Different types of springs and their formations; Darcy's law and its validity;

UNIT -III

Instrumentation in Hydrology: Rain gauging, Snow Gauging, Hydrographs. Water quality assessment for Irrigation and Industries.

UNIT -IV

Elementary idea of Ground Water Exploration; Application of Remote Sensing in Ground Water resources**.** Forms of pollution in Ground Water. Dissolved constituent of groundwater; salinization of groundwater.

Course outcome: *This course will shed light on the importance of water for the existence of human being an assessment of the quantity and quality of underground water resources is of great importance to water management*

BOOKS RECOMMENDED

1. Todd, D.K., (2005): Groundwater Hydrology, 3rd Edition, John Wiley & Sons
2. Fetter, C.W., (2009): Applied Hydrology, 4th Edition, Prentice Hall
3. Raghunath, H.M. (2006): Hydrology: Principles, Analysis, Design, 2nd Edition, NewAge International (P) Ltd.
4. Davies, S. N. and De Wiest, R. J. N. (1966): Hydrogeology, John Wiley and Sons.
5. Karanth, K. R. (1989): Hydrogeology, Tata McGraw Hill Publ.
6. Karimi, H. (2016): Hydrogeology/Hydraulic Conductivity, Intech Publishers
7. Hölting, B. (2019): Hydrogeology, Springer

SEMESTER 6

GEOL 360

(3- Credits)

SEDIMENTOLOGY

Objective of the Paper

Modern Sedimentology deals with the genesis of sediments and sedimentary rocks which play a major role in sedimentary basin analyses and inferring the depositional environment. More recently, the origin of sedimentary basins is viewed in terms of plate tectonics.

UNIT -I

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

UNIT -II

Classification of sedimentary rock based on: genetics, mode of deposition, and grain size. Provenance- Definition and concepts; Heavy minerals and their significance.

UNIT -III

Definition, composition, classification, petrogenesis of Sandstone, Shale, Limestone & Dolomite. The texture of sedimentary rocks. Structures of sedimentary rocks.

UNIT -IV

Depositional environments- eolian, fluvial, and marine environments. Facies concept and facies model. Tectonics and Sedimentation

Course outcome: *The topics in this course will help the students to have a holistic approach to modern Sedimentology and its application in hydrocarbon explorations.*

BOOKS RECOMMENDED

1. Tucker, M.E. (2011): Sedimentary Petrology, 3rd Ed., Wiley
2. Leeder, M.R. (2011): Sedimentology and Sedimentary Basins, 2nd Ed., Wiley
3. Pettijohn, F.J. (1972): Sand and Sandstone 2nd Ed., Springer
4. Tucker, M. (1982): Sedimentary rocks in the field, Wiley

SEMESTER 6

GEOL 360P

(1 -Credit)

SEDIMENTOLOGY (PRACTICAL)

Objective of the Paper

This course is designed to give more emphasis on the field activities and experimental part of petrology and structural geology so students can develop a field-based understanding and experience for future projects and research.

- Megascopic and microscopic examination of conglomerate, breccia, quartz arenite, arkose,lithic arenite, quartz wacke, feldspathic wacke, lithic wacke (greywacke), mud-rocks/shale and limestone.
- Plotting of grain-size parameter on triangular graph.
- Regional or local field work.

Course outcome: *This course provides much needed field-based study and experiential learning on geological structures and rocks.*

BOOKS RECOMMENDED

Ramsay, J.G. and Huber, M.I. (2000): Techniques of Modern Structural Geology,Vol. III, Academic Press.
Sitter, L.U. De (1959): Structural Geology, Mc Graw Hill
Billings, M.P. (1972): Structural Geology, Prentice Hall.

Gill, R. (2010): Igneous Rocks and Processes: A Practical Guide, Wiley-Balckwell
Best, Myron G. (2002): Igneous and Metamorphic Petrology, Blackwell Science.
Blatt, H. and Tracy, R.J. (1996): Petrology (Igneous, Sedimentary, Metamorphic), W.H. Freeman and Co., New York.
Ehlers, E.G. & Blatt, H (1982): Igneous, Sedimentary and Metamorphic Petrology,CBS Publ.

SEMESTER 6

GEOL 361

(3- Credits)

IGNEOUS AND METAMORPHIC PETROLOGY

Objective of the Paper

All the topics of the course have been very meticulously arranged into four units to help a student explore the various petrologic dimensions of igneous rocks. The main objective of this course is to give the student a comprehensive account of knowledge on the origin and evolution of magmatic rocks. The course gives due importance to the petrogenesis of igneousrocks. In this course, an attempt has also been made to present comprehensive coverage of modern concepts, principles, and conceptual data that are highly rewarding to understanding the process of metamorphic evolution. This course deals with the modern concepts of metamorphism, metamorphic facies, petrogenetic grids, and various methods to estimate the P-T conditions ofmetamorphism. Metamorphic rocks are formed due to metamorphic reaction which is stable at certain P-T conditions during equilibrium.

Igneous Petrology

UNIT -I

Genesis of magma, Bowen's Reaction Series; Magmatic differentiation and assimilation; Concepts of rock series and rock association; Classification of Igneous rocks: IUGS, CIPW and Alkali lime index. Phase rule: system, phase and components, Unary component system.

UNIT -II

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

Metamorphic petrology

UNIT -III

Metamorphic zones and isograds; Regional and thermal metamorphism of pelitic, calcareous, and basic igneous rocks. Concept of Metamorphic Facies. Characteristic PT conditions and mineral assemblages in different facies. Anatexis, Metasomatism, Pneumatolysis. Prograde, retrograde, and polymetamorphism.

UNIT -IV

Graphical representation of mineral assemblages in ACF, AKF, and AFM diagrams; Study of Common metamorphic rocks as given below: Slate, phyllite, schist, gneiss, hornfels, marble, quartzite. Petrography and petrogenesis of the following rocks: - Eclogite, Granulite, Khondalites, Gondites, and Migmatites.

Course outcome: *Petrology form the basis of geological studies as well as research. This course will give sufficient knowledge on the same for a proper understanding of the subject.*

BOOKS RECOMMENDED

1. Gill, R. (2010): Igneous Rocks and Processes: A Practical Guide, Wiley-Balckwell
2. Best, Myron G. (2002): Igneous and Metamorphic Petrology, Blackwell Science.
3. Blatt, H. and Tracy, R.J. (1996): Petrology (Igneous, Sedimentary, Metamorphic),
4. W.H. Freeman and Co., New York.
5. Ehlers, E.G. & Blatt, H (1982): Igneous, Sedimentary and Metamorphic Petrology,CBS Publ.
6. Huang: (1962): Petrology, McGraw Hill Book Co.
7. Nockold, Knox, and Chinner (1978): Petrology for students, Cambridge Univ. Press.
8. Winkler, H. G.F. (1967): Petrogenesis of Metamorphic Rocks, Springer–Verlag.
9. Wilson, M. (1989): Igneous Petrogenesis A Global Tectonic Approach, Springer
10. Faure, G. (2001): Origin of Igneous Rocks, Springer
11. Frost, B.R. (2013): Essentials of Igneous and Metamorphic Petrology, CambridgeUniversity Press
12. Winter, J.D. (2013): Principles of Igneous and Metamorphic Petrology, 2nd Ed., Pearson
13. Bucher, K. (1994): Petrogenesis of Metamorphic Rocks, 8th Ed., Springer

SEMESTER 6

GEOL 361P

(1 -Credit)

IGNEOUS AND METAMORPHIC PETROLOGY (PRACTICAL)

Objective of the Paper

This course is designed to give more emphasis on the field activities and experimental part of petrology and structural geology so students can develop a field-based understanding and experience for future projects and research.

UNIT -I

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

UNIT -II

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

Course outcome: *This course provides much needed field-based study and experiential learning on geological structures and rocks.*

BOOKS RECOMMENDED

Ramsay, J.G. and Huber, M.I. (2000): Techniques of Modern Structural Geology,Vol. III, Academic Press.
Sitter, L.U. De (1959): Structural Geology, Mc Graw Hill
Billings, M.P. (1972): Structural Geology, Prentice Hall.

Gill, R. (2010): Igneous Rocks and Processes: A Practical Guide, Wiley-Balckwell
Best, Myron G. (2002): Igneous and Metamorphic Petrology, Blackwell Science.
Blatt, H. and Tracy, R.J. (1996): Petrology (Igneous, Sedimentary, Metamorphic), W.H. Freeman and Co., New York.
Ehlers, E.G. & Blatt, H (1982): Igneous, Sedimentary and Metamorphic Petrology,CBS Publ.

SEMESTER 6

GEOL 362

(3- Credits)

STRUCTURAL GEOLOGY

Objective of the Paper

This course is designed to give more emphasis on geological structures and their mechanics. In this course, some aspects of tectonics will also be discussed.

UNIT -I

Causes of folding; (flexure folding, flow folding, shear folding & folds resulting from vertical movements) & faulting (Direction of displacement, stress & faulting). Mechanics of folding and faulting

UNIT -II

Elementary concept of stress & strain. Rock deformation; elastic, ductile, and brittle deformation. Young's modulus, Poisson's ratio, Mohr circle, Mohr envelope. Calculation of True dip and apparent dip. Determination of Throw/Heave/Stratigraphic separation. Strain analysis of deformed oriented rocks.

UNIT -III

Cleavage and Schistosity, Lineation, Pitch, and plunge of lineation. Stereographic projection and its use in structural analysis. Beta & Pi Diagrams. Representation of geological data using great circles and pole projections.

UNIT -IV

Geophysical methods in structural geology: Gravitational method, Magnetic method, Seismic method, Electrical methods.

Course outcome: *The course outcome is to give the geological behavior of the rocks and the mechanics of different types of geological structures concerning their genetic characteristics.*

BOOKS RECOMMENDED

1. Ramsay, J.G. and Huber, M.I. (2000): Techniques of Modern Structural Geology,Vol. III, Academic Press.
2. Sitter, L.U. De (1959): Structural Geology, Mc Graw Hill
3. Billings, M.P. (1972): Structural Geology, Prentice Hall.
4. Dennis, J.G. (1972): Structural Geology, Ronald Press Company, New York.
5. Hills, E.S. (1963): Elements of Structural Geology, Farrold and Sons, London.
6. Singh, R. P. (1995): Structural Geology, A Practical Approach, Ganga Kaveri Publ.,Varanasi.
7. Monga, J. (2017): Structural Geology of Rocks and Regions, Scitus Press
8. Gokhale, N.W. (2019): Theory of Structural Geology, CBS

SEMESTER 6

GEOL 362P

(1 -Credit)

STRUCTURAL GEOLOGY (PRACTICAL)

Objective of the Paper

This course is designed to give more emphasis on the field activities and experimental part of petrology and structural geology so students can develop a field-based understanding and experience for future projects and research.

- Measurement of dip and Strike, (zero method) joints, pith, plunge.
- Determination of true dip from apparent dip.
- Apparent dip for geological cross section profile.
- Structural problems on Stereographic projection.
- Use of stereonet software for representation of geological data. Regional or local field work.

Course outcome: *This course provides much needed field-based study and experiential learning on geological structures and rocks.*

BOOKS RECOMMENDED

Ramsay, J.G. and Huber, M.I. (2000): Techniques of Modern Structural Geology,Vol. III, Academic Press.
Sitter, L.U. De (1959): Structural Geology, Mc Graw Hill
Billings, M.P. (1972): Structural Geology, Prentice Hall.

Gill, R. (2010): Igneous Rocks and Processes: A Practical Guide, Wiley-Balckwell
Best, Myron G. (2002): Igneous and Metamorphic Petrology, Blackwell Science.
Blatt, H. and Tracy, R.J. (1996): Petrology (Igneous, Sedimentary, Metamorphic), W.H. Freeman and Co., New York.
Ehlers, E.G. & Blatt, H (1982): Igneous, Sedimentary and Metamorphic Petrology,CBS Publ.

SEMESTER 6

GEOL 363

(4- Credits)

Geochemistry and Geodynamics

Objective of the Paper

This course objective is to provide invaluable knowledge on the geochemical and geophysical evolution of earth and the resulting landforms due to Earth's dynamic processes.

UNIT -1

Fundamentals of Geochemistry, Cosmic abundance of elements, Geochemical classification of elements. Primary and secondary dispersion of elements, Trace and path finder elements, Clarke Value, Background Value and Threshold Value. Principle of Diadochic replacement. Types of meteorites and their composition.

UNIT -2

Heat flow, Geothermal gradient. Source of heat generation and temperature distribution inside the earth. Geochronology: Definition, direct and indirect methods (U-th, K-Ar, Rb-Sr, C-14, Fission Tract and Thermoluminescence dating methods.)

UNIT -3

Plate margin processes; active and passive margin, back arc, fore arc, island arc. Benioff zones, evolution of triple junction, trench and island arcs, mantle plume and hot spots. Geodynamics of Indian sub- continent and formation of Himalayas, 90^0E ridge.

UNIT -4

Origin of Earth's magnetic field, magnetic inclination and declination, polar wandering, secular variations, reversal of geomagnetic field. Paleomagnetism – principles, methods and applications. Elementary ideas on magmatism in oceanic ridges and subduction zones.

Course outcome: *This course will enlighten students on the geochemical and geophysical processes crucial for our existence and a better understanding of Earth's dynamics.*

BOOKS RECOMMENDED

1. Colin E. Dunn; Handbook of Exploration and Environmental Geochemistry
2. Michael S. Zhdanov (Eds.); Methods in geochemistry and geophysics 36
3. Naotatsu Shikazono (Eds.) Developments in Geochemistry 8
4. Davis A.M. (ed.), Holland H.D. (ed.), Turekian K.K. (ed.) Treatise on Geochemistry. Meteorites, Comets and Planets [Volume 1]
5. "Introduction to Geochemistry" by Krauskopf K B
6. Introduction To Geochemistry Principles and Applications" by Misra K C
7. Geochemistry" by William M White
8. Mason (1952). Principles of geochemistry.pdf

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SEMESTER 7

GEOL 400

(4- Credits)

Surveying, Field Geology and Morphotectonics

Objective of the Paper

The course introduces basic ideas and practicability of the subject in attempting any geological or engineering survey in the field. After completion of the course students are expected to use their knowledge in practice. Additionally, this course presents contemporary methods of reconstruction of tectonic and neotectonic processes based on geomorphological analysis.

Unit-I

Surveying, objective of surveying (Geodetic and Plane survey uses and Principle of Surveying). Levelling, Principles of Levelling: Simple and Differential. Theodolite Survey: Principles and working.

Unit-II

Basic field gear, planning a field project: Preparations for the field, taking geologic notes in the field: Basic procedures at outcrops- noting characters of igneous, sedimentary and metamorphic rocks, measuring strike and dip (attitude) of planar and linear features using a clinometer compass and Brunton compass.

Unit-III

Application of Drainage Basin Morphotectonic Analysis for Assessment of Tectonic Activities. Slope formation, classification, controls, and analysis. Geomorphic Indices of Active Tectonics. Recent advances in understanding the morphotectonic and neotectonic evolution.

Unit-IV

Morphotectonic mechanisms of tectonic landforms. Erosion surfaces, denudational chronology and tectonics. Geomorphological evidences of neotectonics in India. Recent advances in morphotectonic with the advancement of technologies.

Course outcome: *Students will learn about the types of tectonic structures and their reflection in geomorphology, about restoration of tectonic processes and other processes shaping land surface, with particular emphasis on the evolution of orogenic areas.*

BOOKS RECOMMENDED

1. Punmia, B.C. (2005): Surveying (Volume: 1&2), Laxmi Publication Ltd.
2. Lahee, F.H. (2005): Field Geology, 6th Edition, CBS Publishers & Distributors
3. Gokhale, N.W. (2011): A Guide to Field Geology, CBS Publishers & Distributors
4. Coe, Angela L. (2010): Geological Field Techniques, John Wiley & Sons, Ltd.
5. Compton, R.R. (2020): Manual of Field Geology, N/A
6. Burbank, D.W. & Anderson, R.S. (2011): Tectonic Geomorphology, 2nd Edition,Wiley-Blackwell
7. Scheidegger, A.E. (2004): Morphotectonics, Springer

SEMESTER 7

GEOL 401

(4- Credits)

FUEL AND EXPLORATION GEOLOGY

Objective of the Paper

Coal, petroleum and atomic minerals are most important energy sources for human sustainability. This course provides detail knowledge about the coal, petroleum and atomic minerals and their reserves in India.

UNIT -I

Petroleum: Definition, composition, origin, migration and entrapment. Source reservoir and trap rocks and their characteristics. Study of important oil fields in India: Naharkatia and Borhola oil field.

UNIT -II

Coal: Definition, chemical, petrographic constituents, origin and classification of coal. Coal reserves of India. Distribution of coal with special reference to important Indian coal fields. Gondwana (Raniganj) and Tertiary (Neyvelli and Kashmir)

UNIT -III

Mining terminology, Classification of mining methods (open cast mining and underground mining). Sequence and phases of exploration (pits, trenches and bore holes). Methods of Geological mapping and sampling. Basic concepts on Geobotanical and Geo-zoological Indicators in mineral exploration, Pedological indicators.

UNIT -IV

Geophysical Exploration techniques: Physical parameters used in exploration. Different methods of surface subsurface exploration on different scales. Electrical (Self Potential, Equi-potential, Resistivity and Conductivity methods), Seismic Reflection & Refraction Methods. Gravity, Magnetic and Radioactivity Methods

Course outcome: *This course introduces various exploration methodsemployed in different geological, engineering and mining strategies, including basic procedures and precautions to undertake in attempting any exploration program in different application, either hydrocarbons, mining or engineering projects.*

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BOOKS RECOMMENDED

1. Sharma, N.L. and Ram, K.V.S. (1972): Introduction to India's Economic Minerals,Dhanbad
2. Kriskhnaswamy, S. (1972): India's Mineral Resources, Oxford and IBH PublishingCo. Pvt. Ltd.
3. Chatterjee, K.K. (2004): Indian Mineral Deposits, New Age International
4. Lal, J.K. (2013): Ore Geology And Mining Geology, Anmol Publications
5. Tiwari, S.K. (2019): Ore Geology, Economic Minerals and Mineral Economics,Atlantic
6. Selley, R.C. (2014): Elements of Petroleum Geology 3rd Ed., Academic Press
7. Bjorlykke, K. (1989): Sedimentology and Petroleum Geology, Springer
8. Stach, E. (1982): Coal Petrology, Lubrecht & Cramer Ltd
9. Thomas, L. (2020): Coal Geology, 3rd Edition, Wiley-Blackwell
10. Roger, M. (2010): Geological Methods in Mineral Exploration and Mining, Springer
11. Arogyaswamy, R. (2017): Courses In Mining Geology 4th Ed., Oxford & IBH
12. Milsom, J. (2011): Field Geophysics 4th Ed., Wiley
13. Lowrie, W. (2020): Fundamentals of Geophysics 3rd Ed., Cambridge
14. Kearey, P. (2002): An Introduction to Geophysical Exploration, Wiley-Blackwell

SEMESTER 7

GEOL 402

(4 - Credits)

PRACTICAL FIELD AND SURVEYING

Objective of the Paper

The course introduces basic ideas and practicability of the subject in attempting any geological or engineering survey in the field. After completion of the course students are expected to use their knowledge in practice. Additionally, this course presents contemporary methods of reconstruction of tectonic and neotectonics processes based on geomorphological analysis.

Unit-I

Plane table and theodolite survey.

Study of geomorphic models and topographic maps.

Unit-II

Measurement of morphometric parameters for drainage basin.

Longitudinal profile of a river.

Unit-III

Preparation of map showing the distribution of Petroleum and coal deposits of India.

Preparation of Assay and Isograd maps

Unit-IV

Interpretation of Seismic, electrical and gravity survey data.

Interpretation of Geophysical logs.

Course outcome: *Students will learn about the types of tectonic structures and their reflection in geomorphology, about restoration of tectonic processes and other processes shaping land surface, with particular emphasis on the evolution of orogenic areas.*

BOOKS RECOMMENDED

1. Punmia, B.C. (2005): Surveying (Volume: 1&2), Laxmi Publication Ltd.
2. Lahee, F.H. (2005): Field Geology, 6th Edition, CBS Publishers & Distributors
3. Gokhale, N.W. (2011): A Guide to Field Geology, CBS Publishers & Distributors
4. Coe, Angela L. (2010): Geological Field Techniques, John Wiley & Sons, Ltd.
5. Compton, R.R. (2020): Manual of Field Geology, N/A
6. Burbank, D.W. & Anderson, R.S. (2011): Tectonic Geomorphology, 2nd Edition,Wiley-Blackwell
7. Scheidegger, A.E. (2004): Morphotectonics, Springer

SEMESTER 8
GEOL 460
(4- Credits)
RESEARCH METHODOLOGY

Objective of the Paper

Research methods and ethics, from design to data analysis and report writing. Importance areas of study include Theory of science, research problems and strategies in special needs education, Qualitative and quantitative research designs, methods, instruments, data analysis and presentation, Research ethics, Principles and techniques of statistical analysis, Conceptualizing and conducting a research proposal.

UNIT -I

Objective of research processes and steps in research methodology.

UNIT -II

Field methods used in geological mapping, format for writing thesis, reports and research papers.

UNIT -III

Statistical methods used in earth science /Geology.

UNIT -IV

Principles and Techniques of Research Methodology.

Course outcome: *Completion of this course will enhance students on their research ethics and develop knowledge and capacity for advanced projects and research*.

BOOKS RECOMMENDED

1. Isaaks, E.H. (1990): Applied Geostatistics, OUP
2. Sarma, D.D. (2009): Geostatistics with Applications in Earth Sciences, Springer
3. Wackernagel, H. (2003): Multivariate Geostatistics: AnIntroduction withApplications, Springer
4. Ferguson, J. (2013): Mathematics in Geology, Springer
5. Sagar, B.S.D. (2018): Handbook of Mathematical Geosciences, Springer
6. Pruzan, P. (2016): Research Methodology, Springer
7. Phophalia, A.K. (2010): Modern research methodology new trends and techniques,Paradise Publishers
8. Kothari, C.R. (2013): Research Methodology: Methods and Techniques, New AgeInternational
9. Thomas, C.G. (2021): Research Methodology and Scientific Writing, Springer
10. Alley, M. (1986): The Craft of Scientific Writing, Springer
11. Blckwell, J. & Martin, J. (2011): A Scientific Approach to Scientific

SEMESTER 8

GEOL 461

(4- Credits)

PALEONTOLOGY AND STRATIGRAPHY 2

Objective of the Paper

Paleontology forms an important tool for the classification and correlation of stratigraphic sequences based on the evolutionary trends of organisms. The fossils preserved in the rock record leave signatures on the evolution, depositional environment, paleoecology, and paleogeography. These signatures have to be identified and interpreted to extract the above information. The recent trend is to view stratigraphic sequence in terms of its genesis vis-à- vis global tectonic processes and design model for basin evolution. The course on paleontology is so designed to meet the above objectives.

The thick stratigraphic sequences need to be classified and correlated using basic principles of stratigraphy. This requires information on the origin of the sequences with respect to global changes in the past. The boundaries between rock records of different geological periods need to be delineated. Besides, the Precambrian and Phanerozoic stratigraphy of India needs to be understood by the student in terms of its chrono-, litho-, bio-, sequences- and seismic stratigraphy, and mineral resources.

UNIT -I

Application of paleontology with special reference to correlation, Paleoecology and paleobiogeographic reconstructions; Organic evolution - ancient and modern concepts, evidences, theories of organic evolution: Lamarckism, Darwinism, Synthetic theory. Binomial nomenclature and procedures in taxonomy

UNIT -II

Modes of preservation of plant fossils; Classification and broad characteristics of major plant groups; elementary knowledge of Gondwana flora. Origin and general characteristic of vertebrates; Elementary ideas about vertebrate classes; Elementary knowledge of Siwalik vertebrate fauna.

UNIT -III

A detailed study of succession, lithology, age, economic importance and fossil content of the following – Archaean of South India, Proterozoic of Son Valley, Palaeozoic of Kashmir, Gondwana Supergroup, Triassic of Spiti, Jurassic of Kachchh, Cretaceous of Tiruchirapalli.

UNIT -IV

A detailed study of succession, lithology, age, economic importance and fossil content of the following: Deccan Trap and equivalents, Paleogene of Assam, Kachchh and Andaman, Siwaliks of Jammu and Himachal Pradesh and Karewas of Kashmir.

Course outcome: *This course will give proper knowledge on the fossil assemblages as well as the bio-stratigraphic horizons of the stratigraphic framework of an area which will be a crucial tool for dating, paleoenvironmental analysis and stratigraphic correlation.*

BOOKS RECOMMENDED

1. Black, R.M. (1988): The Elements of Palaeontology, Cambridge Univ..
2. Clarkson, E.N.K. (1986): Invertebrate Palaeontology and Evolution, Allen and Unwin Publ.
3. Jain, P.C. and Anantharaman, M.S. (1983): Palaeontology: Evolution and Animal Distribution, Vishal Publ.
4. Lehmann, U. (1983): Fossils Invertebrate, Cambridge Univ. Press.
5. Moore, R.C., Lalicker, C.G. and Fischer, A.G.(1997): Invertebrate Fossils, CBS Publ.
6. Nield, E.W. and Tucker, V.C.T. (1985): Palaeontology: An Introduction, Pergmon Press.
7. Prothero, D.R. (2004): Bringing Fossil to Life – An Introduction to Paleontology (2nd Ed.), McGraw Hill.
8. Rastogi (1988): Organic Evolution, Kedarnath and Ramnath Publ.
9. Raup, D.M. and Stanley, S.M. (1985): Principles of Palaeontology, CBS Publ..

SEMESTER 8
GEOL 462
(4- Credits)
DYNAMICS OF THE EARTH

Objective of the Paper

This course is designed to give a comprehensive knowledge on the geophysical and geochemical evolution of Earth, endogenic and exogenic processes that shape the Earth

UNIT -I

Earth; shape, mass, density, rotational and revolution parameters; Distribution & Elemental abundance in crust, Mantle and Core. Magnetic field; Radioactivity and Geo-chronology of the Earth;

UNIT -II

Internal structure of the Earth; Geochemical Evolution of the Earth; Geophysical conditions of the Earth: Gravity, magnetism and heat flow; Application of Geophysics in understanding the dynamics of the Earth; Concept and theories of Isostasy;

UNIT -III

Earth's movement and Paleographic distribution and evolution of continents and basin through Geological time (Special emphasis on India's changing position): Orogenic and epi-orogenic phases; Evidences of Continental Drift and Sea Floor Spreading

UNIT – IV

Introduction to Evolution and mechanism of Plate Tectonics theory; nature and types of plate margins. Tectonics of Continental Margins, Continental Shelves, Passive Margins, Active Margins and Marginal Basins; Origin, significance and distribution of mid-oceanic ridges; Trenches and Island-Arc; Mantle Plume and Hot Spots.

Course outcome: Completion of this course will give a detailed knowledge on the Earth' s Dynamic process and the evolutionary history, present day processes and future insights.

BOOKS RECOMMENDED:

1. *Geomorphology – W.D. Thornburg - Wiley Eastern Ltd.*
2. *Text Book of Physical Geology – G.B.Mahapatra - CBS Publ; and Distributors*
3. *Physical Geology - Flint and Skinners - John Wiley and Sons.*
4. *A text book of Geomorphology - P. Dayal- Shukla Book Depot, Patna-4;*
5. *Principles of Physical Geology - Arthur Holmes.*
6. *Geomorphology - Savinder Singh - Prayag Pustak Bhawan, 20-A, University Road,*
7. *Allahabad-2.*
8. *Physical Geology of India-S.M. Mathur-National Book Trust; N.Delhi.*
9. *Physical geology – Plummer ,Mc Geary & Carlson – Mc Graw Hill Pub..*
10. *Plate Techtonics – Condie Kent*
11. *Dynamics of the Earth- Wilson*
12. *Climatology- D.S. Lal – Sharda Pustak **B**hwan*

SEMESTER 8
GEOL 463
(4- Credits)
GEOLOGY OF NORTH EAST INDIA

Objective of the Paper

This course will highlight the stratigraphic, paleontological, structural and economic status of the North Eastern states of India, tectonic history as well as its vulnerability to tectonic hazards.

UNIT -I

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

UNIT -II

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

UNIT -III

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

UNIT -IV

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

Course outcome: *The course will help students to develop a better understanding on the geological aspects of the North Eastern states which is considered one of the most seismically active regions of the world.*

BOOKS RECOMMENDED

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

SEMESTER 8

GEOL 464

(4 - Credits)

GEODYNAMICS, PALEONTOLOGY AND STRATIGRAPHY PRACTICAL

Objective of the Paper

This course consists of practical, field and experimental part of Geol 800 to 803

UNIT -I

Study of morphological characters, systematic positions and age of important genera belonging to the following groups - Brachiopoda, Bivalvia, Cephalopoda, Gastropoda and Plant fossils. Distribution of following geological formations on sedimentary basin map of India - Marine Lower Permian, Gondwana Supergroup, Marine Mesozoics, Deccan Traps and equivalents, Marine Cenozoic and Siwalik Group.

UNIT -II

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

UNIT -III

Interpretation of seismogram, Problems on half-life calculation, Problems on drainage patterns

Study of models on 1. Internal structure of the Earth.2. Plate margins 3. Mid -oceanic ridges. 4.Trenches. Interactive studies of different Geological processes through software. Recognition of different plate positions through geologic time. Utilization of Web resources.

UNIT -IV

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

Course outcome: Practical component of this course will develop students ability in field and research projects with a keen understanding of the subject.

BOOKS RECOMMENDED

1. Nandy,D.R.(2000):Geodynamics of North Eastern India and Adjoining Region
2. Geomorphology - Savinder Singh - Prayag Pustak Bhawan, 20-A, University Road,
3. Allahabad-2.
4. Physical Geology of India-S.M. Mathur-National Book Trust; N.Delhi.
5. Physical geology – Plummer ,Mc Geary & Carlson – Mc Graw Hill Pub..
6. Plate Techtonics – Condie Kent
7. Black, R.M. (1988): The Elements of Palaeontology, Cambridge Univ..
8. Clarkson, E.N.K. (1986): Invertebrate Palaeontology and Evolution, Allen and Unwin Publ.
9. Jain, P.C. and Anantharaman, M.S. (1983): Palaeontology: Evolution and Animal Distribution,
10. Woods, H. (1985): Palaeontology Invertebrate, CBS Publ.
11. Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.