Semester V

Major – 9 (MJ - 9) ECONOMIC GEOLOGY
Credit – 4 **Lectures – 60 Hours**
FM= 100 **T= 100 {75Ext. +25 Int.}**

Instructions:

- There will be two groups of questions. **Group A** is compulsory which will contain **three questions**.
- **Question no. 1** will be **very short answer type** consisting of **five questions of 1 mark each.**
- **Question no. 2 & 3** will be of **short answer type** of **5 marks each**.
- **Group B** will contain **descriptive type six questions** of **15 marks** each, out of which **any four are to answer**.

Course objective:

The primary objective of the course of Economic Geology is

- to introduce fundamental aspects of origin, mode of occurrences and the distribution of ore deposits to the students.

Learning outcomes:

After successfully completing this course, the students will be able to:

- On completion of the course the students are expected to gain knowledge about various economic minerals, their processes of formation, mode of occurrence and uses.

Skills to be Learned:

- To know the basic concepts of the processes of the formation of the ore deposits
- To know the different types of ore deposits in India and in various parts of the world Spatio-temporal distribution of the different kinds of mineral deposits in India

COURSE CONTENT:

Unit	Topic	Total no. of Lectures
Unit 1:	**Ores and gangues**: Ores, gangue minerals, tenor, grade and lodes Classification of economic deposits. Magmatic processes - early magmatic, late magmatic and residual liquid processes; hydrothermal processes; contact metamorphic processes; metamorphic ore forming processes, Sedimentary ore forming processes.	**12**
Unit 2:	Skarns, greisens, and Exogenous processes: weathering products and oxidation and supergene enrichment, placer deposits, petroleum and natural gas - constituents, properties, origin, and uses; coal - physical and chemical constituents, classification, mode of occurrence, origin, and uses; introduction to radioactive minerals	**12**

Unit 3: Metallic ores Mode of Occurrence, chemical composition, uses and distribution in India of following: Metallic deposits: Ores of Iron, Aluminum, Copper, Manganese, Lead and Zinc, Gold	**12**
Unit 4: **Nonmetallic ores** Mode of Occurrence, chemical composition, uses and distribution in India of following: Non-metallic deposits: Mica, Asbestos and Limestone, Kyanite, Barite, Magnesite	**12**
Unit 5: Metallogenic provinces and epochs, types & Nature of ore forming fluids. Fluid inclusions and their application in the genesis of ores. Isotopes and their bearing on ore genesis and application.	**12**

Books Recommended:

- *Guilbert, J.M. and Park Jr., C.F. (1986) The Geology of Ore deposits. Freeman & Co.*
- *Bateman, A.M. and Jensen, M.L. (1990) Economic Mineral Deposits. John Wiley.*
- *Evans, A.M. (1993) Ore Geology and Industrial minerals.*
- *Wiley Laurence Robb. (2005) Introduction to ore forming processes. Wiley.*
- *Gokhale, K.V.G.K. and Rao, T.C. (1978) Ore deposits of India their distribution and processing, Tata- McGraw Hill, New Delhi.*
- *Deb, S. (1980) Industrial minerals and rocks of India. Allied Publishers.*
- *Sarkar, S.C. and Gupta, A. (2014) Crustal Evolution and Metallogeny in India. Cambridge Publications.*

Semester V

Major – 10 (MJ - 10) STRATIGRAPHIC PRINCIPLES & INDIAN STRATIGRAPHY
Credit – 4 **Lectures – 60 Hours**
FM= 100 **T= 100 {75Ext. +25 Int.}**

Instructions:

- There will be two groups of questions. **Group A** is compulsory which will contain **three questions**.
- **Question no. 1** will be **very short answer type** consisting of **five questions of 1 mark each.**
- **Question no. 2 & 3** will be of **short answer type** of **5 marks each**.
- **Group B** will contain **descriptive type six questions** of **15 marks** each, out of which **any four are to answer**.

Course objective:
The primary objective of the course is

- To learn a basic understanding of rock superposition of beds through time and their relative age; understanding of stratigraphy to apply in exploration of energy and mineral resources, codes of stratigraphy

Learning outcomes:
After successfully completing this course, the students will be able to:

- On completion of the course the students are expected to gain knowledge about identification of potential zones of mineral and energy resources; Application of stratigraphy to characterize evolution of life through time and mass extinctions.

Skills to be Learned:

- Identification of potential zones of mineral and energy resources.
- Application of stratigraphy to characterize evolution of life through time and mass extinctions.

COURSE CONTENT:

Unit	Topic	Total no. of Lectures
Unit 1: Principles of stratigraphy, Introduction to the concepts of lithostratigraphy, biostratigraphy, chronostratigraphy, seismic stratigraphy, chemostratigraphy, Magnetostratigraphy; International Stratigraphic Code – development of a standardized stratigraphic nomenclature. Concepts of Stratotypes. Global Stratotype Section and Point (GSSP).		**12**
Unit 2: Principles of stratigraphic analysis and Physiographic and tectonic subdivisions of India Walther's Law of Facies. Concept of paleogeographic reconstruction; Sequence stratigraphy and their subdivisions with Indian examples. Introduction to the physiographic and tectonic sub divisions of India. Introduction to Indian Shield.		**12**

Unit 3: Pre-Cambrian Stratigraphy of India Pre-Cambrian geology of Singhbhum and Karnataka; Introduction to Proterozoic basins of India; Geology of Vindhyan and Cudappah basins of India	**12**
Unit 4: Phanerozoic Stratigraphy of India Geology, 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. Siwalik successions, b. Assam basins. Stratigraphy and structure of Krishna-Godavari basin, Cauvery basin, Bombay offshore basin, Kutch and Saurashtra basins and their potential for hydrocarbon exploration	**12**
Unit 5: Volcanic provinces of India and Stratigraphic boundaries a. Deccan Traps, b. Rajmahal, Important Stratigraphic boundaries in India - a. Precambrian-Cambrian boundary, b. Permian-Triassic boundary, and c. Cretaceous-Tertiary boundary	**12**

Suggested Readings:

- *Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers,*
- *Delhi Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley* ➢ *Ramakrishnan, M. & Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological*

  Society of India, Bangalore.
- *Valdiya, K. S. (2010) The making of India, Macmillan India Pvt. Ltd.*

Semester V

Major – 11 (MJ – 11) (Practical) Economic Geology, Stratigraphic Principles & Indian Stratigraphy
Credit – 4 **Lectures – 60 x 2 =120 Hours**
P = 100 marks

Practical	**Marks Distribution**
1. **Economic Geology Experiment:**	**20**
2. **Stratigraphy Experiment**	**20**
3. **Field Report**	**20**
4. **Class record**	**20**
5. **Viva Voce**	**20**
	Total=100

Suggested Practical

Economic Geology

1. Megascopic identification ore forming minerals (Oxides and sulphides).
2. Study of microscopic properties of ore forming minerals (Oxides and sulphides).
3. Preparation of maps: Distribution of important ores and other economic minerals in India.

Stratigraphy

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 Paleo-geographic maps of Precambrian time;
4. Study of different Proterozoic supercontinent reconstructions.

Geological Mapping of two weeks duration of Economic Geology and Field Work Report based on it.

Semester VI

Major – 12 (MJ - 12) PALEONTOLOGY
Credit – 4 **Lectures – 60 Hours**
FM= 100 **T= 100 {75Ext. +25 Int.}**

Instructions:

- There will be two groups of questions. **Group A** is compulsory which will contain **three questions**.
- **Question no. 1** will be **very short answer type** consisting of **five questions of 1 mark each.**
- **Question no. 2 & 3** will be of **short answer type** of **5 marks each**.
- **Group B** will contain **descriptive type six questions** of **15 marks** each, out of which **any four are to answer**.

Course objective:

The primary objective of the course is

- To study the remains of animals and plants (fossils) of the geological past preserved in the rocks and how life forms had responded to climate and environments.

Learning outcomes:

After successfully completing this course, the students will be able to:

- On completion of the course the students are expected to gain knowledge the evolution of life through time; appreciating how fossils provide information on the paleoenvironments; understanding the adaptability of life in different environments, paleoenvironmental crises and mass extinctions;

Skills to be Learned:

- To know the remains of animals and plants (fossils) of the geological past preserved in the rocks and how life forms had responded to climate and environments.

COURSE CONTENT:

Unit	Topic	Total no. of Lectures
Unit 1:	**Fossilization and fossil record** Nature and importance of fossil record; Fossilization processes and modes of preservation	**12**
Unit 2:	**Taxonomy and Species concept** Species concept with special reference to paleontology, Theory of organic evolution.	**12**
Unit 3:	**Invertebrates** Brief introduction of important fossils groups: morphology and	**12**

geological history of Trilobita, Brachiopoda, Gastropoda, Cephalopoda, Lamellibranch, and Corals.	
Unit 4: **Vertebrates and other fossils** Evolution of horse and intercontinental migrations. Human evolution. Gondwana Flora, Introduction to Ichnology.	**12**
Unit 5: **Application of fossils in Stratigraphy** Biozones, index fossils, correlation Fossils and paleo-environmental analysis, Fossils and paleobiogeography, biogeographic provinces Paleoecology – fossils as a window to the evolution of ecosystems	**12**

Books Recommended:

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

Semester VI

Major – 13 (MJ - 13) GEOMORPHOLOGY
Credit – 4 **Lectures – 60 Hours**
FM= 100 **T= 100 {75Ext. +25 Int.}**

Instructions:

- There will be two groups of questions. **Group A** is compulsory which will contain **three questions**.
- **Question no. 1** will be **very short answer type** consisting of **five questions of 1 mark each.**
- **Question no. 2 & 3** will be of **short answer type** of **5 marks each**.
- **Group B** will contain **descriptive type six questions** of **15 marks** each, out of which **any four are to answer**.

Course objective:
The primary objective of the course is

- To introduce a fundamental understanding of various landforms formed by different agents, exogenic and endogenic forces, earths and its spheres along with generation and movement of several plates.

Learning outcomes:
After successfully completing this course, the students will be able to:

- On completion of the course the students are expected to gain knowledge of the earth and its spheres, various forces operating on it and geological work of various agents and concept of plate tectonics.

Skills to be Learned:

- To know various landforms formed by different agents, exogenic and endogenic forces, earths and its spheres along with generation and movement of several plates.

COURSE CONTENT:

Unit	Topic	Total no. of Lectures
Unit 1:	Introduction to Geomorphology, Endogenic and Exogenic processes, Basic principles of Geomorphology, geomorphological cycles, weathering and erosion; Geomorphic mapping- tools and techniques.	**12**
Unit 2:	Geoid, Topography, Hypsometry, Global Hypsometry; Major Morphological features Large Scale Topography - Ocean basins, Large scale mountain ranges (with emphasis on Himalaya).	**12**
Unit 3:	Surficial Processes and geomorphology: Weathering and associated landforms, Glacial, Periglacial processes and landforms, Fluvial processes and landforms, Aeolian Processes and landforms, Beach/Coastal Processes and	**12**

landforms, Landforms associated with igneous activities	
Unit 4: Endogenic- Exogenic interactions, Rates of uplift and denudation, Tectonics and drainage development, Sea-level change, Long-term landscape development, Types of Drainage Patterns, and Drainage analysis in Geological Interpretation	**12**
Unit 5: Overview of Indian Geomorphology. Application of Geomorphology in groundwater, mineral and oil exploration and Engineering projects.	**12**

Suggested Readings:

- *Robert S. Anderson and Suzzane P. Anderson (2010):*
- *Geomorphology - The Mechanics and Chemistry of Landscapes. Cambridge University Press. M.A. Summerfield (1991) Global Geomorphology. Wiley & Sons.*
- Allen, P., 1997. Earth Surface Processes. Blackwell
- Bloom, A.L., 1998. Geomorphology: A systematic Analysis of Late Cenozoic Landforms (3rd Edition). Pearson Education, Inc.
- Keary, P. and Vine, F.J., 1997. Global Tectonics. Blackwell and crustal evolution. Butterworth-Heinemann.
- Kale, V.S. and Gupta, A., 2001. Introduction to Geomorphology. Orient Longman Ltd.

Semester VI

Major – 14 (MJ - 14) HYDRO GEOLOGY
Credit – 4 **Lectures – 60 Hours**
FM= 100 **T= 100 {75Ext. +25 Int.}**

Instructions:

- There will be two groups of questions. **Group A** is compulsory which will contain **three questions**.
- **Question no. 1** will be **very short answer type** consisting of **five questions of 1 mark each.**
- **Question no. 2 & 3** will be of **short answer type** of **5 marks each**.
- **Group B** will contain **descriptive type six questions** of **15 marks** each, out of which **any four are to answer**.

Course objective:

The primary objective of the course is

- to introduce fundamental aspects of nature, occurrence and movement of groundwater in geological context; water bearing properties of formations, aquifer types and aquifer parameters;
- to understand about ground water exploration and management.

Learning outcomes:

After successfully completing this course, the students will be able to:

- On completion of the course the students are expected to gain knowledge of the fundamental concepts of hydrogeology, occurrence of groundwater, water bearing properties of formations, aquifer types and aquifer parameters;
- Apply the concepts of groundwater exploration in an integrated way; groundwater exploration methods, aspects of groundwater chemistry and groundwater management;

Skills to be Learned:

- To know the basic concepts of the fundamental concepts of hydrogeology, occurrence of groundwater, water bearing properties of formations, aquifer types and aquifer parameters
- To know the concepts of groundwater exploration in an integrated way; groundwater exploration methods, aspects of groundwater chemistry and groundwater management.

COURSE CONTENT:

Unit	Topic	Total no. of Lectures
Unit 1:	Hydrologic Cycle, Distribution of water in Earth crust, Groundwater in hydrologic cycle; Ground water, origin, types, importance; Aquifer, their types and characteristics; Hydrologic properties of aquifer materials: porosity; permeability; specific yield; specific retention, hydraulic conductivity, transmissivity, storage coefficient.	**12**

Unit 2: Forces and laws of groundwater movement; Darcy law and its application in hydrogeology; Confined, unconfined, steady, unsteady and radial flows of groundwater; Methods of pumping test and evaluation of aquifer parameters. Springs: types, origin and movement of water; Water Table map and its significance.	**12**
Unit 3: Hydrographic analyses, Water budget studies; Water resource inventory of the basin; Consumptive and conjunctive use of surface and groundwater; Causative factors for Water Table fluctuation. Wells: types, drilling methods, construction, design and development of wells.	**12**
Unit 4: Physical and Chemical characteristics of groundwater. Interpretation of chemical analysis. Relationship of quality to use. Ground water pollution; Sources of surface and subsurface pollution; Control of ground water pollution	**12**
Unit 5: Chemical characteristics of groundwater in relation to various uses – domestic, industrial and irrigation; Water contaminants and pollutants, natural (geogenic) and anthropogenic contaminants; Saline water intrusion in coastal and other aquifers and its prevention; Groundwater contamination and problems of arsenic and fluoride in Indian subcontinent with special reference to Jharkhand.	**12**

Books Recommended:

- *C.F. Tolman (1937): Groundwater, McGraw Hill , New York and London.*
- *D.K. Todd (1995): Groundwater HydrolGeology, John Wiley and Sons.*
- *F.G. Driscoll (1988): Groundwater and Wells, UOP, Johnson Div.St.Paul. Min. USA.*
- *H.M. Raghunath (1990): Groundwater, Wiley Eastern Ltd.,*
- *H.S. Nagabhushaniah (2001): Groundwater in Hydrosphere (Groundwater hydrolGeology), CBS*
- *K. R. Karanth (1989): HydroGeology, Tata McGraw Hill Publ*
- *S.N. Davies and R.J.N. De Wiest (1966): HydroGeology, John Wiley and Sons, New York.*
- *Patra, H. P., Adhikari, Shyamal Kumar, Kunar, Subrata (2016) Groundwater Prospecting and*
- *Management,Springer*
- *Jakeman, A.J., Barreteau, O., Hunt, R.J., Rinaudo, J.-D.,Ross, A. (2016) Integrated Groundwater Management:Concepts, Approaches and Challenges, Springer*
- *Ramanathan, A., Johnston, S., Mukherjee, A., Nath, B. (Eds.)2015, Safe and Sustainable Use of Arsenic- Contam*

Semester VI

Major – 15 (MJ – 15) (Practical) Paleontology, Geomorphology & Hydro Geology
Credit – 4 **Lectures – 60 x 2 =120 Hours**
P = 100 marks

Practical	**Marks Distribution**
1. **Paleontology Experiment:**	**20**
2. **Geomorphology Experiment**	**20**
3. **Hydro Geology practical**	**20**
4. **Class record**	**20**
5. **Viva Voce**	**20**
	Total=100

Suggested Practical

MJ 12: Paleontology

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

MJ 13: Geomorphology

1. 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.

MJ 14: Hydro Geology

1. Plotting of Ground water provinces of India in political map of India.
2. Study, preparation and analysis of hydrographs for differing groundwater conditions
3. Water potential zones of India (map study).
4. Hydrological Properties of rocks