Vidyasagar University

Curriculum for B.Sc. (Honours) in Geology [Choice Based Credit System]

Semester-V

Course	Course Code	Name of the Subjects	Course Type/ Nature	Teaching Scheme in hour per week			Credit	Marks
				L	T	P		
CC- 11		C11T: Hydrogeology	Core Course-11	4	0	0	6	75
		- Lab		0	0	4		
CC- 12		C12T: Economic Geology	Core Course-12	4	0	0	6	75
		- Lab		0	0	4		
DSE-1			Discipline Specific Electives -1	4	0	4	6	75
DSE-2			Discipline Specific Electives -2	4/5	0/1	4/0	6	75
Semester Total							**24**	**300**

L= Lecture, **T=** Tutorial, **P =** Practical, **CC -** Core Course, **TBD -** To be decided, **DSE:** Discipline Specific Elective.

Semester-V

List of Core Course (CC)

CC-11: Hydrogeology

CC-12: Economic Geology

Discipline Specific Electives (DSE)

DSE-1: Earth & Climate
Or
DSE-1: Introduction to Geophysics

DSE-2: Fuel Geology
Or
DSE-2: Evolution of life through time

SEMESTER –V

Core Courses (CC)

CC-11: Hydrogeology — Credits 06

C11T: Hydrogeology — Credits 04

Course Contents:

Unit 1: Introduction and basic concepts

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

2. Hydrologic cycle: precipitation, evapo-transpiration, run-off, infiltration and groundwater flow. Basic concept of hydrographs Origin of groundwater, Vertical distribution of subsurface water, Genetic classification of groundwater.
3. Classification of rocks with respect to water bearing characteristics, geomorphic and geologic controls of groundwater, Types of aquifer– unconfined, confined and semi-confined. Water table and piezometric surface. Groundwater provinces in India and West Bengal.
4. Rock properties affecting groundwater: Porosity, void ratio, specific retention and Storage coefficient - specific yield, specific storage and storativity, Anisotropy and heterogeneity of aquifers.

Unit 2: Groundwater flow

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

2. Intrinsic permeability and hydraulic conductivity, Transmissivity, Measurement of hydraulic conductivity in laboratory – Constant Head Permeameter and Falling (Variable) Head Permeameter. Water Table and Piezometric surface contour maps and Groundwater flow direction, Laminar and turbulent groundwater flow

Unit 3: Well hydraulics and Groundwater exploration

1. Basic Concepts (drawdown; specific capacity etc)

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

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

Unit 4: Groundwater chemistry

1. Physical, chemical and bacteriological properties of water and water quality
2. Introduction to methods of interpreting groundwater quality data using standard graphical plots
3. Elementary concept on Groundwater pollution: Arsenic, Fluoride and Nitrate, Sea water intrusion in coastal aquifers - Ghyben-Herzberg Relation

Unit 5: Groundwater management

1. Surface and subsurface water interaction. Recharge and discharge areas. Ground water level fluctuations. Effects of Climate Change on Ground water.
2. Basic concepts of water balance studies, issues related to groundwater resources development and management
3. Rainwater harvesting and artificial recharge of groundwater

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. Ltd.
4. Raghunath H, M. 2007, Groundwater, 3rd Ed. New Age International Publishers , New Delhi

C11P: Hydrogeology (Lab) Credits 02

List of Practical

1. Preparation and interpretation of depth to water level maps and water level contour maps. Study, preparation and analysis of hydrographs for differing groundwater conditions
2. Water potential zones of India (map study)
3. 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 and Groundwater flow

CC-12: Economic Geology Credits 06

C12T: Economic Geology Credits 04

Course Contents:

Unit 1: Ores and gangues

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

Unit 2: Mineral deposits and classical concepts of ore formation

1. Mineral occurrence, Mineral deposit and ore deposit
2. Historical concepts of ore genesis: Man's earliest vocation- Mining
3. Plutonist and Neptunist concepts of ore genesis
4. Metallogenic provinces and epochs

Unit 3: Mineral exploration

1. Exploration and exploitation techniques
2. Brief idea on: Remote Sensing, Geophysical and Geochemical Explorations
3. Geological mapping at different scales, drilling, borehole logs and transverse sections

Unit 4: Structure and texture of ore deposits

1. Concordant and discordant ore bodies
2. Endogenous processes: Magmatic concentration, skarns, greisens, and hydrothermal deposits
3. Exogenous processes: weathering products and residual deposits, oxidation and supergene enrichment, placer deposits,

Unit 5: Ore grade and Reserve

Assessment of ore grade and reserve, reserve estimation

Unit 6: Metallic and Non-metallic ores

1. Important deposits of India including atomic minerals: Study of geologic set up, mode of occurrence, mineralogy and genesis of the following ore deposits in India - Iron ore in Singhbhum and Karnatake, Manganese of Central India, Copper of Malanjkhand, lead-zinc of Zawar area, Uranium of Singh bhum.
2. Non-metallic and industrial rocks and minerals, in India.
3. Introduction to gemstones.

Suggested Readings:

1. 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.
2. Evans, A.M. (1993) Ore Geology and Industrial minerals. Wiley
3. Laurence Robb. (2005) Introduction to ore forming processes. Wiley.
4. Gokhale, K.V.G.K. and Rao, T.C. (1978) Ore deposits of India their distribution and processing, Tata-McGraw Hill, New Delhi.
5. Deb, S. (1980) Industrial minerals and rocks of India. Allied Publishers.
6. Sarkar, S.C. and Gupta, A. (2014) Crustal Evolution and Metallogeny in India. Cambridge Publications.

C12P: Economic Geology (Lab) **Credits 02**

List of Practical

1. Hand sample identification of important ores and non-metallic minerals
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

Discipline Specific Electives (DSE)

DSE-1: Earth & Climate **Credits 06**

DSE1T: Earth & Climate **Credits 04**

Course Contents:

Unit 1: Climate system: Forcing and Responses

1. Components of the climate system.
2. Climate forcing, Climate controlling factors.
3. Climate system response, response rates and interactions within the climate system.
4. Feedbacks in climate system.

Unit 2: Heat budget of Earth

1. Incoming solar radiation, receipt and storage of heat transformation
2. Earth's heat budget. Interactions amongst various sources of earth's heat

Unit 3: Atmosphere – Hydrosphere

1. Layering of atmosphere and atmospheric Circulation
2. Atmosphere and ocean interaction and its effect on climate
3. Heat transfer in ocean
4. Global oceanic conveyor belt and its control on earth's climate
5. Surface and deep circulation
6. Sea ice and glacial ice

Unit 4: Response of biosphere to Earth's climate

1. Climate Change: natural vs. anthropogenic effects
2. Humans and climate change
3. Future perspectives
4. Brief introduction to archives of climate change
5. Brief introduction to palaeoclimate
6. Paleoclimate data from India

Unit 5: Orbital cyclicity and climate

1. Milankovitch cycles and variability in the climate
2. Glacial-interglacial stages
3. The Last Glacial maximum (LGM)
4. Pleistocene Glacial-Interglacial cycles
5. Younger Dryas
6. Isotope Palaeontology

Unit 6: Monsoon

1. Mechanism of monsoon
2. Monsoonal variation through time
3. Factors associated with monsoonal intensity
4. Effects of monsoon

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 Environmental Geology – an Earth System Science Approach, by – Dorothy J. Merritts, Andrew De Wet & Kristen Menking,W.H. Freeman & Company, New York.

DSE1P: Earth & Climate (Lab) Credits 02

List of Practical

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

Or

DSE-1: Introduction to Geophysics Credits 06

DSE1T: Introduction to Geophysics Credits 04

Course Contents:

Unit 1: Geology and Geophysics

1. What is geophysics?
2. Interrelationship between geology and geophysics

Unit 2: General and Exploration geophysics

1. Different types of geophysical methods - gravity, magnetic, electrical and seismic; Principles of different methods. Applications of different methods.Elements of well logging.
2. Corrections in geophysical data

Unit 3: Geophysical field operations

1. Data acquisition and Processing. Data reduction.Signal and noise.
2. Different types of surveys, grid and route surveys, profiling and sounding techniques
   a. Scales of survey
   b. Presentation of geophysical data

Unit 4: Application of Geophysical methods

1. Regional geophysics, oil and gas geophysics, ore geophysics, groundwater geophysics, engineering geophysics
2. Geological interpretation of geophysical data

Unit 5: Geophysical anomalies

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

2. Depth of exploration

Unit 6: Integrated geophysical methods

Ambiguities in geophysical interpretation, planning and execution of geophysical surveys

Suggested Reading:

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

DSE1P: Introduction to Geophysics (Lab) Credits 02

List of Practical

1. Anomaly and background- Graphical method.
2. Study and interpretation of seismic reflector geometry.
3. Gravity anomaly: Problems on gravity anomaly.

DSE-2: Fuel Geology Credits 06

DSE2T: Fuel Geology Credits 04

Course Contents:

Unit 1: Energy Resources

Different Sources of energy: Global and Indian scenario

Unit 2: Coal

1. Definition and origin of Coal
2. Basic classification of coal.
3. Fundamentals of Coal Petrology - Introduction to lithotypes, microlithotypes and macerals in coal

4. Proximate and Ultimate
5. Major coal basins of India

Unit 3: Coal as a fuel

1. Concept of clean coal technology
2. Coal Bed Methane (CBM): global and Indian scenario
3. Underground coal gasification
4. Liquefaction of coal

Unit 4: Petroleum

1. Chemical composition and physical properties of crudes oil
2. Origin and migration of petroleum
3. Kerogen: Maturation of kerogen; Biogenic and Thermal effect

Unit 5: Petroleum Reservoirs and Traps

1. Reservoir rocks: general attributes and petrophysical properties.
2. Cap Rocks: definition and general properties
3. Hydrocarbon traps: definition, Classification of hydrocarbon traps - structural, stratigraphic and combination
   a. Time of trap formation and time of hydrocarbon accumulation.
   b. Plate tectonics and global distribution of hydrocarbon reserves
   c. Petroliferous basins of India

Unit 6: Other fuels

1. Nuclear Fuel
2. Gas Hydrate

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.Bastia,
4. R., &Radhakrishna, M. (2012). Basin evolution and petroleum prospectively ofthe continental margins of India (Vol. 59).Newness.

DSE2P: Fuel Geology (Lab) Credits 02

List of Practical

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

OR

DSE-2: Evolution of life through time **Credits 06**

DSE2T: Evolution of life through time **Credits 06**

Suggested Readings:

Unit 1: Life through ages

1. Fossils and chemical remains of ancient life.
2. Geological Time Scale with emphasis on major bio-events.
3. Biomineralization and skeletalization

Unit 2: Principles of evolution

1. Mechanism of evolution
2. Evolutionary lineages
3. Species as basic unit of lineage
4. Constraints in lineage reconstruction

Unit 3: Geobiology

1. Biosphere as a system, processes and products
2. Biogeochemical cycles
3. Abundance and diversity of microbes, extremophiles Microbes-mineral interactions,microbial mats

Unit 4: Origin of life

1. Possible life sustaining sites in the solar system, life sustaining elements and isotoperecords
2. Archean life: Earth's oldest life, Transition from Archean to Proterozoic, theoxygen revolution and radiation of life
3. Precambrian macrofossils – The garden of Ediacara The Snow Ball Earth Hypothesis

Unit 5: Paleozoic Life

1. The Cambrian Explosion.
2. Origin of vertebrates and radiation of fishes
3. Origin of tetrapods - Life out of water
4. Early land plants and impact of land vegetation

Unit 6: Mesozoic Life

1. Life after the largest (P/T) mass extinction, life in the Jurassic seas Origin of mammals
2. Rise and fall of dinosaurs
3. Origin of birds; and spread of flowering plants

Unit 7: Cenozoic Life

1. Aftermath of end Cretaceous mass extinction – radiation of placental mammals Evolutionof modern grasslands and co-evolution of hoofed grazers
2. Rise of modern plants and vegetation Back to water – Evolution of Whales

Unit 8: The age of humans

1. Hominid dispersals and climate setting
2. Climate Change during the Phanerozoic - continental break-ups and collisions Platetectonics and its effects on climate and life.
3. Effects of life on climate and geology

Unit 9: Applications of Evolution

1. Biostratigraphy and Chronostratigraphy in the context of organic evolution
2. Role of fossils in correlation
3. Basis of stage boundaries in the Phanerozoic.

Suggested Readings:

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