

# SCHOOL OF ENVIRONMENTAL & EARTH SCIENCES

North Maharashtra University, Jalgaon

## **M. Sc. (Applied Geology) Syllabus**

### Semester I

- GS 101: Mineralogy & Crystallography.  
GS 102: Principles of Stratigraphy and Palaeontology  
GS 103: Sedimentology  
GS 104: Practicals related to above courses  
GS 105: Practicals related to above courses

### Semester II

- GS 201: Igneous & Metamorphic Petrology  
GS 202: Physics & Chemistry of the Earth.  
GS 203: Geomorphology, Structural Geology and Tectonics  
GS 204: Practicals related to above courses  
GS 205: Practicals related to above courses

### Semester III

- GS 301: Indian Stratigraphy.  
GS 302: Indian mineral deposits, exploration and mining  
GS 303: Remote sensing and GIS  
GS 304: Practicals related to above courses.  
GS 306: Practicals related to above courses.

### Semester IV

- GS 401: Petroleum geosciences.  
GS 402: Hydrogeology  
GS 403: Engineering and environmental geosciences.  
GS 404: Practicals related to above courses  
GS 405: Practicals related to above courses

**Note:** Industrial training/Geological field mapping/allotted geological project work/

Dissertation is compulsory for M. Sc. (Applied Geology) students.

## SEMESTER - I

### **GS-101: MINERALOGY AND CRSTALLOGRAPHY**

#### **Plane polarized light**

- Plane polarized and cross polarized light-Isotropic and Anisotropic minerals Behaviour of minerals in cross polarized light
- Birefringence - Uniaxial and Biaxial minerals - Uniaxial and Biaxial Indicatrises - Orientation of indicatrises as per the section
- Interference of light waves - Passage of light through doubly refracting minerals Generation of interference colours

#### **Conoscopic or convergent polarized light**

- Conoscopic or convergent polarized light - Generation of Uniaxial and Biaxial interference figures - Forms of interference figures related to sections- Optical accessories like mica, gypsum and quartz plates - Determination of Optic sign of uniaxial and biaxial minerals
- True and apparent optic axial angle,  $2V$  and  $2E$ , - Methods of determination of optic axial angle - Use of Universal stage
- Dispersion of light - its effect on interference figures
- Absorption of light by minerals - Scheme of pleochroism

#### **Mineral structure and chemical composition**

- Structure, relation of Chemical composition with optical, physical properties, alteration products and paragenesis of following group of minerals.
- Olivine, Pyroxenes, Feldspar Amphiboles, garnet, Mica, Alumino silicate, Epidote, , Fledspathoid, Zeolite and Clays

#### **Crystal systems**

- Definition of Crystal - Classification of crystals into Crystal systems
- Concept of unit cell - Proper and improper symmetry operations

#### **Classification of crystals**

- Concept of Point Group - Classification of crystals into 32 Point Groups
- Concept of Space lattice - Derivation of 14 Bravais lattices – HCP
- Concept of Space Group - Symmorphic and Asymmorphic Space Groups

**X-ray diffraction methods and mineral chemistry** X-ray diffraction methods in mineralogical investigations – Identification of X-ray patterns - Twinning in crystals

- Mineral Chemistry - Concepts and examples of Isomorphism, Polymorphism, solid solutions

## **GS-102: PRINCIPLES OF STRATIGRAPHY AND PALAEOLOGY**

### **History and development**

- History and development of Stratigraphy
- Stratigraphic procedures (Surface and Subsurface)
- Concept of Lithofacies & Biofacies

### **Stratigraphic Correlation**

- Stratigraphic Correlation (Litho-, Bio- and Chronostratigraphic Correlation)
- Study of standard stratigraphic code (Lithostratigraphic, Biostratigraphic and Chronostratigraphic)
- Concepts of Magnetostratigraphy, Chemostratigraphy, Event stratigraphy, and Sequence stratigraphy
- Techniques in Palaeontology - mega fossils - microfossils - nannofossils - ichnofossils - collection, reformation & illustration - binomial nomenclature

### **Invertebrate Palaeontology**

- Invertebrate Palaeontology - A brief study of morphology, classification, evolutionary trends and distribution of Molluscs i.e. Bivalves and Gastropods, Echinoids, Corals & Brachiopods.

### **Vertebrate Palaeontology**

- Vertebrate Palaeontology - Brief study of vertebrate life through ages, Evolution of reptiles and mammals

### **Palaeontological perspective**

- Palaeontological perspective : Use of palaeontological data in a) Stratigraphy b) Palaeoecology and evolutions

### **Introduction to Micropaleontology**

- Introduction to Micropaleontology
- Types of Microfossils
- Paleopalynology
- Foraminifera & Ostracods

## **GS-103: SEDIMENTOLOGY**

### **Field procedures**

- Field procedures in Sedimentary Petrology
- Geologic cycle

### **Sedimentary textures**

- Sedimentary textures (Granulometric analysis, shape and roundness studies, surface textures)
- Heavy mineral and Insoluble residue analysis

### **Petrography**

- Petrography of rocks of clastic, chemical and biochemical origin (Conglomerates, Sandstone, Mudstone, Limestone & Dolomite)
- Evaporite, Phosphorite, Chert, Iron and Manganese rich sediments
- Volcanogenic sedimentary rocks

### **Clastic transport and fluid flow**

- Clastic transport and fluid flow (fluid flow in theory and in nature, Reynold's Numbers, Froude Number, Sediment lift, transport, deposition, sedimentary gravity flow)

### **Sedimentary structures**

- Sedimentary structures (Physical structures, Biogenic sedimentary structures, Diagenetic structures)

### **Sedimentation and Tectonics**

- Concept of Sedimentary facies association models (Marine, Nonmarine, and Mixed Depositional Environment)
- Sedimentation and Tectonics
- Paleocurrents & Basin Analysis

## **GS-104: PRACTICALS RELATED TO ABOVE COURSES**

1. Study of interference figures - determination of optical sign of minerals, determination of 2V and 2E, determination of composition of plagioclase feldspars - determination of birefringence of minerals - Scheme of pleochroism
2. Construction of Stereograms and Gnomonograms - measurement of interfacial angle with contact goniometer - study of X-ray diffractograms
3. Study of rock forming minerals in thin sections
4. Study of rock forming minerals in hand specimens
5. Construction of rank charts for lithostratigraphy, biostratigraphy & chronostratigraphy
6. Construction of graphical logs from text descriptions
7. Exercises in correlation from given data or logs
8. Study of palaeontological technique related to megafossils.
9. Study of morphology of Bivalves, Gastropods Echinoids, Brachiopods
10. Separation, Processing, wet sieve analysis, preparation of slides of microfossils.
11. Morphology and morphological descriptions of planktonic and benthonic foraminifera, ostracodes.

## **GS-105: PRACTICALS RELATED TO ABOVE COURSES**

1. Size Analysis (Procedures, Cumulative curve, Histogram, Visher's curve and Statistical calculation)
2. Shape analysis (Calculation and Classification)
3. Heavy mineral analysis (Procedure and identification)
4. Insoluble residue analysis (Procedure and identification)
5. Megascopic and studies of conglomerate and breccia
6. Megascopic and microscopic study of sandstone
7. Megascopic and microscopic study of limestone
8. Sedimentary structure (identification and classification)
9. Paleocurrent and basin analysis calculation

## SEMESTER – II

### GS-201: IGNEOUS PETROLOGY AND METAMORPHIC PETROLOGY

#### Igneous Petrology:

##### Magmatism

- Magmatism and Plate tectonics
- Textures and structures of Igneous rocks
- Classification of Igneous rocks - historic perspective and the IUAG systematic
- Petrogenetic Provinces: Continental areas , Layered gabbroic intrusions , Plutonic, Oceanic areas and Oceanic Rift valleys
- Volcanic , Plutonic and Hypabyssal Igneous rocks
- Indian Igneous Rocks and their genesis

##### Geochemical tracers of mantle processes

- Continental and oceanic mantle lithosphere
- Mid-Oceanic-Ridge-Basalt (MORB)
- Island arc basalts

##### Magma Crystallisation and Evolution

- Partial melting and Magmatic differentiation
- Contamination and Mixing of magmas
- Role of Volatile components
- Binary and Ternary systems

##### Metamorphic Petrology

- Types of metamorphism and their controlling factors
- Grades of Metamorphism
- Common minerals of metamorphic rocks
- Metamorphic Texture and Structures
- Metamorphic facies
- Metamorphism types & products

##### Effects of Metamorphism

- Phase diagrams and graphic representation of mineral assemblages
- Prograde and retrograde metamorphism, Metasomatism
- Metamorphic reactions, elemental exchange and P-T conditions of isograds.

##### Metamorphism in space and time

- Plate tectonics and metamorphic processes
- Paired metamorphic belts, Archaean and Proterozoic terrains
- Pressure-temperature time paths in regional metamorphic rocks, Polymetamorphism

## **GS-202: PHYSICS AND CHEMISTRY OF THE EARTH**

### **Universe, Solar system and comparative planetary geology:**

- Origin and components of solar system
- Galaxies their classification, Stars and star formation processes
- Meteorites and their classification
- Earth in relation to the solar system and universe
- Theories of origin of solar system
- Cosmic Abundances of elements
- Composition of the planets and meteorites

### **Seismology and interior of the Earth:**

- Seismic waves and their velocities
- Internal structure of the earth,
- Structure Composition and evolution of the earth and distribution of elements,
- Geochemical classification and distribution of elements in the earth
  
- Structure and atomic properties of elements
- The Periodic table
- Laws of Thermodynamics and phase diagrams
- Geochemistry of hydrosphere, biosphere and atmosphere
  
- Elementary crystal chemistry and thermodynamics

### **Geochronology and age of the Earth**

- Law of Radioactivity,
- Principles of isotopic dating, Decay schemes and Derivation of equation of age.
- Introduction to isotope geochemistry
- Rb/Sr, U-Th-Pb methods of dating the rocks.
- Age of the Earth.
- Trace elements

### **Gravity, magnetism and thermal history of the Earth**

- Density distribution, shape and mass of the earth. density vs depth profile.
- Gravity and gravitational mechanics, gravity anomalies and their interpretation
- The earth as Magnet, Earth's magnetic field, changes in magnetic field, origin of geomagnetic field, palaeomagnetism
- Various Geophysical Exploration Methods

### **Geochemical Methods**

- Introduction to Geochemistry – its scope, Geochemical Classification of the elements
- Geochemical Cycle, path finder Elements, threshold values and Mode of Occurrence
- Geochemical methods – Geochemical Anomalies – 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

## **GS-203: GEOMORPHOLOGY, STRUCTURAL GEOLOGY AND TECTONICS**

### **Geomorphology**

- ❖ Introduction to Geomorphology : History, basic concepts type and tools
- Landforms : Role of lithology, climate and tectonics
- Denudational processes - weathering, erosion, transportation, weathering products and soils - profiles, types, duricrusts
- Hillslopes : Their characteristics and development, fluvial processes on hill slopes
- River and Drainage basin : Drainage patterns, network characteristics, Valleys and their development. Process of river erosion, transportation and deposition
- Landforms produced by geomorphic agents
  - a) Fluvial b) Coastal c) Aeolian, d) Glacial, e) Karst, and Desert landforms
- Applied Geomorphology : Application of geomorphology in geohydrology, mineral prospecting, engineering geology, watershed management, urban planning and environmental studies
- Geomorphology of India : Geomorphological features and zones
- Geomorphic mapping, slope analysis and drainage basin analysis
- Physiographic zones of Maharashtra
- Topographical maps

### **Structural Geology**

- Principles of geological mapping and map reading
- projection diagrams
- Mechanical principles of rock deformation,
- Behaviour of rock material under stress, strain analysis
- Classification and genesis of folds, faults, lineations, foliations, joints and fractures
- Scope of structural analysis , concept of Tectonite fabric and Tectonite Symmetry
- Structural analysis on microscopic, mesoscopic and macroscopic scales
- Introduction to petrofabrics
- Structural behavior of igneous rocks, diapirs and salt domes diapirs and salt domes

### **Tectonics**

- Structure and physical characters of continental and oceanic crust
- seismic belts of the earth
- Continental drift – geological and geophysical evidence, mechanics, objections, present status
- Sea - floor spreading and Plate Tectonics, Structure and Tectonics of divergent margins, transform faults, convergent margins
- Geodynamics of the Indian Plate and Tectonic framework of India
- Heterogeneity of the earth's crust
- seismicity and Plate movements
- Palaeomagnetism
- Neotectonics - Features and evidences-characteristic landforms, Methods of analysis
- Orogeny and epeirogeny
- Isostasy
- Gravity and magnetic anomalies at Mid-ocean ridges, deep sea trenches, continental shield areas and mountain chains, , Island arcs, Oceanic islands and volcanic arcs,

## **GS-204: PRACTICALS RELATED TO ABOVE COURSES**

1. Characterisation of igneous rocks, textures & structures.
2. Characterisation of different rock types under microscope  
Igneous rocks and Metamorphic rocks
3. CIPW normative calculation for igneous rocks.
4. Variation diagrams  
Igneous: Binary and Ternary

## **GS-205: PRACTICALS RELATED TO ABOVE COURSES**

1. Structural problems by orthographic and stereographic methods.
2. Construction of structural sections and interpretation of geological maps.
3. Plotting and interpretation of mesoscopic structural data
4. Drainage basin and network morphometry
5. Relief and slope analysis - Profiles and maps
6. Identification of landforms on toposheets, aerial photographs and satellite images
7. Study of representative soil profiles

### **Text books for Semester -II**

Barker - Igneous Rocks, Magmatic Rocks - Middle most, Igneous Rocks - Rock  
Philpot - Igneous & Metamorphic Petrology, Jackson (ed.) - Earth's mantle  
Davis - Earth Dynamics, Yoder - Basalt, Yoder & Tilly - Basaltic magmatism  
Jackson Ian (Ed) - The Earth's Mantle : Composition, structure and Evolution  
Davies G.F. - Dynamic Earth : Plates, plumes and Mantle convection  
Turner and Verhoogen : Igneous and Metamorphic Petrology  
Philpotts : Principles of Igneous and Metamorphic Petrology  
Harker : Metamorphism, Turner : Metamorphic Petrology  
Wrinkler : Petrogenesis of Metamorphic Rocks, Miyashiro : Metamorphism and Metamorphic Belts  
Yardley : An Introduction to Metamorphic Petrology, Spry : Metamorphic Textures  
Best : Igneous and Metamorphic Petrology, Patwardhan : The dynamic Earth System  
E.M.Moore & R.J.Twiss : Tectonics, Valdiya : Aspects of Tectonics - focus on south central Asia  
V.V.Belousov : Geotectonics, Condie : Plate Tectonics & Crustal Evolution  
BillinAG : Structural Geology  
BadAGey : Structural & Tectonic Principles  
Turner & Weiss : Analysis of Metamorphic Tectonites  
Ramsay : Folding & Fracturing of Rocks  
De Sitter : Structural Geology  
Sander : Introduction to Deformation of Geologic Bodies  
Thornbury : Principles of Geomorphology  
Rice : Fundamentals of Geomorphology  
Kale & Gupta : Introduction to Geomorphology  
A.D. Howard and I Remson : Geology in Environmental Planning  
Brown and Mussett : The inaccessible Earth  
Jackson (ed.) : The Earth's Mantle  
Stacy : Physics of the Earth  
Melchior : The physics of the Earth's Core : An Introduction  
Jacobs, Russels and Wilson : Physics and geology  
Sheidegger : Principles of Geodynamics  
Van Bemmelen : Developments in Geotectonics No.2 (Geodynamics Model : An evaluation and synthesis)  
Jeffreys : The Earth : Its origin, History & Physical constitution  
Kaula : An Introduction to Planetary Physics  
Physics and Chemistry of the Earth - Paragon Press  
Takanaki and Kanamori : Debate about the Earth

## SEMESTER – III

### GS-301: INDIAN STRATIGRAPHY

#### **Precambrian Stratigraphy of India –Part 1- Archaeans**

##### **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)
- Granulites, charnockites, Khondolites of eastern ghats
- Structure, tectonics and stratigraphy of the OMG, OMTG, Iron Ore Group (Singbhum Craton)
- Stratigraphy of the Sukma, Bengpal, and Bailadila series from Central India
- Stratigraphy of BGC /Bhilwara Super Group of Rajasthan
- Ancient granites, viz. Singbhum, Chitradurga, etc.
- Archaeans of the Extra Peninsular region

#### **Precambrian stratigraphy of India-Part 2- Proterozoic**

##### 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
  - ❑ Vindhyaans
  - ❑ Cuddapah
  - ❑ Pranhita-Godavari
  - ❑ Bhima
  - ❑ Kaladgi

#### **Phanerozoic stratigraphy of the Extra peninsular region**

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
- Statigraphy and tectonics of the Siwaliks

## **GS-302: INDIAN MINERAL DEPOSITS, EXPLORATION AND MINING**

### **Indian mineral deposits and mineral economies:**

- Occurrence and distribution in India of metalliferous deposits – base metals, iron, manganese, aluminum, chromium, nickel, gold, silver, molybdenum, Indian deposits of non-metals – mica, asbestos, barites, gypsum, graphite, apatite and beryl, Gemstones, refractory minerals, abrasives and minerals used in glass, fertilizer, paint, ceramic and cement industries, Building stones, Phosphorite deposits, Placer deposits, rare earth minerals.
- Coal deposits: Classification, genesis and distribution of coal fields in India
- Strategic, critical and essential minerals,
- India's status in mineral production changing patterns of minerals consumption, National Mineral Policy,
- Mineral Concession Rules, Marine mineral resources and Law of sea.

### **Ore genesis:**

- Ore deposits and ore minerals Magmatic processes of mineralization.
- Porphyry, Skarn and hydrothermal mineralization.
- Fluid inclusion studies.
- Mineralization associated with – (i) Ultramafic, mafic and acidic rocks. (ii) Greenstone belts. (iii) Komatites, Anorthositic and Kimberlites and (iv) submarine volcanism,
- Magma-related mineralization through geological time.
- Stratiform and Stratabound ores,
- Ores and metamorphism- cause and effect relations.

### **Mineral exploration:**

- Methods of surface and subsurface exploration,
- prospecting for economic minerals – drilling, sampling and assaying,
- Geophysical techniques – gravity, electrical, magnetic, airborne and seismic,
- Geomorphological and remote sensing techniques,
- Geobotanical and geochemical methods,
- Borehole logging and surveys for deviation.

### **Mining:**

- Guides to ore: Regional and Topographical Guides, Mineralogical Guides , Structural Guides and 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

### **Practicals Related To Indian Mineral Deposits, Exploration and Mining**

- Delineation of ore deposit based on exploration data.

- Economic evaluation of ore deposit.
- Preparation of technical report.
- Geochemical map interpretation, Interpretation of anomalies groundwater and river water, Selection of geochemical methods in mineral exploration.
- Interpretation of field geophysical data gravity, magnetic, electrical, seismic and radio active in deciphering groundwater, mineralized zones and construction site evaluation.
- Study of metallic and non- metallic economic minerals.

### **Books and references**

1. Geochemistry In Mineral Exploration Awakes, H & Wobb J.S. Harper & Row New York.
2. Principles Of Geochemical Prospecting, Ginsburg. I.I. Pentagon Press, N.Y. london.
3. Geochemistry Of Rare And Dispersed Chemical Elements In Society, Vinogradev.
4. Biochemical Methods Of Prospecting, Malyuga, D.P.
5. Geochemistry Of Epigenesis - Faibidge.
6. Principles of Mining Geology, Arcokiaswamy..
7. Introduction To Geophysical Prospecting - Milton B, Dobrin Mc-Graw Hill Book Company, Inc
8. Exploraion Geophysics - Jakaosku, J.J.
9. Outlines Of Geophysical Prospecting - A manual for Geologists. M.B.R. Rao. Prasaranga, Mysore University
10. Geophysical Methods in Geology - P.V. Sharma.
11. Applied Geophysics In The Search For Minerals - Eve. A.S.Keys.
12. Geophysical Exploration - Heilava. C.H.
13. Exploration Geophysics for Geologists And Engineers - Edited by Bhimasanakaran, V.L.S. Gour. V.K. - The Association of Exploration Geophysists - Hyderabad
15. Principles of Applied Geophysics - D.S. Parasnis
16. Introduction to Geophysics -C.H.Howel.
17. The Geology Of Ore Deposits - John M. Guilbert and charles. F.Park, Jr.W.H.Freeman and Co., New York. 1986.
18. Economic Mineral Deposits, Bateman, A.M.
19. Ore Deposits - Park, Jr. C.F.
20. Geology Of Mineral Deposits - Smirnov, U.J.
21. The Ore Minerals And Their Intergrowths - Ramhor, Dr. Paul.
22. Ore Petrology - Stanton, R.L.
23. India's Mineral Resources - Krishnaswamy, S.
24. Metallic and Industrial minerals - Lamey Carl, A.
25. Introduction To India's Economic Minerals - Sharma, N.L. & Ram. K. S.
26. A Treatise On Industrial Minerals Of India-Sinha, R.L.
27. Mineral Deposits Of India, Mukerjee 1999: Allied publications.
28. Elements of Mining Geology, Young
29. Elements of Mining - Lewis
30. Mining Of Mineral Deposits – Shevyekov
31. Introduction Of Mining - Stoces

## **GS-303: REMOTE SENSING AND GIS**

### **Fundamentals of Remote Sensing**

Concepts and principles of Remote Sensing

The nature and generation of EMR

Interaction of EMR with the atmosphere and earth's surface features.

### **Satellite Remote Sensing:**

Satellite Remote Sensing – Data products and their specifications

Remote Sensing observations and platforms

Types of sensors, Data Resolution

Global and Indian Space missions

### **Digital Image Processing and Image Interpretation**

Digital Image Structure and Data recording formats

Image rectification and restoration

Image enhancement and classification

Image transformation and data fusion

Ground truths and training sets in image processing and in automated processing

Visual photo interpretation techniques based on 'photo elements' and 'terrain elements'

### **Geographic Information Systems (GIS) and GPS**

Principles and applications of GIS

Map Projections Systems, Map Visualization

Traditional maps, map scales and their interpretation

Components of GIS

GIS data models and structures

GIS analysis and GIS modeling

Integration of Remote sensing and GIS techniques and its applications in Geological Sciences

Principles and applications of GPS

### **Computer Applications**

Basic concepts of computer, hardware, operating systems

Application software in Geology: word processing, spreadsheets, graphics and data base,

### **Practicals related to Remote Sensing & GIS:**

Determination of photo scale,

Study of traditional maps

Visual interpretation of earth's features from aerial photographs and satellite images

Stereo-photo interpretation

Photogrammetric computation

Preparation of different thematic maps in GIS

Operation of GPS

Drawing flow charts for the computer programs required in solving Geoscientific problems

## **Books and references:**

1. Aerial photographic interpretation, Principles and applications - D.R.Leuder.
2. Photogeology - Miller, J.C.
3. Manual of colour aerial photography -Ed. Smith, J.T.Jr.
4. Manual of photogrammetry - Ed: Morrie M.Thompson.
5. Manual of Remote sensing - Ed: Robert G Reeves.
6. Theory of pattern recognition and modern forecasting - V.Karpin and Wright Pattern.
7. Remote sensing in Geology - Parry S. Siegal & Alan. R.Gillespie
8. Manual of photographic interpretation - Ed: Colwell, R.N.
9. Principles of Remote Sensing - Patel Singh; SP publication
10. Digital Remote Sensing - Pritivish Nag M Kudrat ; Concept publication
11. Principles of GIS for land and resources assessment, Burrough, P.A., 1986, Oxford.
12. An introduction to Geographical information systems: Ian Heywood, Sarah Cornelius and Steve Carver.Publisher: Longman.
13. Geographical information systems Vol 1 & 2. Edited by: Paul A.Longley, Michael F.Goodchild, David J. Maguire & David W.Rhind.
14. Geographical information systems and digital image processing – Muralikrishna 1999. Allied Publication

## SEMESTER – IV

### GS-401: PETROLEUM GEOSCIENCES

#### **Composition of Reservoir and Source rocks**

- Composition of hydrocarbons & non hydrocarbons component
- Physico-chemical properties of hydrocarbons (oil, gas, oil field waters, Coal bed methane, hydrates)
- Surface & subsurface occurrences of hydrocarbons
- Theories of Organic & inorganic Origin of hydrocarbons: Merits & De-merits  
Organic petroleum geochemistry and conversion of organic matter into hydrocarbons
- Kerogen : Composition, classification and types
- Source & reservoir rocks (porosity & permeability); petroliferous basins

#### **Total Petroleum Systems**

- Migration-Primary & Secondary, characteristics & processes
- Accumulation: Favorable & unfavorable conditions; nature of accumulation
- Clastic & non clastic Reservoirs rocks
- Traps: introduction, conditions of formation and Types

#### **Distribution of Reservoir fluids and Oil Field Waters**

- Introduction to Oil-Water, Gas-Oil Contacts
- Fluid flow within Reservoirs

#### **Exploration & Logging**

- Introduction to Geophysical, Geo-bio-chemical and Geobotanical prospecting
- Logging: Introduction, Types & Interpretation.
- Seismic methods: Principles, techniques, tools and interpretation
- Electrical logs: Principles, techniques, tools and interpretation
- Gamma ray & neutron logs: Principles, techniques, tools and interpretation

#### **Development of Hydrocarbon deposits**

- Development of mature oil-gas fields: Objectives, stages, processes and execution;
- Enhance Oil Recovery (EOR): Primary, Secondary & Tertiary

#### **Drilling Techniques**

- Introduction to Drilling methods, Rigs and their types,
- Component of Rigs & Drilling Mechanism.
- Drilling and mud parameters

#### **Petroliferous basins-**

- World scenario and at least one case study of economically important Hydrocarbon deposits;
- Petroliferous basins of India: Stratigraphy, lithology, structure and reserve estimation of – Bombay high, Krishna Godavari, Assam, Cambay and Jaisalmer Basins

## **GS-402: HYDROGEOLOGY**

### **Introduction**

- Hydrosphere – Evaporation, condensation, precipitation, interception, runoff cycle (surface, subsurface and groundwater), infiltration.
- Factors that affect occurrence of groundwater – Climate, topography, geology and hydrogeologic properties of rocks.
- Hydrogeological classification of rocks
- Constraints of water resources

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

- Vertical distribution of groundwater.
- Hydrologic properties of Rocks – Porosity, Hydraulic conductivity
- Derivation and validation of Darcy's Law.
- Aquifers – Characteristics of unconfined and confined aquifers
- Behaviour of alluvium, sedimentary, crystalline and volcanic rocks as aquifers
- Flow net analysis
- Types of well

### **Pumping tests**

- Pumping tests – principles – types of pumping tests, procedures, determination of aquifer properties and well characteristics by simple graphical methods.
- Significance of transmissivity, storativity and specific capacity of wells.

### **Groundwater quality**

- Quality of groundwater – chemical standards for drinking and irrigational water- concept of hydrogeochemical facies
- Seawater intrusion – Ghyben Herzberg relation – remedial measures

### **Exploration techniques**

- Integrated approach to groundwater prospecting: Role of toposheets and remote sensing in groundwater exploration
- Hydrogeomorphological mapping
- Surface and subsurface Geophysical methods,
- Tracer techniques Exploratory Borewell programme

### **Watershed Development and management**

- Introduction to Watershed development : Artificial recharge techniques, surface water harvesting techniques.
- Conjunctive use of surface and groundwater.
- Groundwater provinces of India.
- Groundwater in Maharashtra state.
- Groundwater legislation

## **GS-403: ENGINEERING AND ENVIRONMENTAL GEOSCIENCES**

### **Introduction to Engineering Geology**

- Scope of Engineering Geology
- Engineering properties of rocks and soils; and their determination.
- Rock mechanics: Behavior of rocks under stress, Rock failure mechanisms
- Geological considerations for the selection of dam sites, Spillways, tunnels and Bridges

### **Geo-material**

- Building stones and road metals; Aggregates 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
  5. Selection of equipment's for drilling, loading, hauling to crusher site
  6. Methods of extraction of aggregate resources
  7. Use of synthetic materials used as remedial measures
  8. Estimation of overburden thickness & rock strata classification

### **Introduction to Environmental Geology:**

- Introduction, Fundamental concepts, scope. Man and environment.
- Natural and Man- made hazards and disasters
  - Lithospheric hazards- volcanoes, earth quakes, landslides, land subsidence, tsunamis, meteorite strike, etc.
  - Hydrospheric hazards- sea level changes, coastal hazards, water pollution (sea, river and ground water), floods
  - Atmospheric hazards- air pollution, acid rain, etc
  - Man-made hazards- industrial, nuclear, mining, etc

### **Remedial measures:**

- Introduction: origin, characteristics and preventive measures- water pollution, soil pollution and air pollution.
- EIA (Environmental Impact Assessment), case studies.

### **Introduction to marine Geology**

- Introduction and significance of Physical, Chemical and Biological oceanography

### **Marine resources**

- Shallow and deep water Marine Resources and significance: E.g. Polymetallic nodules and oozes
- Tidal Energy: Introduction and harnessing
- Marine pollution: Oil spills and nuclear waste disposal

#### **GS-404: PRACTICALS RELATED TO ABOVE COURSES**

- Lithofacies analysis
- Preparation of structure contour maps and structural cross sections
- Porosity and permeability measurements
- Well correlations: geologic and bio-stratigraphic
- Well log interpretations
- Isopach and lithofacies maps, Fence diagram
- Oil Reserve Estimation
- Core analysis
- Analysis of rainfall data
- Preparation of water level contour maps and their interpretation
- Analysis of pumping test data using different methods of aquifer and well characteristics determination.
- Plotting and analysis of hydrogeochemical data
- Morphometric analysis and site selection for water conservative measures.
- Water audit.

#### **GS-405: PRACTICALS RELATED TO ABOVE COURSES**

- Various methods of Surveying used in engineering geology, Chain Surveys, Plane table surveys, Use of Surveying equipments
- Determination of Engineering properties of Geological materials
- Interpretation of borehole data, Preparation of bore logs / Lithologs.
- Preparation of Report and Presentation of Engineering data
- Water and Soil analysis, Plotting and interpretation of geochemical data.
- Preparation of hazard Zonation map.
- Quantification of EIA.
- Heavy Mineral: Separation, identification and interpretation
- Sediment Size and shape Analysis and interpretation
- Trace element Analysis
- Organic Carbon and Total Phosphorus Analysis
- Foraminiferal and nano-planktons studies

## **Books and references**

1. Todd, D.K. – Groundwater Hydrology
2. Karanth K.R. – Groundwater Assessment Development and Management
3. Raghunath H.M. – Groundwater
4. Davis S.n. and Dewiest R.J.M. – Hydrogeology
5. Freeze and Cherry – Groundwater
6. Leveson : Geology of Petroleum
7. Russel : Petroleum Geology
8. Brown and Day : India's Mineral Wealth
9. Dobrin : Introduction to geophysical prospecting
10. Kearey and Brooks: An Introduction to Geophysical Exploration
11. Soroie: Geology for Engineers
12. Krynine and Judd: Principles of Engineering Geology and Geotechniques
13. Rise and Wateson: Elements of Engineering Geology
14. Faure : Principles of Isotope Geology
15. Panigrahi D.C. : Mine Environment and Ventilation
16. Primer of Oil well drilling : By IADC
17. Bhagwan Sahay : Mud logging
18. Person : Geological Well drilling technology
19. Cray and Cole : Oil & well drilling technology
20. Kennedy : Fundamentals of Drilling
21. Hearst & Nelson : Well logging for physical properties
22. Killops & Killops (200) Organic Geochemistry
23. F. K North Petroleum Geology
24. Petroliferous Basins of India- ONGC
25. Kennet : Marine Geology
26. Menard : Marine Geology
27. Keller : Environmental Geology
28. Tank : Environmental Geology
29. A.D.Howward and I. Remson : Geology in Environmental Planning
30. Strahler and Strahler : Environmental Geology
31. Ordway : Earth Science and Environment
32. Turk and Turk : Environmental Geology
33. K.S.Valdiya : Environmental Geology
34. Bryant E. : Natural Hazards, Cambridge University Press
35. Bell F.G. : Geological Hazards
36. Smith K. : Environmental Hazards
37. Dhravabaraya V.V., Sastry and patnaik V.S. - Watershed Management  
Books on Disaster Management course of IGNOU