

**M.Sc. GEOLOGY**  
**Semester III**

Theory Paper/ Practical	Title	Teaching Scheme (Hrs/ week)			Credits	Examination Scheme					
		Th	Pr.	Total		Duration (Hrs)	Max. Marks		Total Marks	Min. Passing Marks	
							External	Internal		Th	Pr.
Paper-I	Fuel Geology (Coal, Petroleum and Nuclear) (2+1+1)	4		4	4	3	80	20	100	40	
Paper-II	Environmental Geology & Engineering Geology (2+2)	4		4	4	3	80	20	100	40	
Paper-III	Geomorphology, Remote Sensing and GIS (1+2+1)	4		4	4	3	80	20	100	40	
Paper-IV	Hydrogeology & Watershed Management (3+1)	4		4	4	3	80	20	100	40	
Practical I	Fuel Geology, Environmental Geology & Engineering Geology (Marks: 75 Pract. Exam. + 05 viva-voce + 20 Internal Assessment and Class Record)		8	8	4	3	80	20	100		40
Practical II	Geomorphology, Remote Sensing, GIS, Hydrogeology & Watershed Management (Marks: 75 Pract. Exam. + 05 viva-voce + 20 Internal Assessment and Class Record)		8	8	4	3	80	20	100		40
	Seminar	2		2	1	---		25	25	10	
	<b>Total</b>	<b>18</b>	<b>16</b>	<b>34</b>	<b>25</b>		<b>480</b>	<b>145</b>	<b>625</b>	<b>170</b>	<b>80</b>

## **Paper I**

### **Fuel Geology (Coal, Petroleum and Nuclear)**

#### **Unit I:**

Origin of coal; Sedimentology of coal bearing strata; Structures associated with coal seams; Proximate and Ultimate analysis of coal; Rank, grades and types of coal; Indian and International classification for coking and non-coking coals; Coal preparation: coal carbonization, coal gasification, underground coal gasification (UCG), coal hydrogenation and coal combustion.

#### **Unit II:**

Coal Petrology – concept of 'lithotype', 'maceral' and 'microlithotype'; Classification and optical properties of macerals and microlithotypes; Techniques and methods of coal microscopy. Reflectance and fluorescence microscopy; Application of coal petrology for different industrial purposes; Geological and geographical distribution of coal and lignite deposits in India; Coal exploration and estimation of coal reserves; Indian coal reserves and production of coal in India; Coal Bed Methane (CBM): Generation, retention and exploration of methane from coal beds.

#### **Unit III:**

Petroleum: Different states, natural occurrences, chemical composition and physical properties of different fractions; Origin of Petroleum: Transformation of organic matter into kerogen, organic maturation, thermal cracking of kerogen; Migration of oil and gas; Reservoir rocks: General attributes and petrophysical properties; Classification of reservoir rocks- fragmental reservoir rocks and chemical reservoir rocks; Reservoir fluids- water, oil and gas; Hydrocarbon traps: Structural, stratigraphic and combination traps; Cap rock: Definition and general properties; Petroliferous basins of India; Elements of petroleum exploration; Hydrocarbons: Present status and future prospects.

#### **Unit IV:**

Mineralogy and geochemistry of radioactive minerals; Mode of occurrence, origin, association and distribution of atomic minerals in nature (U, Th, Be, rare metals and REE etc); Atomic minerals as source of energy; Metallogenic epochs and provinces of uranium mineralisation; Principles and methods of exploration for radioactive mineral deposits; Radiometric surveys: Methods of detection and

measurement of radioactivity; Geiger Muller Counters and Scintillation Counters; Gamma ray logging of bore holes; Application of radioactivity in geochronometry; Uranium and thorium exploration in India; Productive geological horizons in India; Atomic fuels and environment; Nuclear power stations of India and future prospects.

### **Practicals**

Macroscopic characterization of banded coals; Completion of outcrop in the given maps and calculation of coal reserve; Preparation of polished particulate mounts of coal; Microscopic examination of polished particulate mounts (identification of macerals); Proximate analysis of coal; Laboratory analysis related to coal bed methane studies.

Study of geological maps and sections of important oil fields of India; Calculation of petroleum reserves; Problems on classification of oil field water based on chemical composition.

Megascopic identification of common minerals used in atomic industry.

### **Books Recommended:**

#### **Coal Geology:**

Taylor, G.H., Teichmuller, M., Davis, A., Diessel, G.F.K., Littke, R. and Robert, P. (1998) Organic Petrology, Gebruder Borntraeger, Stuttgart.

Chandra, D., Singh, R.M. and Singh, M.P. (2000) Textbook of Coal (Indian Context), Tara Book Agency, Varanasi.

Singh, M.P. (Ed.) (1998) Coal and Organic Petrology, Hindustan Publ. Corp., New Delhi.

Stach, E., Mackowsky, M.T.H., Taylor G.H., Ghandra, D., Telchmuller, M. and Telchmuller, R. (1982) Stach's Text Book of Coal Petrology, Gebruder Borntraeger, Stuttgart.

Acharyya, S.K. (2000) Coal and Lignite Resources of India: An overview, Geological Society of India, Bangalore.

Francis, W. (1961) Coal, Edward Arnold Ltd.

Scott, A.C. (1987) Coal and Coal-bearing strata: Recent Advances, Blackwell Scientific Publications.

Thomas, Larry (2002) Coal Geology, John Wiley and Sons Ltd., England.

Van Krevelen, D.W. (1993) Coal: Typology-Physics-Chemistry-Constitution, Elsevier Science, Netherlands.

Stach, E. et al. (1975) Stach's textbook of coal petrology. Berlin: Gebruder Borntraeger.

Taylor, G.H., Teichmüller, M. and Davis, C. (1998) Organic Petrology: A new handbook incorporating some revised parts of Stach's Textbook of Coal Petrology.

#### **Petroleum Geology:**

Levenson, A.L. (1970) Geology of Petroleum, Freeman and Company.

North, F.K. (1985) Petroleum Geology, Allen and Unwin.

Holson, G.D. and Tiratsoo, E.N. (1985) Introduction to Petroleum Geology, Gulf Publ. Houston, Texas.

Tissot, B.P. and Welte, D.H. (1984) Petroleum Formation and Occurrence, Springer- Verlag.  
Selley, R.G. (1998) Elements of Petroleum Geology, Academic Press.

**Nuclear Geology:**

Durrance, E.M. (1986) Radioactivity in Geology, Principles and Application. Ellis Horwood.  
Dahlkamp, F.J. (1993) Uranium Ore Deposits, Springer Verlag.  
Boyle, R.W. (1982) Geochemical Prospecting for Thorium and Uranium Deposits, Elsevier.  
Aswathanarayana, U. (1985) Principles of Nuclear Geology, Oxford Press.

**Paper II**

**Environmental Geology and Engineering Geology**

**Unit I:**

Components of environmental geology; Time scales of global changes in the ecosystem and climate; Major icehouse and greenhouse periods; Impact of oceanic and atmospheric circulation on climate and rain fall; Methodologies for estimation of present and past atmospheric carbon-dioxides; CO<sub>2</sub> increase and global warming in the present and past atmospheres; Physical, chemical and biological domains of environment; Air, water and noise pollution, their causes and remedial measures; Surface weathering, development of soil and soil pollution; Pollution in the mining areas.

**Unit II:**

Earthquake and tsunami – causes and their impact on environment; Seismic hazard zones; Neotectonics in seismic hazard assessment; Landslide and volcanic hazards their causes and control; Coastal erosion, its causes and control; Major river belts of India, flood hazards and their mitigation; Problems of urbanization, human population and their impact on environment; Alternative sources of energy; Waste disposal and related problems; Environmental legislations.

**Unit III:**

Scope of geology in civil engineering and mining industry; Various stages of engineering geological investigations for civil engineering projects; Engineering properties of rocks and soils; Rock

discontinuities; Physical characters of building stones, metal and concrete aggregates; Use of remote sensing in engineering geology.

#### **Unit IV:**

Geological investigations for the various engineering projects: dams, reservoirs, landslides, tunnels, highways, bridges, hydroelectric power projects, shoreline and airfield engineering; Earthquake and seismicity, seismic zones of India, aseismic design of building; Exploratory drilling: study and construction of subsurface sections based upon drilling data; Core logging: core recovery, preservation of cores, R.Q.D. analyses; Preparation and presentation of geotechnical reports.

#### **Practicals:**

##### **Environmental Geology:**

Preparation of seismic zonation maps of India; Demarcation of landslide prone areas in the Himalaya; Demarcation of flood prone areas in the outline map of India; Preparation of volcanic hazard zonation map; Preparation of oceanic and atmospheric circulation maps.

##### **Engineering Geology:**

Study of engineering properties of rocks/ soil with reference to their use in engineering projects; Study of models and maps of important engineering structures; Interpretation of geological maps for various engineering geology projects; Preparation of subsurface sections based on drilling data; RQD analysis.

#### **Books Recommended:**

##### **Environmental Geology:**

- Bell, F.G. (1999) Geological Hazards, Routledge, London.  
Bryant, E. (1985) Natural Hazards, Cambridge Univ. Press.  
Keller, E.A. (1978) Environmental Geology, Bell and Howell, USA.  
Lal, D.S. (2007) Climatology, Sharda Pustak Bhawan, Allahabad.  
Perry, C.T. and Taylor, K.G. (2006) Environmental Sedimentology, Blackwell Publ.  
Patwardhan, A.M. (1999) The Dynamic Earth System, Prentice Hall.  
Smith, K. (1992) Environmental Hazards, Routledge, London.  
Subramaniam, V. (2001) Textbook in Environmental Science, Narosa International.  
Valdiya, K.S. (1987) Environmental Geology – Indian Context, Tata McGraw Hill.

##### **Engineering Geology:**

- Bell, F.G. (1981) Engineering properties of Soils and Rocks, Butterworths Publication, London.  
Bell, F.G. (1993) Fundamentals of Engineering geology, Butterworths Publication, London.  
Garg, S.K. (2009) Physical and Engineering Geology, (6<sup>th</sup> Ed.), Khanna Publishers, New Delhi.

GSI (1975) Engineering Geology Case Histories, Geological Survey of India, Misc. Publ., No. 29.

Gupte, R.B. (2002) Text Book of Engineering Geology. Vidyarthi Griha Prakashan, Pune.

Keary, P., Brooks, M. and Hill, I. (2002) An introduction to geophysical exploration, (3<sup>rd</sup> Ed.), Blackwell.

Kesavulu, N.C. (2009) Textbook of engineering geology, (2<sup>nd</sup> Ed.), Macmillan Publishers India Ltd.

Krynine, D.P. and Judd, W.R. (1998) Principles of Engineering Geology and Geotechnics. CBS Publishers & Distributors, New Delhi.

Reddy, D.V. (1998) Engineering Geology for Civil Engineering. Oxford & IBH Pub.Co. Pvt. Ltd., Delhi.

Rider, M.H. (1986) The Geological Interpretation of Well Logs. (Rev. Ed.) Whittles Publishing, Caithness.

Ries, H. and Watson, T.L. (1947) Elements of Engineering Geology (2<sup>nd</sup> Ed.). John Wiley & Sons, New York.

Schultz, J.R. and Cleaves, A.B. (1951) Geology in Engineering. John Willey and Sons, New York.

Singh, P. (1994) Engineering and General Geology. S.K. Kataria and Sons, Delhi.

Telford, W.M., Geldart, L.P., Sherrif, R.E. and Keys, D.A. (1976) Applied Geophysics, Cambridge Univ. Press.

Verma, B.P. (1997). Rock Mechanics for Engineers (3<sup>rd</sup> Ed.), Khanna Publishers, New Delhi.

Wittke, Walter (1990). Rock Mechanics: Theory and Applications with case Histories, Springer –Verlag Publication.

### **Paper III**

#### **Geomorphology, Remote Sensing and GIS**

##### **Unit I:**

Geomorphic concepts; Landforms: Role of Lithology, peneplanation, endogenous and exogenous forces responsible, climatic and tectonic factors and rejuvenation of landforms; Denudational processes: Weathering, erosion, transportation, weathering products and soil formation, slope processes; Drainage basin morphometry; Major processes and associated landforms: Tectonic, fluvial, aeolian, coastal, karst and glacial; Geomorphic features and zones of India.

##### **Unit II:**

Fundamentals of EMR, radiation laws, black and grey body radiation, atmospheric effect in remote sensing; Interaction of EMR with atmosphere and Earth surface; Interaction of TIR wavelength with terrain feature and vegetation; Interaction of Microwave with Earth surface.

Aerial photography: Sequence involved in the aerial photography: Classification, types, stereoscopy, geometrical characteristic, film and filter; Instrumentation and vertical exaggeration; Calculations of heights and slopes from aerial photographs; Principles of photogrammetry; Aerial photo interpretation – photo recognition elements and Interpretation of different geological features on B/W aerial photographs.

#### **Unit III:**

Orbit and Sun-synchronous aspect of satellite; Remote Sensing Sensor: Platforms and sensor resolution and calibration aspects of remotely sensed data, microwave sensor and False Colour Composite (FCC); Fundamentals of digital image processing: Image rectification, Image enhancement and Image classification; TIR remote sensing and its applications; Principle of microwave remote sensing and its applications; Geological applications of remote sensing; LANDSAT, SKYLAB, SPOT, SEASAT, ICONOS and other foreign systems of satellites and their interpretation for geological studies; Space research in India: Bhaskara, IRS series and their applications.

#### **Unit IV:**

Principles and components of GIS; Geospatial data, data for GIS application, spatial data models and data structures; Vector and raster based GIS; Spatial data acquisition, Vector overlay analysis; Neighbourhood Operation; Raster spatial analysis; Buffer analysis; Visualization and query of spatial data; Overlay analyses; Terrain analysis (DEM); Line generation; Introduction to GIS and remote sensing software; Geological applications of GIS; Principle and application of GPS.

#### **Practicals:**

##### **Geomorphology, Remote Sensing and GIS:**

Topographical map interpretation for different landforms; Analysis of weathering trends; Drainage basin morphometry; Relief and slope analyses; Determination of photo scale, aerial photo interpretation for geological and geomorphological applications, parallax measurements for height determination, dip and thickness of beds; Study of landforms and interpretation of lithology and structure from aerial photograph and satellite images; Tracing of lineament and rosettes; Identification of landform on toposheets, aerial photographs and satellite images; Generation of DEM and DTM; FCC interpretation of satellite images; Image processing and GIS software.

#### **Books Recommended:**

##### **Geomorphology:**

Sharma, H.S. (1990) Indian Geomorphology, Concept Publishing Company, New Delhi  
Thornbury, W.D. (1980) Principles of Geomorphology, Wiley Easton Ltd., New York

Kale and Gupta, Introduction to Geomorphology.

Rice, Fundamentals of Geomorphology.

### **Remote Sensing and GIS:**

Lattman, L.H. and Ray, R.G. (1965) Aerial photographs in field geology, McGraw Hill.

Pande, S.N. (1987) Principles and Applications of Photogeology, Wiley Eastern Limited.

Drury, S.A. (1997, 2001) Image Interpretation in Geology, Chapman and Hall, London.

Gupta, R.P. (1991) Remote Sensing Geology, Springer-Verlag.

Lillesand, T.M. and Kiefer, R.W. (2000) Remote Sensing and Image Interpretation, John Wiley and Sons Inc., New York.

Siegal, B.S. and Gillespie, A.R. (1980) Remote Sensing in Geology, John Wiley.

Miller, V.C. (1961) Photogeology, McGraw Hill

Sabins, F.F. Jr. (2000) Remote Sensing Principles and Interpretations, W.H. Freeman & Company, USA.

Berhardsen, T. (1999) Geographic Information System: an introduction, Wiley, New York

Curran, P.J. (1985) Principles of Remote Sensing, Longman Scientific & Tech. Group, Essex, England

Richards, J.A. (1986) Remote Sensing Digital Analysis: an introduction, Springer-Verlag, Berlin.

Burrough, P.P. and MacDonnel, R.A. (1998) Principles of GIS, Oxford University Press.

Ray, R.G. (1969) Aerial Photographs in Geologic Interpretations, USGS Proc Paper 373

Mikhail, E.M. (1980) Photogrammetry, Harper and Row

Paine, D.P. (1981) Aerial photography and Image Interpretation for Resource Management, John Wiley.

Jensen, J.R. (1986) Introductory Digital Image Processing: A Remote Perspective. Prentice Hall, New Jersey.

Jain, A.K. (1989) Fundamentals of digital image processing, Prentice Hall India.

Bonham-Carter, G.F. (1994) Geographic Information System for Geoscientists: Modelling with GIS, Pergamon.

Maguire, D.J., Goodchild, M.F. and Rhind, D.W. (1991) GIS - Principles and Applications, Longman Scientific and Technical.

Burrough, P.A. (1986) Principles of Geographical Information Systems for land resources assessment. Clarendon Press, Oxford.

## **Paper IV**

### **Hydrogeology and Watershed Management**



**Unit I:**

Hydrological cycle; Controls of geology on groundwater occurrence, movement and distribution; Classification of aquifers and aquifer systems; Mode of occurrence of groundwater in different geological formations and groundwater provinces of India; Darcy's law and Reynolds number; Aquifer parameters; Water table contour maps and flow net analysis; Seepages and springs.

**Unit II:**

Groundwater quality and environmental aspects; Chemical characteristics of groundwater in relation to various uses – domestic, industrial and irrigation; Saline water intrusion in coastal and other aquifers and its preventive measures; Environmental effects of over-exploitation of groundwater; Water logging problems; Causative factors of groundwater level fluctuations and environmental influences; Radioisotopes in hydrogeological studies.

**Unit III:**

Surface and subsurface methods of groundwater exploration; Application of remote sensing in groundwater exploration; Collection of hydrogeological data and preparation of hydrographs; Selection of suitable site for well construction; Type and design of wells, methods of well construction, well completion and well development; Pump tests and evaluation of hydrologic properties through various methods for steady and unsteady flow.

**Unit IV:**

Artificial recharge to groundwater and rainwater harvesting; Management of groundwater resources; Conjunctive use of groundwater and surface water; Concept of watershed: Watershed characters, importance of water resources; Technical aspects of artificial recharge structures; Groundwater legislation; Role of NGOs and government policies in watershed development.

**Practicals:**

Delineation of hydrological boundaries on water-table contour maps and estimation of permeability; Determination of groundwater flow direction; Problems in calculating transmissivity, specific retention and specific yield; Interpretation of well inventory data; Analysis of hydrographs and estimation of infiltration capacity; Pumping test: time-drawdown and time-recovery tests and evaluation of aquifer parameters; Step drawdown tests, Electric resistivity sounding for delineation of fresh aquifers; Study of geophysical well logs; Estimation of TDS using resistivity and SP logs; Exercises on groundwater exploration using remote sensing techniques; Water budgeting problems.

**Books Recommended:**

Davies, S.N. and De Wiest, R.J.N. (1966) Hydrogeology, John Wiley and Sons, New York.

Driscoll, F.G. (1988) Groundwater and Wells, UOP, Johnson Div. St. Paul. Min. USA.  
Karanth, K. R. (1989) Hydrogeology, Tata McGraw Hill Publishers.  
Nagabhushaniah, H.S. (2001) Groundwater in Hydrosphere (Groundwater hydrology), CBS Publ.  
Raghunath, H.M. (1990) Groundwater, Wiley Eastern Ltd.,  
Todd, D.K. (1995) Groundwater Hydrology, John Wiley and Sons.  
Tolman, C.F. (1937) Groundwater, McGraw Hill, New York and London.