

## SEMESTER – III

### GL 301: INDIAN STRATIGRAPHY (4 Credits)

- Precambrian Stratigraphy of India –Part 1- Archaeans** **15**
- Precambrian stratigraphic framework of India
  - Classification, structure and tectonics of the Dharwar craton
  - Ancient Supracrustal (Sargur Type)
  - Gold bearing schist belts of Eastern Karnataka (Kolar Type)
  - Younger Schist belts (Dharwar Type)
  - Gneiss Complex, Granulites, charnockites
  - Structure, tectonics and stratigraphy of the OMG, OMTG, Iron Ore Group (Singbhum Craton)
  - Stratigraphy of the Sukma, Bengpal, and Bailadila series from Central India
  - Ancient granites, viz. Singbhum, Chitradurga, etc.
  - Archaeans of the Extra Peninsular region
- Precambrian stratigraphy of India-Part 2- Proterozoic** **15**
- Archaean-Proterozoic boundary
  - Stratigraphy, geology, tectonics and evolution of the following Proterozoic basins / Purana formations in India
    - ❑ Delhi-Aravalli Supergroup
    - ❑ Singbhum Group
    - ❑ Sausar-Sakoli Groups
    - ❑ Vindhya
    - ❑ Cuddapah
    - ❑ Pranhita-Godavari
    - ❑ Bhima
    - ❑ Kaladgi
- Phanerozoic stratigraphy of the Extra peninsular region** **15**
- Paleozoic stratigraphy of Himalayan sequences from Kashmir, Spiti, Kumaon region, Cambrian of Spiti, Triassic of Spiti, Triassic of Pin valley
  - Geology of the Indus Ophiolite belt, the Indus Group and Sangeluma Group
  - Geology of the Shyok Ophiolite belt
  - The Trans-Himalayan & Karakoram granite batholith
  - Stratigraphy and tectonics of the Siwaliks
- Phanerozoic stratigraphy of the Peninsular India** **15**
- Gondwana Nomenclature, litho-bio-stratigraphy, age limits, correlation
  - Jurassic of Kutch
  - Cretaceous of South India
  - Cretaceous of Narmada valley
  - Stratigraphy of the Deccan Volcanic Province
  - Cretaceous-Tertiary boundary
  - Quaternaries of Peninsular India

- Neogene-Quaternary boundary

## **GL 302 : EXPLORATION METHODS (4 credits)**

### **Gravity and Magnetic Methods**

**15**

- Concept of scientific methods of exploration- Geophysical and Geochemical exploration
- Principles of Exploration Geophysics concept of Geophysical Anomaly – factors controlling Geophysical Anomalies
- Gravity method – Principles behind gravity method Relative measurement of earth gravity – Types of gravimeter – Field procedure corrections to gravity data – concept of Bouguer Anomaly - Generalized interpretation of Gravity data- salient case studies
- Magnetic Method Principles of magnetic method – main and anomalies magnetic field associated with the earth – concepts of total field intensity, intensity of magnetization and magnetic susceptibility measurement of magnetic field- Types of magnetometers – Magnetic anomalies and their interpretation – salient case studies

### **Seismic and Electric Methods**

**15**

- Seismic Method Principles of seismic method – Types of seismic waves, movement of seismic waves within subsurface – Seismic instruments and field procedures
- Seismic Reflection Method : Principles of reflection method – zero offset time – NMO- CDP and multiple coverage techniques
- Seismic Refraction Method Principles of refraction method single and multiplayer refraction measurement of seismic velocities and layer thickness
- Processing of seismic data – salient case studies
- Electric Method – Principles of electrical method – electrical properties of rocks
- Resistivity Method – factors controlling resistivity of rocks measurement of resistivity – Electrode configurations and field procedures – Interpretation of resistivity data – salient case studies
- Self potential method – origin of self potential instrumentation and field procedure – salient case studies

### **Electrical Methods II and well logging**

**15**

- Induced polarization method – electrolytic and electrode polarization – instruments and field procedure – salient case studies
- Electromagnetic Method – Principles – instruments – parallelline and Horizontal loop method-salient case studies
- Well logging – techniques – principles and instrumentation of electrical, radioactive, sonic, caliper logging techniques interpretation of logs

### **Geochemical Methods**

**15**

- Geochemical methods – Geochemical cycle – Dispersion patterns – Geobotanical indicators of minerals – surface and subsurface methods of sampling
- Geological Principles of ore search – Introduction to Assaying and valuation of mineral deposits

## GL-303: PETROLEUM GEOLOGY (4 Credits)

### **Occurrence and Source rocks** 15

- Classification and composition of Petroleum
- Physical properties of petroleum
- Occurrence of petroleum
- Nature of source rock, composition of biomass
- Kerogen : Composition and types

### **Reservoir, Traps, Origin & Migration** 15

- Reservoir rocks, pore space and fluids
- Reservoir Traps
- Origin, migration and accumulation of petroleum

### **Prospecting, Drilling and Logging** 15

- Geophysical prospecting for petroleum
- Drilling, logging and subsurface correlation

### **Indian Oil fields** 15

- Oil bearing basins of India and the world
- India's position as regards to petroleum and natural gas future prospects

## GL 304: ENVIRONMENTAL GEOLOGY (4 CREDITS)

### **Introduction to Environmental Geology and its scope:** 15

- Fundamental concepts of environmental geoscience, its scope and necessity
- Definition, structure, composition and general characteristics of lithosphere, hydrosphere, atmosphere and biosphere
- Concept of ecology, ecosystem, its structure and functions, types of ecosystem
- Biogeochemical cycles of carbon, nitrogen, phosphorus and sulfur

### **Environmental issues** 15

- Water pollution and other issues : Drinking water sources, quality criteria and standards, characteristics of water, types of water pollution, groundwater pollution sources, pathways and mechanism, attenuation processes, case histories of natural (arsenic and fluoride poisoning) and man-made water pollution water logging, causes, effects and remedial measures, declining groundwater tables, subsidence and compaction of aquifers
- Soil pollution : Soil formation, classification and properties, soil salinity and alkalinity, characteristics of saline / alkali soils, soil amendments. Soil pollution sources, causes and effects. Soil pollution control measures.
- Air pollution : definition, terminology, sources and classification of air pollutants, effects of air pollution, acid rain, green house effects and ozone layer depletion. Air pollution control and management

**Natural hazards, zoning, risk assessment and management** **15**

- Extreme events and hazards, catastrophic geological hazards, study of landslides, subsidence, floods, droughts, earthquakes, volcanoes, their causes, classifications, assessment, prediction and prevention. Coastal hazards, cyclones, tsunamis, and shoreline and sea level changes. Strategies for hazard mitigation

**Mining and Environment** **15**

- Mining and its impact on environment, wastes from mining industry, waste disposal methods, acid mine drainage, heavy metal pollution due to mining, environmental impacts of coal utilization, fly ash, recycling of resources and management

**GL-306: FIELDWORK COMPONENT (1 CREDIT)**

**GL-307: ISOTOPE GEOCHEMISTRY (2 Credits)**

**Fundamentals of Isotope Geochemistry & Geochronology** **15**

- Discovery of radioactivity, its impact on Geology
- Law of radioactivity & its mathematical base
- Nuclear systematics, atomic structure of atom
- Decay mechanisms of radioactive atoms
- Radioactive Decay and growth. Radioactive & stable isotopes
- Principles of mass spectrometry & its applications

**Isotopic methods of age determinations of rocks** **15**

- Derivation of equation of age based on law of radioactivity
- Rb-SR, K-Ar, U-Th-Pb, C-14, U-Series disequilibrium methods of age determinations of rocks
- Applications of above methods for determining ages of igneous, metamorphic and sedimentary rocks
- Stable isotopes and their applications
- Oxygen and hydrogen in the hydrosphere and the atmosphere ;
- Fractionation of stable isotopes, Snow & ice stratigraphy,
- Palaeoclimatology geothermal waters etc & use of stable isotopes
- Oxygen & hydrogen in ore deposits, igneous and sedimentary rocks & petrogenesis etc.
- Sulfur isotopes their biogenic fractionation, sulfide ore, deposits & isotope fractionation
- Carbon in modern biosphere & fossil fuels, Marine and non-marine carbonates, carbon in igneous rocks, hydrothermal and ore deposits etc.

**GL-308: QUATERNARY GEOLOGY AND CLIMATE CHANGE (2 Credits)**

**The Concept of Quaternary Geology and Climate Change:** **15**

Quaternary as chronostratigraphic unit, Standard sub-divisions of the Quaternary period and their climatic significance, standard global stratotype sections, Plio-Pleistocene boundary, Glacial-Interglacial stages, Marine Oxy Isotope (MIS) stages and sea level oscillations, Archeological sub-divisions of Quaternary.

The concept of modern climate, climate dynamics, factors controlling the climate change, its cyclicity and climate deteriorations with special emphasis on Asian Monsoon.

Linkage of the modern climate to past climatic variations (with special emphasis on the Late Pleistocene-Holocene period)

The concept of local, regional and global climatic changes, the long term and abrupt changes during Quaternary with special emphasis to tropical-Subtropical climate.

An overview of the processes and mechanism of the Quaternary sedimentation over Indian sub-continent in relation to its climatic and/or tectonic controls.

Stratigraphic relations of the Quaternary deposits in India with special emphasis on its regional and global correlations.

Fluvial, Fluvio-lacustrine, glacial and glacio-lacustrine-fluvial and Deserts and their response to tectono-climatic changes with special emphasis on Ganga basin, Thar desert and Himalayan Quaternary sequences.

### **Quaternary Records and Methods:**

**15**

Mechanism and style of climatic response in the natural systems: a) Marine, b) Ice sheets/glaciers, c) Lacustrine, d) Fluvial and aeolian (including pedogenic), e) Tree rings/vegetation and f) migrations (/radiation) of animal, human and plant communities.

Research history and current trends in understanding the climate forcing mechanisms for major climatic changes.

Records of Climate change and Tectonics with special reference to Himalaya and Tibetan plateau.

Climate adaptability and extinction of species during Quaternary period.

Introduction to Quantitative methods in Quaternary Geology:

Quaternary Geochronology and Stratigraphic Correlation methods: Exposure dating methods (Luminiscence Dating, Cosmogenic radionuclides, lichenometry, U-Series), Pb<sup>210</sup>, ESR dating, Environmental Magnetism.

Magnetostratigraphy, Dendrochronology, Palynology, and other classical as well as advanced techniques in paleoclimate studies.

Landform evolution exploratory methods: GPR and other methods of Shallow subsurface studies, OSL, Gamma Ray logging. Mapping of the Quaternary landforms: Total station, DEM, remote sensing methods.

## **GL-309: OIL FIELD SERVICES (2 Credits)**

### **Introduction to Oil Well Drilling:**

**15**

- Types oil wells and geotechnical order
- Methods of Oil well drilling: Cable tool drilling and rotary drilling
- Components of rotary drilling system
- Monitoring of drilling process i.e depth ROP, WOB, sampling.
- Concept of Subsurface pressure.
- Types of Drilling Rigs: Onshore and offshore rigs
- Controlled Directional Rotary Drilling, Horizontal Drilling
- Drilling Mud: Mud hydraulics, uses and functions of drilling mud.

- **Coring:** Introduction, Techniques and Applications of Coring in Petroleum Geology.

### **Formation Evaluation:**

15

- Wire line logs: Introduction  
Basic Principles, tools of SP, gamma ray, Neutron, Density, Caliper, Dipmeter, Temperature and Sonic Logs and their interpretation.
- Mud logging: Principle, techniques and tools of mud logging.  
Interpretation of gas, drilling and mud parameters.
- MWD (Measurement While Drilling)/LWD (Logging While Drilling):  
Principle and tools of MWD/LWD, data analysis and interpretation.
- Formation (Drillstem) Testing:  
Introduction  
Tools and Techniques of DST.

## **GL-310: NATURAL Resource Management (2 CREDITS)**

### **Introduction to Natural Resources**

15

- Description of the Resources
- Classification of the Natural Resources
- Exhaustible resources – Minerals and Mining
- Energy Resources- Oil, Coal, Natural Gas, atomic minerals
- Soil as resource – types of soils
- Rivers resources
- Coastal resources, Coastal Processes
- Renewable resources
- Water resources
- Land resources
- Function and values of the resource
- Human use and impact on the resource
- Supply and demand of the resources

### **Development and Management of Natural Resources**

15

- Management tools and techniques – Natural Resources Policy
- Watershed Management
- Methods of soil Conservation
- Flood Control Measures
- Coastal Zone Management
- Application of Remote Sensing Techniques in resource management
- Environmental Impact Analysis
- Mineral Resources: Conservation and Management
- Policies and legislation concerning natural resources

## **GL-311: Computer Applications in Geology (2 Credits)**

**30**

- Computer Fundamentals – Basic Computer Organization, Data Representation: Non – positional and Positional Number Systems, Binary, Octal and Hexadecimal Number Systems, Computer Arithmetic
- Computer Codes, Boolean Algebra and Logic Circuits, Computer Software, Operating Systems. Planning the Computer Programme, Algorithms
- Introduction to Computer Graphics – Scientific visualization based on computer graphics technologies, Computer Graphics Applications, Display Technologies, Random – Scan Display Processing Unit, Raster – Scan Display Processing Unit, Mathematical Modeling in Geosciences

## **SEMESTER – III**

### **GL-305: PRACTICALS RELATED TO GL 301 TO GL 311 (8 Credits)**

#### **Practicals for GL 301: (2 Credits)**

1. Study of typical hand specimens of rocks from different lithological units of Indian stratigraphy
2. Preparation and study of Palaeogeographical maps of India for different geological periods
3. Study of geological maps of different unit of Indian stratigraphy and construction of geologic cross-sections

#### **Practicals for GL 302: (2 Credits)**

1. Study of patterns of geophysical responses from various geological mediums.
2. Plotting a Drift curve for a gravimeter application of elavation correction to observed gravity data – plotting and interpretation of gravity profiles – simulation of causative bodies
3. Analysis of seismic refraction data for velocities and thickness of subsurface layers.
4. Plotting and interpretation of resistively data
5. Plotting and analysis of self potential data
6. Simple interpretation of geophysical well logs

#### **Practicals for GL 303: (2 Credits)**

1. Lithofacies analysis
2. Preparation of structural contour maps
3. Preparation of isopach maps
4. Preparation of carbonate concentration maps
5. Correlation of electrical logs
6. Preparation of geologic crosssection from well data

#### **Practicals for GL 304: (2 Credits)**

1. Water and Soil analysis

2. Plotting the geochemical data on variation diagrams
3. Preparation of map showing hazards
4. Preparation of hazard zonation maps

**Practicals for GL 307: (1 Credits)**

1. Preparation of samples for geochronological analysis
2. Study of fission tracks
3. Calculation of dates from the isotope data
4. Calculations pertaining to binding energies of the elements

**Practicals for GL 308: (1 Credit)**

1. Deducing climate cyclicity (/Mylankowitch) using time series methods on the NOAA, GISP database.
2. Calculation of CAI from geochemical data and interpret the elemental mobility to infer climate/weathering trends.
3. Calculation of Oxy Isotope and deducing the MIS stages for climatic inferences.
4. Calculation of ages using luminescence dating,  $Pb^{210}$ , tree rings etc.
5. Calculation of ages using magnetostratigraphy.
6. Reading and interpretation of GPR profiles for subsurface interpretations.
7. Clay mineralogy from XRD data and its relation to weathering pattern
8. Environmental Magnetism practicals.
9. Total station survey practicals.
10. Multiparametric inferences using proxy climatic parameters

**Practicals for GL 309: (1Credit)**

1. Description and identification of well cuttings based on physical properties, calcimetry and fluorescence.
2. Percentage lithology and Master log preparation.
3. Gas curve identification and gas ratio plotting.
4. Description of core samples.
5. Wire line log interpretation.
6. Well hydraulic calculations such as annular volume, lag time calculations.
7. Calculations of Shale factor and shale density.

**Practicals for GL 310: (1Credit)**

1. Introduction to the methods of Environmental Impact assessment
2. Assessment of Soil – Water – Energy Mineral Resources
3. Delineation of natural resources by using remote sensing techniques
4. Study of physical properties of Coal
5. Study of physical properties of Atomic Minerals

**Practicals for GL 311: (1 Credit)**

1. Designing a Logical Database
2. Querying and Reporting
3. Preparation of computer maps and terrain models
4. Piper and Stiff diagrams



5. Conversion of data into vector, wire frame, image, shaded relief and post maps.
6. Statistical data analysis in Geosciences

### **Text books for Semester – III**

Wadia: Geology of India and Burma  
 Krishnan: Geology of India  
 Naqui and Rogers: Precambrian Geology of India  
 Saha A.K.: Crustal Evolution of Singhbhum North Orissa  
 Geological Society of India: Purana Basins of India  
 Geological Society of India: Quaternary of India  
 Geological Society of India: Precambrian of the Aravalli Mountain  
 Geological Society of India: Geology of the Central and Western India.  
 Geological Society of India: Geology of Karnataka.  
 Dobrin : Introduction to geophysical prospecting  
 Kearey and Brooks: An Introduction to Geophysical Exploration  
 Parasnis D.S. : Principles of Applied Geophysics  
 Hawkes and Webb : Geochemistry in mineral exploration  
 Telford : Applied Geophysics  
 Brown and Day : India's Mineral Wealth  
 Levenson : Geology of Petroleum  
 Russel : Petroleum Geology  
 Keller : Environmental Geology  
 Tank : Environmental Geology  
 A.D.Howard and I. Remson : Geology in Environmental Planning  
 Strahler and Strahler : Environmental Geology  
 Ordway : Earth Science and Environment  
 Turk and Turk : Environmental Geology  
 K.S.Valdiya : Environmental Geology  
 Faure : Principles of Isotope Geology  
 Lowe, J.J. & Walker, M.J.C., 1997: reconstructing Quaternary Environments Longman. ISBN 0-582-100166-2. Pp. 1-16, 148-373.  
 Bradley, 1999, Paleoclimatology.  
 Peixoto and Oort, 1992, Physics of Climate.  
 Ruddiman: "Earth's Climate, Past and Future"  
 Bell, M. & Walker, M.J.C. 1992. Late Quaternary Environmental Change; Physical and human perspective. Longman Scientific and Technical, New York.  
 Bradely, R.S. 1985/1999. Palaeoclimatology; reconstructing climates of the Quaternary. 2<sup>nd</sup> Edition Harcourt Academic Press: San Diego.  
 Ice Age Earth: Late Quaternary Geology and Climate (Physical Environment) by Alastair G. Dawson  
 Late Quaternary Environmental change: Physical and Human Perspectives by Martin Bell  
 Many Research articles and special publications on each of the above issues available in:

- Journal of Quaternary Science
- Boreas
- The Holocene

- Quaternary Science Reviews
- Quaternary Science
- Palaeogeography, Palaeoclimatology, Palaeoecology
- Journal of Archaeological Science

Primer of Oil well drilling : By IADC

Bhagwan Sahay : Mud logging

Person : Geological Well drilling technology

Cray and Cole : Oil & well drilling technology

Hearst & Nelson : Well logging for physical properties

Leroy & Leroy: Subsurface Geology

Holechek, J. L., R. A. Cole, J. T. Fisher, and R. Valdez. 2003. *Natural Resources Ecology, Economics*

*and Policy* (2nd Edition). Prentice Hall Education.

Shenk, T. M., and A. M. Franklin. 2001. *Modeling in Natural Resource Management Development,*

*Interpretation, and Application.* Island Press.

Wondolleck, J. M. and S. L. Yaffee. 2000. *Making Collaboration Work Lessons from Innovation in*

*Natural Resource Management.* Island Press

Paine, D. P. 1981. Aerial Photography and Image Interpretation for Resource Management. John Wiley and Sons. New York, New York. 571 p.

Rajaraman V. Fundamentals of Computers

Shrivastava C. Fundamentals of Information Technology

Sinha Pradeep Computer Fundamentals

Tonge. Fred M. : Computing – Introduction to Procedures

Roger C Parker : MS Office for Windows 95

Tom Badgett : Compact Guide to Word

Dan Gookin : Word for Windows 95

Greg Harvey : Excel for Windows 95

Rick Altman : Mastering Corel Draw 6

Jinjer L Simon : VB Script Superbible – The complete reference to Programming in Microsoft VB Scripting edition

Noel Jerke : Visual Basic 6 : The Complete Reference

John C Davis : Statistics and Data Analysis in Geology

Association of Indian Universities : Handbook of Computer Education

James H Earle : Graphics Technology

## SEMESTER – IV

### GL-401: ECONOMIC GEOLOGY (4 Credits)

#### **Ore forming processes (I)**

15

- Scope and application of economic geology
- Genetic classification of ore deposits
- Concept of the terms ore, gangue, grade, tenor, resources, reserves etc.
- Mineralisation related to Plate tectonics Structural controls on ore localization
- Broad tectonic setting and magmatism associated with various types of ore deposits

#### **Ore forming processes (II)**

15

- Magma and its relation to mineral deposits
- Ore forming fluids: origin, types, nature and migration
- Magmas as ore forming fluids
- Hydrothermal fluids, types composition and transport, wall rock alteration
- Physico-chemical principles of ore-deposition
- Primary and secondary ore forming processes

#### **Indian ore deposits (I)**

15

- Mode of occurrence, geological and geographic distribution, classification and genesis of the following mineral deposits
  - ❑ Chromium
  - ❑ Iron
  - ❑ Manganese
  - ❑ Copper
  - ❑ Skarn Deposits

#### **Indian ore deposits (II)**

15

- Mode of occurrence, geological and geographic distribution and genesis of the following mineral deposits
  - ❑ Lead and Zinc
  - ❑ Gold
  - ❑ Aluminum (Bauxite)
  - ❑ Barite
  - ❑ Uranium
  - ❑ Coal
  - ❑ Introduction to Mineral Economics

### GL-402: MARINE GEOLOGY (4 Credits)

#### **Morphology, Stratigraphy and Tectonics of Oceans**

15

- Geophysics and Ocean morphology
- Marine Stratigraphy
- Tectonic history of the oceans

**Ocean Circulation** 15

- Oceanic Crust
- Ocean circulation
- Sea level history and seismic Stratigraphy
- Near shore geological processes and the continental shelf

**Ocean margins and Oceanic sediments** 15

- Continental margin type
- Terrigenous deep sea sediments
- Biogenic and authigenic oceanic sediments

**Bottom currents and Paleoceanography** 15

- Geological effects of bottom currents
- Approaches to Paleoceanography
- Palaeo oceanographic and sediment history of ocean basins
- Critical events in ocean history

**GL-403: GEOGRAPHICAL INFORMATION SYSTEM (2 CREDITS)**

**Introduction to GIS** 15

- Definition, scope, history application
- Hardware & software requirements
- Spatial and non-spatial data, attributes
- GIS data modes - VECTOR & RASTER

**Analysis in GIS** 15

- Digitization & Rasterization
- Overlay analysis
- Buffer analysis
- Digital Terrain Model
- Multi-criteria analysis
- Query analysis

**GL-404: ENGINEERING GEOLOGY & GEOTECHNIQUES (4 Credits)**

**Introduction to Engineering Geology** 15

- Scope of Engineering Geology
- Engineering properties of rocks
- Methods of determining engineering properties of rocks
- Behavior of rocks under stress
- Rock failure mechanisms
- Engineering properties of soils
- Methods of soil investigations

**Geology and Engineering Structures** 15

- Geological considerations for the selection of sites
- Dam sites and types of Dams & Spillways

- Forces acting on Dam wall
- Reservoir competency
- Silting of reservoirs
- Tunnels: Tunnel sites & Tunnel alignment
- Bridges, Y ducts, Roads & similar structures
- Slope stability analysis
- Types of remedial measures

### **Geo-material in Engineering Construction**

15

- Building stones and road metals
- Characteristics of rocks as building stones and road metals
- Aggregate and its classification
- Rock testing: Mechanical test, Chemical test , Durability test
- Aggregate resource development
  1. Requirement of primary fragmentation
  2. Planning of quarry, hill slope side or open pit.
  3. Removal of overburden and its disposition at suitable site
  4. Selection of drilling, blasting method for main blasting and secondary breaking for given size of fragmentation
- Selection of equipment's for drilling, loading, hauling to crusher site
- Methods of extraction of aggregate resources

### **Geo-techniques**

15

- Introduction to the methods of Geophysical exploration
- Seismic Method
- Gravity Method
- Electrical Surveying
- Magnetic surveying
- Use of Remote Sensing methods in engineering Geology
- Types of synthetic materials used as remedial measures
- Estimation of overburden thickness & rock strata classification
- Preparation of Report and Presentation of Engineering data

### **GL-406: FIELDWORK COMPONENT (1 CREDIT)**

### **GL-407: HYDROGEOLOGY (4 Credits)**

### **Hydrosphere and Groundwater exploration**

15

- Scope and importance of Groundwater,
- Hydrosphere – Evaporation, condensation, precipitation, interception, runoff (surface, subsurface and groundwater), infiltration,
- Factors that affect occurrence of groundwater – Climate, topography, geology
- Exploration techniques - Integrated approach to groundwater prospecting: Role of toposheets and Remote sensing in groundwater exploration, Hydrochemical methods, surface and subsurface Geophysical methods, Tracer techniques, Exploratory Borewell programme, use of computer software in exploration of groundwater.

### **Occurrence and distribution of Groundwater**

**15**

- Vertical distribution of groundwater. Hydrologic properties of Rocks – Porosity, Hydraulic conductivity, Derivation of Darcy's Law. Aquifers – Characteristics of unconfined and confined aquifers
- Aquifer properties – Concepts of Transmissivity and Storativity
- Behaviour of sedimentary, crystalline and volcanic rocks as aquifers – factors controlling hydrologic, aquifer properties and yield of wells in different rock types
- Impact of drought and groundwater overexploitation on aquifers.

### **Groundwater flow and Pumping tests**

**15**

- Principles of groundwater flow : concept of groundwater potential, validity of Darcy's law for laminar and turbulent flow – Tracing of groundwater movement with flow nets
- Pumping tests – principles – types of pumping tests, procedures, concept of well hydraulics, determination of aquifer properties and well characteristics by simple graphical methods – significance of transmissivity and storativity data.
- Introduction to software in pumping tests.

### **Groundwater Recharge and Quality of groundwater**

**15**

- Measurement of groundwater recharge, Artificial recharge techniques, surface water harvesting techniques, structures for developing groundwater, Conjunctive use of surface and groundwater.
- Quality of groundwater – Geochemical processes in the groundwater, water types and water quality classification -Interaction of water with its ambient environment, Types of interaction: chemical, physical, kinetic- Assessment of groundwater quality, Use of software in water quality assessment.
- Seawater intrusion – Ghyben Herzberg relation – remedial measures
- Groundwater provinces of India. Groundwater in Maharashtra state. Concept of groundwater legislation

### **GL-408: DISSERTATION (4 Credits)**

Field studies, Laboratory studies / data processing, reference work and presentation of the thesis are four major components of the course. Students opting for this course should adhere to the following procedure.

1. Precise title and outline of work is to be submitted to the Head of the Department.
2. The student shall spend about one week in the field.
3. The field work shall be carried out only during vacation or holidays, and in no case student will be permitted to be absent from regular teaching on account of dissertation.
4. The student shall maintain field diaries and other record relevant to dissertation.
5. Every month the student shall submit the progress report and laboratory work done, through the supervisor to Head of the Department.
6. The student shall do dissertation at his own cost. The department will not spare funds for this purpose.
7. The student shall give a seminar before the submission of the dissertation.

8. The student shall submit the dissertation before the commencement of practical examination.
9. The supervisor shall submit the practical sets based on topic of dissertation develop for the students to Head of the Department prior to the commencement of practical examination.
10. Non compliance of any of the above rules will disqualify students for grant of terms.

Three copies neatly typed on thesis size paper, well bound together with maps and illustrations of the Dissertation, on the basis of the work carried out by the student, will be submitted, through the supervisor concerned, to the Head of the Department of Geology, before the commencement of the practical examination, for being forwarded to the Board of Examiners.

In case of student receiving help (training and / or participation in ongoing research activities) from other Institution / Organization for their dissertation work, the associated scientist from that Institute / Organization will function as co-supervisor.

Assessment of Dissertation will be out of 100 marks and shall include a viva-voce examination carrying 20 marks. The Dissertation will be examined at the time of the practical examination at the end of IV<sup>th</sup> Semester, by the board of examiners. The board of examiners consist of supervisor, Head of the Department and one teaching faculty member appointed by Head of Department in consultation with the supervisor.

### **GL-409: WATERSHED MANAGEMENT(2 Credits)**

#### **Watershed Development**

**15**

- Concept of watershed - watershed characteristics – Importance of water resources in watershed – concept of watershed development in relation to water resources – salient features of development measures like counter budding, gully plugs, stream bunds, percolation tank, subsurface dams, afforestation etc. - significance of geology in watershed development measures – Role of NGO's and State Government in watershed development.

#### **Watershed Management**

**15**

- Concept of watershed management in relation to water resources –water balance equation for watershed – sustainability of water resources - conjunctive use of surface and groundwater resources – concepts of peoples participation in community based watershed management – concept of water users group – Role of NGO's and State Government in watershed management.

### **GL-410: DISASTER MANAGEMENT (2 Credits)**

#### **Fundamentals, Types and Remedies**

**15**

- Concepts related to physical system and human interference
- Types and genesis of atmospheric, hydrospheric, biospheric and lithospheric disasters
- Remedial measures for preventing and minimizing disasters
- Hazard zonation maps : preparation and utilization

### **Preparedness and Awareness**

**15**

- Mitigation strategy : Relief measures, community health, casualty management Role of Government, Non Governmental and media agencies, Reconstruction and Rehabilitation
- Awareness through print and electronic media, involving youth in field observations

### **GL-411: GEMMOLOGY AND INDUSTRIAL MINERALOGY (2 Credit)**

#### **Gemmology**

**15**

- Introduction to Gems - basic properties of gems – Formation of gem stones - Use of refractometers, Polariscopes, Dichroscopes - Methods of Specific Gravity determination - Causes of colours in gemstones - Introduction To special optical properties like chatoyancy, asterism, luminescence, play of colours, labradorescence, inclusions etc. Distinction between synthetic and natural gem stones

#### **Industrial Mineralogy**

**15**

- Industrial Mineralogy - Introduction to industrial specifications of raw materials used in following industries  
Ceramics and Refractories, Abrasive, Construction, Cement, Fertilizers, Paints, Electronics etc - Outline of techniques used in testing raw materials

### **GL 412 : MINING GEOLOGY (2 Credit)**

#### **Guides to ore:**

**15**

- Ringed Target and Intersecting loci
- Regional and Topographical Guides
- Mineralogical Guides
- Structural Guides
- Stratigraphic Guides

#### **Drilling Methods:**

- Percussion Drills – Jumper bar drills- Pneumatic drills - Churn drills-Reichdrills
- Rotary Drills -Auger drills -Colyx drills-Turbo drills- Diamond drills
- Miscellaneous Drills - Jet drills-High temp. flame drills- Banka drills (Empire drills)- Burnside drills
- Mining Methods - Alluvial Mining- Open Cast Mining - Under ground Mining
- Ore Dressing-Crusher's-Grinder's-Jiggings & Takling-Flotation



## SEMESTER – IV

### **GL : 405 PRACTICALS RELATED TO GL 401 TO GL 412 (8 Credits)**

#### **Practicals for GL 401: (2 Credits)**

1. Study of ores in hand specimens
2. Preparation of charts showing distribution of important ore deposits in India
3. Mineralogical and textural study of common ores under microscope
4. Chemical analysis of ore minerals assaying
5. Megascopic characterisation of banded coals
6. Proximate analysis of coal
7. Microscopic examination of polished coals (Identification of macerals in coal)

#### **Practicals for GL 402: (2 Credits)**

1. Study of rocks of ocean floor
2. Study of hand specimens and thin sections of Beach rocks
3. Study of heavy minerals of offshore sands
4. Study of maps related to morphology and tectonic history of ocean basins
5. Distribution of carbonate and siliceous oozes
6. Identification and description of microfossils
7. Patterns of sediment distribution in Indian ocean
8. Pattern of distribution of glacio-marine pelagic clay, and volcanogenic sediments

#### **Practicals for GL 403: (2 Credits)**

1. Nature of sources of geographical data
2. Sources of errors in GIS database
3. Data quality parameters
4. Information of various scales
5. Need of projection
6. Spherical co-ordinate system
7. Properties of map projections
8. Preparation of vector database and maps: manual method for point line and area entities
9. Preparation of a raster database and map : manual method for point line and area entities
10. Measurement of distance between two points for vector and raster data
11. Measurement of area – vector and raster data

#### **Practicals for GL 404: (2 Credits)**

1. Various methods of Surveying used in engineering geology
2. Chain Surveys
3. Plane table surveys
4. Use of Surveying equipments
5. Determination of Engineering properties of Geological materials
6. Interpretation of borehole data
7. Preparation of bore logs / Lithologs.

**Practicals for GL 407: (2 Credits)**

1. Analysis of rainfall data
2. Preparation of water level contour maps and their interpretation
3. Analysis of pumping test data by simple graphical methods for determination of aquifer and well characteristics
4. Plotting and analysis of hydrogeochemical data
5. Hydrogeological significance of morphometric parameters of a watershed
6. Use of computer

**Practicals for GL 409 : (2 Credits)**

1. Salient points for the constructive of contour bunds, stream bunds, percolation tank subsurface dams etc.
2. Use of morphometric analysis in planning watershed development
3. Calculation of water balance for a watershed

**Practicals for GL 410: (2 Credits)**

1. World wide distribution of disasters
2. Mapping of disaster-prone zones with the use of toposheets / remote sensing tools
3. Preparing questionnaires, getting feed back, analyzing and interpreting the data about impact / socio-economic aspects etc

**Practicals for GL 411: (2 Credits)**

1. Visual observation of gem stones
2. Use of refractometers
3. Identification of Anisotropic and Isotropic gem stones
4. Determination of specific gravity
5. Observation of inclusions to identify synthetic from natural gem stones.
6. Study of physical properties of industrial minerals and materials in hand specimens with respect to industrial specifications,
7. Preparation of charts showing specifications of materials required for different industries,
8. Determination of specific gravity, use of DTA and DTG techniques in characterizations of raw materials

**Practicals for GL 412: (2 Credits)**

1. Mine Valuation and Calculation :
2. Uniform spacing on rectangular co-ordinate (Extended area)
3. Included area problems related to valency
4. Area influenced methods of combining irregular spaced assay
5. Triangle grouping of irregular spaced assayed
6. Veins problems (linear groups, minimum stoping widths)
7. Cross section of faulted ore bodies
8. Mine survey problems
9. Flow sheets of important ore deposits

### Text books for Semester – IV

- Craig and Vaughan, 1981: Ore Petrography and Mineralogy, John Wiley  
Mookherjee, 2000: Ore Genesis – a holistic approach. Allied. Publ. New Delhi  
Sawkins, 1984: Metal deposits in relation to plate tectonics  
Stanton, 1972: Ore petrology, McGraw Hill, New York  
Guilbert and Park, 1986: Geology of Ore deposits  
Taylor et al, 1998: Organic Petrology, Gebruder Borntraeger, Stuttgart  
Singh (ed), 1998: Coal and Organic Petrology  
Chandra, 2000: Textbook of Coal (Indian context). Tara Book Agency, Varanasi  
Dahlkamp, 1993: Uranium ore deposits Springer Verlag, Berlin.  
Kennet : Marine Geology  
Menard : Marine Geology  
Richason, B. F., Jr. ed. 1978. Introduction to Remote Sensing of the Environment. Kendall/Hunt Publishing Company. Dubuque, Iowa. 496 p.  
Spurr, S. H. 1960. Photogrammetry and Photo-Interpretation. The Ronald Press Company. New York, New York.  
472 p.  
Burroughs, P.A. (1986) : Principles of Geographical Information Systems for land Resources Assessment, Oxford University Press  
Environmental Systems Research Institute (1993) : Understanding GIS : The Arc Info method Training Course for GIS for resource management and development planning :  
Lecture notes, V1 : GIS Fundamentals and Techniques, Government of India  
Berhardsen, Tor (1999) : Geographic Information Systems : An Introduction, John Wiley and Sons  
Clarke, Keith C. (1999) : Getting Started with Geographical Information Systems, Prentice Hall  
Demers, Michael N. (2000) : Fundamentals of Geographical Information Systems, John Wiley  
Haywood, Ian (2000) : Geographical Information Systems, Longman  
Chang, Kang-taung (2002) : Introduction to Geographic Information Systems, Tata McGraw-Hill  
Soroie: Geology for Engineers  
Krynine and Judd: Principles of Engineering Geology and Geotechniques  
Rise and Wateson: Elements of Engineering Geology  
Todd, D.K. – Groundwater Hydrology  
Karanth K.R. – Groundwater Assessment Development and Management  
Raghunath H.M. – Groundwater  
Davis S.n. and Dewiest R.J.M. – Hydrogeology  
Freeze and Cherry – Groundwater  
Dhravabaraya V.V., Sastry and patnaik V.S. - Watershed Management  
Bryant E. : Natural Hazards, Cambridge University Press  
Bell F.G. : Geological Hazards  
Smith K. : Environmental Hazards  
Books on Disaster Management course of IGNOU  
Read : Beginners Guide to Gemmology  
Webster Anderson : Gems  
Anderson B.W. : Gem Testing  
Webster R. : Practical Gemmology

Bates : Geology of industrial rocks and minerals  
Roy : Indian Mineral Resources  
Baungart, Dunham, and Amstutz : Process Mineralogy of Ceramic Materials  
Panigrahi D.C. : Mine Environment and Ventilation  
Singh B. : Blasting in Ground Excavation and Mines  
Sinha R.K. Mineral Economic  
Goulelin : Ore Dressing  
Banter & Parks : Examination and Valuation of Mineral Property  
Macnestry : Mining Geology