

**M. Sc. Part – II**  
**Geology Syllabus (Revised)**

(To be implemented from June 2012)

**Structure of the M. Sc. Part II: Geology Course: Semester III and IV and  
Equivalence in accordance with titles and contents of papers**

**Semester III**

<b>Sr. No.</b>	<b>Paper/ Practical No.</b>	<b>Title of the Old Paper (Old syllabus)</b>	<b>Title of the New Paper (Revised syllabus)</b>	<b>Marks</b>
13	Paper IX	Hydrogeology	Hydrogeology	100
14	Paper X	Geophysics and Exploration Methods	Geophysics and Exploration Methods	100
15	Paper XI	Geochemistry	Geochemistry	100
16	Paper XII	One of the following Optional Papers- (a) Gemmology and Industrial Mineralogy (b) Mining Geology and Mineral Economics (c) Marine Geology (d) Geoinformatics	One of the following Optional Papers- (a) Gemmology and Industrial Mineralogy (b) Mining Geology and Mineral Economics (c) Marine Geology (d) Geoinformatics	100
17	Practical- V	Related to Papers IX and X	Related to Papers IX and X	100
18	Practical -VI	Related to Papers XI and XII	Related to Papers XI and XII	100
Semester III : Total – 4 Papers and 2 Practicals				<b>600</b>

Note: Dissertation work will be assigned to each student at the beginning of Semester III and assessed at the Practical Examination of Semester IV.

**Semester IV**

<b>Sr. No.</b>	<b>Paper No.</b>	<b>Title of the Old Paper</b>	<b>Title of the New Paper</b>	<b>Marks</b>
19	Paper- XIII	Engineering Geology and Geo-techniques	Engineering Geology and Geo-techniques	100
20	Paper - XIV	Natural Resource Management	Natural Resource Management	100
21	Paper - XV	Environmental Geology	Environmental Geology	100
22	Paper - XVI	Dissertation	Dissertation	100
23	Practical - VII	Related to Paper XIII and XIV	Related to Paper XIII and XIV	100
24	Practical -VIII	Related to Paper XV and XVI	Related to Paper XV and XVI	100
Semester IV: Total – 4 Papers and 2 Practicals				<b>600</b>
<b>Total of Second Year - Semester III = 600, Semester IV = 600</b>				<b>1200</b>

**M. Sc. Part – II: Geology**  
**Detailed Syllabus (Revised)**  
(To be implemented from June 2012)

**Semester III**

**Paper IX – Hydrogeology**

**Unit I**

Groundwater – Origin, types, importance, occurrence and distribution of water in the earth crust. Hydrological cycle – Precipitation, runoff, infiltration and evapotranspiration. Groundwater reservoir and Groundwater movement. Influent and effluent seepage, springs, Types of aquifers and their properties.

**Unit II**

Hydrologic properties of rocks: porosity, permeability, specific yield, specific retention, hydraulic conductivity, transmissivity, storage coefficient, Darcy's law, Occurrence of groundwater in different rock types.

**Unit III**

Water well technology, types of wells, Drilling methods, Construction, development and maintenance of wells. Water table contour maps, Hydrographs.

**Unit IV**

Well hydraulics, confined, unconfined, steady, unsteady and radial flow, Water level fluctuations, causative factors and their measurements, Methods of pumping test and analysis of test data, Evaluation of aquifer parameters from pumping test analysis.

**Unit V**

Surface and subsurface geophysical and geological methods of groundwater exploration. Hydrogeomorphic mapping using remote sensing techniques. Radio-isotope Tracers in hydrogeological studies. Collection of hydrogeological data and preparation of hydrogeological maps, Statistical and probability analysis of hydrological data.

**Unit VI**

Groundwater quality: Physical, Chemical and Bacteriological parameters and their estimation, Water quality – major and minor constituents and their characters, Groundwater Standards for drinking and irrigation : BIS, WHO. Diagrammatic representation of chemical data, Water contaminants and pollutants: Pollution factors, sources and nature of pollution, Pollution mechanism, its detection and prevention.

## **Unit VII**

Water management in rural and urban areas: Problems of overexploitation of groundwater, artificial and natural factors controlling water recharge, Rain water harvesting, artificial recharge of groundwater, Groundwater legislation, Groundwater intrusion in coastal aquifers and remedial measures, watershed management and related environmental aspects.

## **Unit VIII**

Groundwater quality of various regions in India, Problems of arsenic and fluoride contamination.

Hydro-stratigraphic units of India, Paleo-hydrological studies. Groundwater Modeling.

## **Practicals**

Identification and demarcation of Watershed boundaries,

Interpretation of well inventory data, Determination of groundwater flow direction,

Preparation of water table contour map.

Estimation permeability.

Analysis of hydrographs and estimation of infiltration capacity.

Pumping test – Time, Drawdown and time recovery tests. Evaluation of aquifer parameters, step drawdown test.

Study of depth and yields of bore wells.

Study of Electric resistivity sounding data for delineation of fresh and saline aquifers.

Study of geophysical well logs.

Exercises on groundwater exploration using remote sensing techniques.

Exercises related on ground water modeling with given data.

## **Books Recommended**

Groundwater hydrogeology – D. K. Todd (1980), John Wiley and Sons Inc, New York.

Hydrogeology – S. N. Davis and R. J. M. Dewiest (1966). Hydrogeology. John Wiley.

Ground water – Freeze, R.A. and Cherry, J.A. (1979). Prentice Hall Publication.

Water- Subramaniam, V. (2000). Kingston Publication London.

Groundwater studies – R. H. Brown and others

Groundwater Hydrology – Herman Bouver

Groundwater Resources Evaluation – W. C. Walton

Hydrogeology – C. F. Fetter

Hand book of applied hydrology – Ven Te Chew

Groundwater and wells – Hohnson publication

Physical and chemical hydrogeology – Patrick A. D. Dominics

Applied hydrogeology – Chow M. Mays, Mac Graw Hil Publicaiton

Hydrogeology and wet housed conservation – Gulman – wiley publication

Groundwater survey and investigation – Gautham Mahajan ApH puls.

Hydrogeology – Raghunath HM

Hydrogeology – Karanth K R, Tata Mac Graw Hill Co. Ltd., New Delhi.

Groundwater Assessment Development and Management – Karanth KR, Tata Mac Graw Hill  
Groundwater – S. Ramakrishnan  
Palehydrology and Environmental change : Bemite, V R Babar and K. J. Gregong, Wiley, Chichester  
Global Environment Changes, the context of paleolydrology, J. Brauson. A. G. Brown, K. S. Gregory, Wiley Chichester.  
Groundwater in Hydrosphere (Groundwater Hydrology)- Nagabhushanian,H.S. (2001). CBS Publisher, New Delhi.  
Applied hydrogeology – Fetter C. V. ( 1990 )  
Regional Groundwater Quality – Alley W. M. ( 1993 ) VNR, New York

## **Paper X- Geophysics and Exploration Methods**

### **Unit I**

The Exploration by Geological criteria of mineral deposits, Geochemical tools and methods involving various geochemical mapping techniques. Integrated approach of geophysical methods in mineral exploration, groundwater and petroleum exploration

### **Unit II**

Variation of gravity over the surface of the earth; principles of gravimeters; gravity field surveys; various types of corrections applied to gravity data; preparation of gravity anomaly maps and their interpretation in terms of shape, size and depth.

### **Unit III**

Geomagnetic field of the earth; magnetic properties of rocks; working principles of magnetometers; field surveys and data reductions; preparation of magnetic anomaly maps and their quantitative interpretation; magnetic anomalies due to single pole, dipole; introduction to aeromagnetic surveys, three dimensional current flow, potential due to a point current source.

### **Unit IV**

Resistivity methods; basic principles; various types of electrode configurations; field procedure profiling and sounding and interpretation, application of electrical method in groundwater prospecting and civil engineering problems. Interpretation techniques for resistivity sounding, self-potential methods, Induced polarization methods.

### **Unit V**

Seismic methods; fundamental principles of wave propagation; refraction and refraction surveys for single interface, horizontal and dipping cases; concept of seismic channels and multy- channel recoding of seismic data; End- on and split spread shooting techniques; CDP method of data acquisition; sorting; gather; stacking and record section; seismic velocity and interpretation of seismic data.

## **Unit VI**

Electromagnetic methods- Basic principle, instruments used and interpretation of electromagnetic surveys. Introduction to the methods using artificial and natural fields-Telluric, Magneto-telluric and airborne electromagnetic methods.

## **Unit VII**

Introduction to logging, Aims and objectives, Classification of logging methods and techniques, Basic principles, Instrumentation, field procedures. Interpretation of well logs and their applications.

## **Unit- VIII**

Radioactivity of rocks and minerals, Alpha, Beta and Gamma radiation sources, Occurrence of radioactive minerals, Half-life, fussion, fission; Dating radioactive traces, field equipment and procedures.

## **Practicals**

Application of geophysical data for geological purpose.

Interpretation of surface geophysical data in mineral exploration- gravity data, magnetic data, electrical data. Utility of seismic reflection data in recognition of subsurface structures; interpretation of seismic data.

Interpration of logging data.

## **Books Recommended**

Sharma, P.V. (1986) Geophysical Methods in Geology

Dobrin, M.B.(1976) Introduction to Geophysical Prospecting, McGraw Hill.

Paransis, D.S.(1975) Principles of Applied Geophysics

Stanislave,M.(1984) Introduction to Applied Geophysics

Rao, M.B.R. Outlines of Geophysical Prospecting Manual for Geologists

Ramam, P.K. (1989). Principles and Practices of Mineral Exploration, Geological Society of India,Banglore.

Stenislave, M. (1984). Introduction to applied Geophysics, Reidel Publ.

Lowrie, W. (1977). Fundamental of Geophysics, Cambridge University Press.

Mussette, A.E. and Khan, M.A. (2000). Looking into the earth: An introduction to geological geophysics, Cambridge University Press.

## **Paper XI - Geochemistry**

### **Unit I**

Origin and abundance of elements in the Earth, solar system and its constituents.

### **Unit II**

Atomic structure and properties of elements in the periodic table, Special properties of transition and rare – earth elements.

### **Unit III**

Goldschmidt's Principles of Geochemistry. Geochemical classification of elements in the Earth. Principles of Geochemical Cycle.

#### **Unit IV**

Isomorphism and Polymorphism, Principles of Geothermobarometry.

#### **Unit V**

Radiogenic Isotopes; Radioactive decay scheme of V – Pb, Sm – Nd, Rb – Sr, K – Ar and growth of daughter isotopes; Radioactive dating of single minerals and whole rocks; Stable Isotopes- nature, abundance and fractionation, fluid interaction and biological processes.

#### **Unit VI**

Laws of thermodynamics, Concept of free energy; Activity, fugacity and equilibrium constant; Thermodynamics of ideal, non – ideal and dilute solutions.

#### **Unit VII**

Principles of ionic substitution in minerals; Element partitioning in mineral/rock formation and Concept of simple distribution coefficients and exchange reaction distribution coefficients; Element partitioning (partitioning ?) in mineral assemblages and its use in the pressure – temperature estimation.

#### **Unit VIII**

Chemistry of natural waters; mineral stability in Eh-pH diagram; Rock weathering and soil formation; Elemental mobility in surface environment; Concept of geochemical – biogeochemical cycle and Global climate.

#### **Practicals**

Preparation and Interpretation of geochemical maps.  
Analysis of Rock / Sediment / Soil samples.

#### **Books Recommended**

Allegre, C.J. and Michard, G. (1974). Introduction to Geochemistry, Reidel Holland.  
Mason, B. (1982). Introduction to Geochemistry, Wiley Eastern.  
Anderson, G.M. and Crerar, D.A. (1993). Thermodynamics in Geochemistry-the equilibrium model, Oxford Univ. Press, NY.  
Introduction to Geochemistry – Mason B and Moore C. B. (1991)  
Introduction to Geochemistry – Krauskopf K. B and Bird D. K. (1967)  
Geochemistry – Goldschmidt V. M (1962), Clarendon Press.  
Encyclopedia of Geochemistry – Marshal C. P and Fairbridge R. W. (1999)  
Stable Isotope Geochemistry – Hoefs J. (1980)  
Principles of Isotope Geology – Faure G. (1986)  
Handbook of Exploration Geochemistry – Govett G. J. S. (1983)  
Geochemistry of Natural Waters – Drever J. I. (1982)  
Marine Chemistry – Home R. A. (1969)

## **Paper XII (a)- Gemmology & Industrial Mineralogy**

### **Unit I**

Introduction to Gems –Precious and Semiprecious stones and their economic importance. Basic Properties of Gems- Hardness, Specific Gravity, Refractive Index, Luster, Play of colours, Qualities & Classification of gem materials- the 4 ‘C’s;

### **Unit II**

Introduction to Special optical properties like Chatoyancy, Asterism, Luminescence, Play of colours, Labradorescence, Inclusions.

### **Unit III**

Gem Testing- Refractometers, Polariscope, Dichroscope, Ultra Violet lamps- Principles and Uses. Methods of determination of Specific Gravity. Distinction between synthetic and natural gemstones

### **Unit IV**

Formation of Gemstones. Occurrence of Gems in India. Gem Industry in India.

### **Unit V**

Introduction to industrial specifications and preparations of raw material used in Ceramics and Refractories, Abrasives, Construction / Building Materials, Cement, Drilling mud.

### **Unit VI**

Outline of techniques for testing raw materials in Ceramics and Refractories, Abrasives, Construction / Building Materials, Cement, Drilling mud.

### **Unit VII**

Introduction to industrial specifications, and preparations of raw material used in Paints, Fertilizers, Electronics, Chemical Industry, Glass Industry, Metallurgical Industry.

### **Unit VIII**

Outline of techniques of testing raw materials in Paints, Fertilizers, Electronics, Chemical Industry, Glass Industry, Metallurgical Industry.

### **Practicals**

Visual observation and identification of Gemstones - Diamond, Ruby, Blue & Yellow sapphire, Emerald, Aquamarine, Tourmaline, Alexandrite, Topaz, Malachite.

Visual observation and identification of Precious & Semi precious stones- Rose quartz, Amethyst, Agate, Opal, coral, Pearl, Amber, Synthetic stones.

Use of refractometers. Determinations of Specific Gravity.

Observation of inclusions for distinction between synthetic and natural gem stones.

Study of physical properties of Industrial minerals and materials in hand specimens with respect to industrial specifications.

Preparation of charts showing specifications of materials required for different industries.

Use of DTA & DTG techniques in cauterization of raw materials.



**Books Recommended**

Beginner's Guide to Gemmology-Read

Gems – Webster Anderson

Gem Testing – Anderson B. W.

Practical Gemmology – Webster R.

Geology of Industrial Rocks and Minerals – Bates

Indian Mineral Resources – Roy

Process Mineralogy of Ceramic Materials – Boungart, Dunham, and Amstutz

Gems and Gem Industry in India – Karanth, R.V.

Enhancement of Gems –Karanth, R.V.

Gems of the World – Phillips Series

Diamonds in India - Babu T. M.(1998) Geological Society of India, Bangalore

**Paper XII (b)- Mining Geology and Mineral Economics****Unit I**

Application of geology in mining, functions of mining geologist, guides in the location of ore deposit- physiographic, lithologic, stratigraphic, mineralogic and structural guides, Appraisal of exploration data for exploratory mining. Terms used in exploratory mining, introductory aspect of mine planning. Mine development

Types of mining- Alluvial Mining, Quarrying and Open cast Mining, Underground Mining.

Open Cast Mining Methods- Excavation, Benching, Levelling. Methods of breaking rocks- Blasting practices- Drilling blast holes, Explosives used in mining, Transportation of ore.

**Unit II**

Underground Mining Methods for metallic, non-metallic minerals- Modes of entry to mineral deposits Adit, Tunnel, Incline or vertical Shaft. Underground exploration methods in mining, geotechnical investigations for mine planning, mining machinery, transportation: haulage and hoisting. Mine organization and operations- Shaft Sinking, drifting, cross cutting, winzing, stopping, room & pillaring, top – slicing, sub – level caving and block caving; Mine drainage; ventilation; illumination.

**Unit III**

Mine hazards and Safety works- Mine inundation, Fire and Rock burst, Subsidence.

Support of mine excavation; timber treatment, safety measures in underground and open cast mines, rescue work.

**Unit IV**

Factors in evaluating mineral deposits. Objectives of valuation, Mine examination.

Theory and methods of Sampling, Sampling calculations, recoverable values.

## **Unit V**

Cost of mining, Life of mine, Future costs and profits, Present value of mine and its determination by compound interest and Hoskold formula method. Amortization; Calculation pertaining to valuation of mines of uniform and non- uniform annual income, Sale of mineral products, Metal prices and mine valuation; Valuation of prospects; Developed mines and working mines; Valuation report.

## **Unit VI**

Scope of Mineral Dressing; Historical Outline; Properties of Ores and minerals applied to mineral beneficiation – Hardness, specific gravity, Colour, Diaphaneity. Ore microscopy. Operating steps involved- Size reduction– Crushing- Crushers – Jaw Crushers, Blake type, and Dodge type. Gyratory crushers, Cone crushers, Roll crushers – Angle of NIP, Fine crushers, Special crushers. Ri Hinger's Law, Kick's Law, Bond's Theory. Screening – Hand screening, Automatic screening, Sieve shakers. Laboratory sizing – Graphical representation of size analysis.

## **Unit VII**

Principles of Concentration Processes, Flowing film Concentration Process, Gravity Concentration Process. Jigging, Tabling, Comparison between Jigging & Tabling, Jigging cycles. Magnetic separation- Principles and applications, Classification of magnetic separators- Ball Norton Drum Separator, Ding's Wet Magnetic Separator. Principle of Electromagnetic separators.

## **Unit VIII**

Pneumatic concentration – Amalgamation, Flotation principles, Types of flotation, Reagents used in flotation, Collectors, Frothers, Depressants, Modifiers, Coal Dressing – Heavy Media separation. Agglomeration Techniques – Pellitisation Process, Nodulizing Process, Briquetting process, Sintering process.

## **Practicals**

Determination and evaluation of ore in mines; classification of ore reserves and mineral resources (UNFC classification system), use of computers in ore reserve estimation, Sampling calculations; recoverable values; cost of mining; Future costs and profits, Life of a mine. Determination of present value of mine. Drawing cross section of mine with the help of available data.

Problems – Roll crusher angle of NIP, Relation between size of feed and size of produce; Size analysis of ground material their graphical representation; Study of settling rate of solids with respect to Stoke's Law and Rittinger's Law using clay samples; Calculation of ratio of concentration and recovery percentages.

## **Books Recommended**

Elements of Mining – Young G. J.

Elements of Mining – Lewis R. A. & Clark G. A.

Mining Geology – Arogyaswami – Courses in mining geology: Oxford and IBH Pub. Co., New Delhi.

Mining Geology – McKinstry H. E. (1972). Prentice Hall Inc.

Mining of Mineral deposits – Sheryanthov L.  
 Principles of Mineral Dressing – Garudin A. M. (McGraw Hill)  
 Elements of Ore Dressing – Taggart A. F. ( John Wiley)  
 Principles of Mineral Beneficiation – Wells & Wells  
 Mineral Processing – Pray ( Elsevier)  
 Ore Processing – Jain S. K. (Elsevier)  
 Peele, R. and Church, J.A. (1967). Handbook of mining (Vol.I and II) Wiley Eastern Ltd,  
 New Delhi

## **Paper XII (c)- Marine Geology**

### **Unit I**

History of Marine Geology, Distribution of Land and Sea, World's Oceans- Oceans and Seas, Origin of the seawater, Bathymetric Provinces.

Instruments used in Marine Geology, Position fixing, Depth measurement and sea bed mapping technique, Side-scan Sonar, Hydrography, Hydrographic chart.

Marine mineral resource management, Law of the sea bed, Indian strategy and future perspectives.

### **Unit II**

Origin of Ocean Basins, Isostasy, Rock Magnetism, Sea-floor Spreading, plate tectonics, Submarine earthquakes and tsunamis. Volcanism, Marine slides.

Classification of shores and coasts. Clifed coast, Estuaries, Delta, Beach.

Beach profile. Near shore geological processes- Circulation in the surf zone, erosion, transport and deposition sand budget. Beach morphodynamics- variations in beach morphology, and its significance.

Petrology of the Ocean Floor, Submarine geomorphology;

### **Unit III**

Marine depositional environments-coastal, shallow marine, and deep sea.

Shelf sedimentation- Concept of Sedimentary facies, Factors controlling nature and distribution of facies.

Coral reefs.

Deep- sea sedimentation, Sources of sediments to deep sea.

Rate of sedimentation in the oceans. Geological effect of bottom sea currents

Sedimentary and faunal markers of palaeoenvironmental conditions.

### **Unit IV**

Dissolved Organic Matter in the sea water- Chemical and biological aspects, Source of supply and processes of removal of dissolved organic matter.

Suspended Matter in sea water- Composition and characteristics of suspended matter, Settling rate of suspended matter.

Component composition and geochemistry of deep-sea sediments.

Origin and distribution of gas hydrates in marine sediments.

Radioactivity- Classification-Primary, cosmogenic and artificial radio nuclides, their occurrence,distribution and decay series. Sampling and storage of radionuclides and their application in geochronology of marine sediments.

## **Unit V**

The role of micropalaeontology in Marine Geology and Oceanography including palaeo-oceanography, palaeoclimate, marine archaeology. Environmental significance of microfossils. Micropalaeontology in Petroleum Exploration.

Fossilisation process, Types of microfossils and their classification,

Brief account of dinoflagellate – Marine diatoms and silicoflagellates.

Techniques for palaeoclimate reconstruction with respect to oxygen isotope studies.

## **Unit VI**

Physical and Chemical structure of the ocean. Physical and Chemical nature of sea water, Ocean circulation – Wave motion, Wave phenomenon, Tides, Ocean currents.

Astronomical tides of ocean, Wind waves, swells-seiches-storm surges, Tsunamis,

Turbulence – stirring – mixing – diffusion.

Littoral current- Longshore sediment transport, Wave refraction, diffraction.

Atmosphere- Ocean climate coupling, Climatic role of the ocean, Carbon Cycle, Global energy budget.

## **Unit VII**

Process of formation of Heavy Mineral Placers in Beaches, near shore areas and submerged beaches

Placer deposits of drowned river valleys.

Manganese Nodules- Occurrence and distribution, Physical characters, Morphology, Mineralogy, Chemical composition of Mn-nodules, Nodule growth. Hydrothermal sulphates, Manganese crust. Sea bed minerals with emphasis on Indian Ocean- Polymetallic nodules, phosphorites, carbonates, Petroleum resources. Gas hydrates.

## **Unit VIII**

Beach mineral exploration method, Mining of beach sands. Method of exploration and mining of drowned river valleys.

Deep sea exploration and offshore mining methods, Shallow sea exploration and mining methods, Environmental disturbance caused by mining and remedial measures.

Petroleum exploration and monitoring marine pollution.

## **Practicals**

Beach profile survey and sediment sample collection using grab and corer, Sample preservation, Grain size (sand grade) analysis and data computation, Graphical representation and interpretation.

Depositional environment studies using a data set. Techniques for heavy mineral separation and identification.

Study of microfossils.

Study of bathymetry maps, Graphical representation and interpretation of bathymetry data set.

Determination of dissolved organic N and P in seawater. Determination of particulate organic C, N and P in seawater. Determination of Fe and B in seawater by

Spectrophotometric method.

Sediment digestion procedure- Determination of Mn, Cr, and Ni in sediments by AAS method, Determination of organic C, N and P in sediments.

### **Books Recommended**

Submarine Geology- Shephard, F. P. 1973, Harper and Row  
The Sea Floor – Seabold, E. and Berger, W. H., 1982, Springer Verlag  
Introduction to Marine Geology and Geomorphology- King, C. A. M. 1975, Edward Arnold, London.  
Geological Oceanography- Shephard, F.P. 1978, Heinmann, London  
Coastal and estuarine sediment dynamics- Dyer, K. R. , 1986, John Wiley and Sons  
Beach Process and sedimentation – Komar, P. D. , 1976, Prentice Hall  
Depositional Sedimentary environments – Reineck, H. E. and Singh, I. B., 1986, Springer Verlag  
Introduction to geochemistry, Krauskopf, K.B., 1967, McGraw-Hill  
Geochemistry-Goldschmidt, V. M., 1962, Clarendon Press.  
Chemical Oceanography (Vol.1 to 3)- Riley, J. P. and Skirrow, G., 1975.  
Marine chemistry- Home, R. A. 1969.  
Introduction to Marine Micropalaeontology- B.U.Hag and A. Boersma  
Microfossils – Brasier M.D.  
Elements of Micropalaeontology – B'gnor B.  
Waves and Beaches- The dynamics of the ocean surface –Basiom W.  
Coastal Sedimentary Dynamics – Daris R.A.  
CRC Handbook of coastal process and erosion – Komar P.D.  
Oceanography – Paul R. Pinet  
Principles of Physical Oceanography- G. Neumann and W. J. Pierson  
Mineral wealth of ocean – A. K. Ghosh and Randhir Mukhopadhyay  
The mineral resources of the sea – J. L. Mero  
Handbook of marine mineral deposits- D. S. Cronon  
The Indian Ocean- Exploitable mineral and Petroleum resources – Roonwal G. S.

## **Paper XII (d)- Geoinformatics**

### **Unit I**

Geographical Information Systems (GIS): Principle, Definitions & Terminology, Roots of GIS, Need of GIS, Component of GIS. Spatial analysis- spatial elements, entities and attributes, patterns.

### **Unit II**

Map as geographic data base- Map scale, Classes of Map, Geographic Coordinate system, map projections- conformal and mathematical projections and properties, map reading.

### **Unit III**

Concept of Cartography, history and sequence of development, Cartographic processes, cartographic abstraction, generalization, accuracy and reliability. Georeferencing, Attribute data for Thematic Mapping & Preparation of Thematic maps

#### **Unit IV**

Graphic representation of data Raster & Vector, Relation between data representation & Data Analysis

#### **Unit V**

Input & Output methods, Remote sensing as raster data input

#### **Unit VI**

Editing- importance, editing errors, edge matching and rubber sheeting,

#### **Unit VII**

Digital Terrain Models (DTM)- Definition & Terminology, Approaches to DTM, Acquisition of Data, data processing & Visualization, Applications of DTM

#### **Unit VIII**

Applications of GIS- geological, geographical, Land use/Land cover, Watershed development, Environmental, Urban planning

#### **Practicals**

Identification of Geographic features, Map registration, digitization and editing, Linking external tables, Vector analysis, Raster analysis, Terrain analysis and watershed delineation. Use of sophisticated GIS based software.

#### **Books Recommended**

Remote Sensing and Geographical Information System – Anji Reddy  
Conceptes and Techniques of Geogrphical Information System – C. P. Lo and Albert K. W. Yeung  
Star J. And Estes, J.E. (1990). Geographic Information System: An introduction, New Jersey, Printice Hall.  
Aronoff, S. (1991) geographical Information Syatem- a management perspective, WDL Publication Ottawa, Canada.  
Tyner, J. (1992). Introduction to thematic Cartography, Prentice-hall, Englewood Cliff, New Jersey.  
Mishra, R.P. and A. Ramesh (1989). Fundamental of Cartography, Concepts Publishing Company, New Delhi.  
Ian Heywood, Sarah Cornwlius and Steve Carver (2000) An introduction to Geographical Information System, Addison Wesley Longman Limited, New York.  
Monkhouse, F.J. and Wilkinson, H.R. (1976). Maps and diagrams, Metheun & Co., London.  
Lawrence, G.R.P. (1971). Cartographic methods, Metheun & Co.,Canada.  
Andon, R.W. (Ed). (1984). Basic Cartography for students and technicians, Vol. 2, International Cartographic association, Elsevier Applied Science Publisher London.

**Field Work:** Five to Seven ‘One-day independent visits’ to Geological-field sites, Industries or Commercial Units of geological interest and submission of a report thereof is compulsory at the time of Practical Examination / Viva voce.

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## **Semester IV**

### **Paper XIII- Engineering Geology and Geo-techniques**

#### **Unit I**

**Introduction:** Definition, Scope of Engineering Geology in Civil Engineering and mining industry.

**Building Stones:** Engineering properties of rocks and their dependence upon geological characters, rock discontinuities, inbuilt stresses in rocks, measurement of these stresses by Flat Jack Method. Requirement of good building stone, Building stones of India, Engineering properties of soils.

#### **Unit II**

**Preliminary Geological Investigation:** Geological and geophysical studies for various projects, Engineering consideration of structural features, Importance of hydrogeology in civil engineering structures.

#### **Unit III**

**Exploratory drilling:** Observations, Preservation of cores, Core logging, Core recovery, R.Q.D., Graphical representation of core log, Limitation of exploratory drilling method, numerical problems on core drilling.

#### **Unit IV**

**Classification of dams, Geotechnical investigations for dams and reservoirs, Criteria for selection of a good dam site, Dam foundation problems, Reservoir problems, Reservoir Induced Seismicity.**

#### **Unit V**

**Earthquake and Seismicity, Seismic zones of India, Engineering problems, precautionary measures and mitigations of hazards related to seismicity. Aseismic design of Engineering Projects.**

#### **Unit VI**

**Tunnelling:** Definition, Civil Engineering terms, difficulties during tunnelling, Influence of geological conditions on tunnelling, Lining after tunnelling, Geological consideration while choosing tunnel alignment, Tunnel in folded strata, sedimentary rocks.

#### **Unit VII**

**Geology of Bridge sites:** Types of bridges, Geological investigation for selection of sites for bridge. Geotechnical studies for Beach engineering, hydroelectric power generation, Highways etc.

## **Unit VIII**

Engineering Geology of Deccan Traps: Types of basalts and associated volcanic rocks, Engineering characteristics of these rock types, Engineering significance of variation in size, number and infillings of gas cavities, Compact and amygdaloidal basalt as construction material, Effects on jointing, hydrothermal alteration and weathering on engineering behaviour of various varieties of Deccan traps. Tail channel erosion problem in Deccan Trap region, suitability of basalts from tunnelling point of view, Problems due to columnar basalt, dykes, red bole, tachylitic basalt, Volcanic breccia and fractures, Laterites-Origin, occurrence and engineering aspects. Ground water bearing capacity of the rocks of Deccan Trap region, Percolation tanks, Geological conditions suitable and unsuitable for construction of percolation tanks.

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## **Practicals**

Study of geological map of Maharashtra state and India.

Core logging of exploring drill hole.

Study and construction of subsurface sections based upon data of the series of drill holes.

Use of Electrical Resistivity Method for determining depth of bedrock.

Study of engineering properties of rock and soil samples.

Suitability of different rock types for the civil engineering work.

Problems related to RQD

Preparation of Rose diagram

Soil classification/ rock classification related problems

## **Books Recommended**

Engineering and General Geology – By Prabin Singh, S. K. Katariya and sons, Delhi.

A Text Book of Geology – By P. K. Mukerjee, The World Press Pvt.Ltd., Calcutta.

Geology Hand book in Civil Engineering- By R. F. Legget – McGrawHill, New York.

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

Engineering Properties of Rocks – By L. W. Farmer, Chapman & Hall, London.

Experiments in Engineering Geology – By K. V. G. K. Gokhale & D. M. Rao, TMN, New-Delhi.

A Text Book of Engineering Geology – By R. B. Gupte, Pune Vidyarthi Griha Prakashan, Pune.

Engineering Geology for Civil Engineering – By Dr. D. V. Reddy, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Engineering Geology - By B. S. Sathya Narayanswami, Dhanpat Rai & Co.(P) Ltd, Delhi.

Engineering Geology Laboratory Manual.

Geology of India and Burma- M. S. Krishnan, Higginbothams Pvt. Ltd.

Koyana Earthquake Journal (1968) Indian Geophysics Uni.

Introduction to Rock Mechanics by Verma B. P., Khanna Publisher, Delhi.



## **Paper XIV: Natural Resource Management**

### **Unit I**

Meaning and Classification of Natural Resources- Renewable and non-renewable resources.

Identification of natural resources – Economic minerals, Natural Fuels, Water, Land, Soil, and Forests. Human use and its impact on the resources.

Management tools and techniques. Planning for Sustainable Development. National Policy for Natural Resources.

### **Unit II**

Classification of economic minerals based on their use, Ore minerals- Production, treatment and use of Precious metals, Ferrous metals, Rare earth / minor element resources. Non-metallic minerals-Classification, Production, treatment and uses in - Ceramic, refractory, pigments, paints, fertiliser etc. industry.

Mineral resources management and conservation. Principles and Criteria of management. Scientific methods of mineral processing and recycling.

### **Unit III**

Marine Mineral Resources- Factors controlling occurrence and distribution of Polymetallic / Manganese nodules, Phosphorites, Hydrocarbons, Beach Placers, Evaporites, Rare metals, Ornamental stones- Corals, Pearls, and Shells.

Management of Marine Resources- Principles and parameters.

### **Unit IV**

Land Resources- Land as a natural resource, Land use and Land cover classification system. Physiography, climate, structure and composition of –Forest, Croplands, Grazing, Desert and Wastelands. Land use evaluation and planning. Techniques of terrain evaluation.

Management of Land Resources – Croplands, Wasteland, Grazing land, Forests and Deserts.

### **Unit V**

Soil resources – Soil profile, Soil Types – Components and Genesis. Physico-chemical parameters of soil in relation to Agriculture and Engineering Practices. Soil erosion- preventive measures. Soil Conservation Practices.

### **Unit VI**

Water resources – Water as a Renewable Resource – River resources and Flood control, Groundwater resources- Occurrence and Distribution.

Management of water resources- Identification of problems of overdraft, over-irrigation- Salination of soil and water, Seawater intrusion in coastal aquifers, Surface water and Groundwater Pollution.

Remedial Measures- Water budgeting-Demand and Supply evaluation. Sustainable Watershed Development. Surface water conservation methods. Groundwater Recharge- Natural and Artificial methods,

Water Quality parameters and standards for domestic, agriculture and industrial use.

Water use and Law, National and Maharashtra State Water Policy.

## **Unit VII**

Natural Energy Resources –Role of energy resources in the development of a Nation. Non- Renewable energy resources-Coal, Petroleum, Natural Gas and Atomic Minerals- Production, treatment and use. Indian occurrences. Planned development and Integrated use.

## **Unit VIII**

Conventional and Non-conventional Energy Resources. Wind Energy as a Resource, Wind availability, Geomorphological considerations in the site selection for windmills. Solar Energy as a Resource, Geological, Climatological aspects in Harnessing Solar Energy.

Forests resources – Forest cover, Integrated use of forest resources, Degradation of forest resources and remedial measures.

Coastal resources and problems.

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## **Practicals**

Study of Mineral Map of India. Preparation of land use pattern maps from field studies, Water budgeting, Study of Toposheets and Remote Sensing data, Analyses of multidisciplinary data such as water availability, land use, agricultural practice, soil character and composition for optimum and sustainable development.

## **Books Recommended**

Natural Resource Ecology, Economics and Policy - Holechek, J. L., Cole, R. A., Fisher, J. T., and Valdez, R., 2<sup>nd</sup> Edition, 2003, Prentice Hall Education.

Modelling in Natural Resource Management Development, Interpretation and Application- Shenk, T. M. and Franklin A. M., 2001, Island Press.

Making Collaboration Work- Lessons from Innovation in Natural Resource Management- Wondolleck, J. M. and Yaffee, S. L., 2000, Island Press

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

Principles of Geographical Information System for land Resources Assessment - Burroughs, P. A., 1986, Oxford University Press.

Understanding GIS: The Arc Info method Training Course for GIS for resource management and development planning- Environment Systems Research Institute, 1993.

Examination and Valuation of Mineral Property- Banter and Parks

India's Mineral Wealth-Brown and Day.

Groundwater Assessment, Development, and Management- Karanth K. R.

Geology of Petroleum- Leverson

Petroleum Geology- Russel

## **Paper XV- Environmental Geology**

### **Unit I**

Introduction, fundamental concept and scope of Environmental Geology, Concepts of lithosphere, hydrosphere and atmosphere and their Physico–chemical characteristics. Time scales of changes in the ecosystem and climate.

### **Unit II**

Ecology –Meaning and Scope, Concept of Ecosystem, Energy flow in ecosystem, Earth systems and cycles: Carbon Cycle, Nitrogen Cycle, Oxygen Cycle, Phosphorus cycle.

### **Unit III**

Natural hazards – Types, causes, effects and controlling of natural disasters- Volcanism, Earthquakes and tsunamis, Avalanches, Floods, Landside, Coastal hazards, Desertification : Planning for disaster mitigation, Remedial measures and Case studies,

### **Unit IV**

Air Pollution: Sources and Classification of air pollutants, Effects of air pollution on environment, antipollution measures, Acid rain, Ozone depletion, Green House Effects & Global Warming, Remedial measures. Water pollution: BIS and WHO Standards for water quality, Sources and Classification of surface water and groundwater pollutants - Domestic waste, Agricultural waste, Fertilizers and pesticides, Remedial measures.

### **Unit V**

Soil Pollution: Geological conditions vulnerable to soil pollution- Rock type, Soil cover, Depth of weathering, Porosity and Permeability. Sources and Classification of pollutants effects on soil, alkaline / saline soil, acidic soils, formation of wasteland and its reclamation.

### **Unit VI**

Environmental aspects of mining and refineries- Open cast and underground mining, refineries. Hazardous Waste Disposal - Solid and liquid waste. Geological factors in selection of sites for solid, liquid, hazardous waste disposal, remedial measures.

### **Unit VII**

Environmental Impact Assessment (EIA)– Risk Assessment and Analysis, Remedial Measures, Environment Management Plan (EMP).

### **Unit VIII**

Role of Geology in Environmental management. Hazard Zonation Maps and Preparedness Plans with respect to Mining, Earthquakes and Tsunamis, Volcanism, Landslides, Floods and Desertification.

## **Practicals**

Methods of collection of surface and groundwater samples.

Analysis of water samples,– pH, EC, ( Electrical Conductivity), total hardness, Ca, SO<sub>4</sub>.

Classification of water samples for finding its suitability as drinking, irrigation, industrial suitability with reference to BIS and WHO standards.

Presentation of chemical analysis data and plotting chemical classification diagrams.

Preparation of hazard zonation maps for different kinds of hazards.

## **Books Recommended**

Principles of Environmental Science- Watt K. E. F., McGraw Hill Book Company

Environmental Geology- K.S. Valdiya, 1987, Tata McGraw Publication

Environmental Geology –Keller, E. A. 1978, Bell and Howell, USA

Fundamentals of Ecology- E. P. Odum

Natural Hazards – Bryant, E., Cambridge University Press

Geological Hazards – Bell, F. G., 1999, Routledge, London

Disaster Management- Prakash I., Rashtriya Prahari Prakashan.

Disaster Management- Sharma, V. K. I. I. P.A. New Delhi

Chemical and Biological Methods for Water Pollution Studies- R. K. Trivedi and P. K. Goel, Enviro Publication

Environmental Biology- K. C. Agarwal, Agro-Bios Jodhapur.

Environmental Impact Assessment – Larry W. Canter, McGraw Hill Industrial Edition.

The Dynamic Earth System – Patwardhan, A. M., 1999, Prentice Hall

## **Paper XVI- Dissertation**

Each student is required to undertake a Dissertation / Institutional Training under the Guidance of a Faculty Member at the beginning of Semester III. The work may involve field investigations, survey of useful of earth materials in industries, laboratory studies, a theoretical investigation accompanied by computational work, data processing and analysis or a combination of these.

Towards completion of the work each student should present his work using Power Point to the audience consisting of his/her Guide, Head of the Department, Staff and Students of Geology Department and interested persons from other departments. The draft of the thesis should then be then finalised and typed. The dissertation guide should review the draft thesis at least twice in due consultation with the concerned student before finalising it.

Each student should prepare and submit two copies of the thesis to the Head of the Department one week prior to the Practical Examination. One copy of the thesis will be returned to the student and the other will be retained by the guide.

The dissertation work carries 100 marks which will be evaluated as per following guidelines:

- 50 marks- Evaluation by the Guide and Head of the Geology Department on the basis of performance of the student – punctuality, enthusiasm, and aptitude- during fieldwork / survey of industries / laboratory work / theoretical investigations / data processing as applicable.

- 50 marks for Power Point Presentation and Preparation of the thesis– to be evaluated by the Internal and External Examiners.

### **Practical**

During practical examination of dissertation work the students will display the following with appropriate labels and explain the same to examiners.

- a) Geological specimens/samples collected during fieldwork,
- b) Thin sections and /or other laboratory material prepared for dissertation work,
- c) Thesis with Map and/or other literature, photographs etc relevant to the area of study.

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### **Teaching Hours**

4 Lectures of 60 minutes duration per Theory paper per week.

6 Clock hours per Practical per week.

Total 40 Lecture periods of 60 minutes per Theory paper of 100 marks per Semester.

Total 15 Practical amounting to total 90 clock hours per Practical-paper per Semester.

### **Pattern of Examination**

Theory and Practical Examination will be held at the end of each Semester.

There will be 4 theory papers of 100 marks each and 3 hours duration each.

There will be 2 Practical-papers of 100 marks each. Each practical-paper will last for six hours. Total 2 days practical examination.

### **Nature of Question Papers**

#### **Theory**

Each theory paper will consist of 7 questions of 20 marks each, out of which 5 questions are to be solved (amounting to maximum 100 marks) as detailed below:

Q. No. 1: Compulsory : This will be Objective Type involving Multiple Choice Questions / One line answers / Definitions / Reasoning etc.

Out of Question Numbers 2, 3 and 4 any two questions are to be solved: These will be Long Answer Type / Descriptive.

Out of Question Numbers 5, 6 and 7 any two questions are to be solved: These will be Short Answer Type with Internal Options.

#### **Practicals**

Each practical will be for 100 marks out of which 80 marks will be for respective practical work and 20 marks will be allotted to

- i) Journal – 5 marks
- ii) Viva – 5 marks
- iii) Fieldwork Report and Collection – 10 marks.

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