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<tr>
<th>Theory Paper/Practical</th>
<th>Title</th>
<th>Teaching Scheme (Hrs/week)</th>
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<tr>
<td>Paper-I</td>
<td>Ore Geology and Ore Microscopy (3+1)</td>
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<td>Paper-II</td>
<td>Indian Mineral Deposits and Mineral Economics (3+1)</td>
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<td>Paper-III</td>
<td>Mining Geology and Mineral Exploration (1+3)</td>
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<td>Paper-IV</td>
<td>Optional (Any one)</td>
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<td>1. Petroleum Exploration (4)</td>
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<td>2. Elements of Mining and Drilling Techniques (3+1)</td>
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<td>3. Marine Geology and Oceanography (2+2)</td>
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<td>Practical I</td>
<td>Ore Geology, Ore Microscopy, Optional and Geological Field Work (Marks: 55 Pract. + 05 Viva-voce + 20 Field Work + 20 Internal Assessment and Class Record)</td>
<td>8</td>
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<td>Practical II</td>
<td>Project Work</td>
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<td>(Marks: 60 Project Evaluation + 20 Project Seminar / Presentation + 20 Viva-voce)</td>
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<td>Seminar</td>
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M.Sc. GEOLOGY
Semester IV
FIELD WORK:

Candidate shall attend geological excursion organized by the Department for a period of two to four weeks. This will include field work, visit to geologically important places, mines, geological and scientific organisations. Candidates should submit the field report at the end of excursion along with the geological specimens collected during the programme. The field work is a part of Practical I of Semester IV.

PROJECT WORK:

Every student is required to carry out Experimental / Field Based Project Work (this is in lieu of practical II of semester IV) on a related research topic of the subject/course. On the basis of this work, student must submit the Project Report (typed and properly bound) in two copies at least one month prior to commencement of the final Practical Examination of Semester IV.

After Semester-II the candidates are required to carry out geological mapping independently in an area of about 50 Sq. Km. approved by the Head of the Department and Project Guide for about two to three weeks as a part of project work. The area/topic of the project work shall be assigned to the students at the end of Semester - II depending upon the expertise available in the Department.

The Project report shall comprise introduction, aims and objectives, short literature review, methodology/materials and methods, experiments and results, discussion, conclusion and references along with the declaration by the candidate that the work is original and not submitted to any University or Organization for award of the degree, and certificate by the supervisor and forwarded through Head of the Department. The project report will be essentially evaluated by two referees, which includes Project Guide as internal referee and one external referee.

The Project Work will carry total 100 marks and will be evaluated by both external and internal examiner in the Department.

For written Project work : 80 Marks (20 marks for project presentation)
For Viva-Voce : 20 Marks

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Total : 100 Marks
Paper-I
Ore Geology and Ore Microscopy

Unit I:
Modern concept of ore genesis; Spatial and temporal distribution of ore deposits - a global perspective; Comparison between Earth’s evolutionary history and evolutionary trends in ore deposits; Ore deposits and Plate Tectonics; Mode of occurrence of ore bodies - morphology and relationship of host rocks; Study of principal ore mineral groups, their textures and structures; Paragenesis and zoning of ores and their significance; Geological thermometers; Fluid inclusion in ores: principles, assumptions, limitations and applications.

Unit II:
Concept of ore bearing fluids, their origin and migration; Wall-rock alteration; Structural, physico-chemical and stratigraphic control of ore localization. Petrological ore associations with Indian examples wherever feasible: Orthomagmatic ores of mafic-ultramafic association - diamonds in kimberlites, REE in carbonatites, Ti-V ores, chromite and PGE, Ni ores, Cyprus type Cu-Zn deposit.

Unit III:
Petrological ore associations with Indian examples wherever feasible: Ores of silicic igneous rocks - Kiruna type Fe-P, pegmatoids, greisens, skarns, porphyry associations, Kuroko-type Zn-Pb-Cu; Ores of sedimentary affiliation - chemical and clastic sedimentation; Stratiform and stratabound ore deposits (Sedimentary BIF, manganese, non-ferrous ores); Placers and palaeoplacers; Ores of metamorphic affiliations; Ores related to weathering and weathered surfaces - laterite, bauxite, Ni/Au laterite; Contemporary ore-forming systems (black smokers, mineralized crusts, Mn nodules).

Unit IV:
The ore microscope; preparation of polished section of ores; Physical and optical properties of ore minerals under reflected light; quantitative measurement of reflectivity and microhardness; Microchemical techniques- etch test and microchemical elemental test, contact chromatography of polished section of ores and its uses; Structures and textures of ores, their interpretation and paragenesis; Application of ore microscopy in mineral dressing.

Practicals:

Ore Geology:

Study of physical properties and identification of ores, non-metallic minerals, industrial rocks and minerals, gemstones and semi-precious minerals in hand specimens.

Ore Microscopy:

Description of optical properties and identification of ore minerals in polished sections under incident light and determination of paragenetic sequence; Exercises in the determination of reflectivity and microhardness of common ore minerals.

Books Recommended:

Ore Geology:

Barnes, H.L (1979) Geochemistry of Hydrothermal Ore Deposits, John Wiley.

Ore Microscopy:

Paper-II

Indian Mineral Deposits and Mineral Economics

Unit I:

Study of the following Indian ore deposits with reference to their mineralogy, mode of occurrence, origin, geological association and geographical distribution: Iron, manganese, gold, aluminium, chromium, copper, lead and zinc.

Unit II:

Study of the following Indian ore deposits with reference to their mineralogy, mode of occurrence, origin, geological association and geographical distribution: Tin, tungsten, titanium, nickel and molybdenum; Minerals used in metallurgical, refractory and abrasive industries.
Unit III:

Study of the following Indian mineral deposits with reference to their mineralogy, mode of occurrence, origin, geological association and geographical distribution: Minerals used in ceramics, cosmetic, glass, fertilizers, cement, chemical, paints and pigments, electrical and gemstone industries.

Unit IV:

Concept of mineral economics; Significance of minerals in National economy; Use of various minerals in industries; Production and its effect on prices of minerals; Demand and supply, their effect on prices; International aspects of mineral industries; Cartels and their influence on mineral industry; Mineral resources in India and their present status and future development; Strategic, critical and essential minerals; Conservation and substitution of minerals; Mines and mineral legislation in India, Mineral development fund; Law of sea bed for marine mineral resources; United Nations Framework Classification (UNFC); National Mineral Policy; Statistical modelling for the future requirements and production levels of minerals in India.

Books Recommended:

Indian Mineral Deposits:


Mineral Economics:


Paper-III
Mining Geology and Mineral Exploration

Unit I:

Application of Geology in mining; Geological work at an operating mine; Guides in the location of ore deposits- physiographic, lithologic, stratigraphic, mineralogic and structural guides; Intersecting loci and ringed targets; Location and extension of ore deposits and dislocated ore bodies; Persistence of ore in
depth; Duties of mining geologist; Preparation of Mine plans; Geotechnical investigations for mine planning; Geological report writing.

Unit II:

Mineral Exploration – its significance, necessity and objectives; Methods in mineral exploration-objectives and limitations of different methods; Stages of mineral exploration; Geological methods of surface and subsurface exploration-evaluation of outcrop, panning, trenching, pitting, drilling etc; Drilling methods used in mineral exploration; choice of drilling; Types of drill patterns and density of exploratory drilling; Exploratory mining methods; Methods in outlining the ore body; Geological modeling for mineral exploration with specific examples of Indian mineral deposits.

Unit III:

Fundamentals of geochemical prospecting; Geochemical environments, mobility and distribution in dispersion of elements in primary and secondary environments; Geochemical exploration practices in different environments glacial, desertic and tropical; Methods of geochemical exploration: lithogeochemical, pedogeochemical, biogeochemical, hydrogeochemical, atomogeochemical, geobotanical methods; Statistical analysis and interpretation of geochemical prospecting data; Designing exploration models for search of different type of mineral deposits.

Unit IV:

Geophysical methods of prospecting of metallic and non-metallic mineral deposits. 
Gravity method: Principle, instrumentation, field procedure and application; Gravity field surveys; Various types of corrections applied to gravity data; Preparation of gravity anomaly maps and their interpretation.
Magnetic method: Principle, instrumentation, field procedure and application; Introduction to Aeromagnetic survey.
Electrical methods: S.P. and I.P. method; Resistivity method: Principle, instrumentation, field procedure and application.
Seismic methods: Principle, instrumentation, types, field procedure and application.
Radioactivity methods: Principle, instrumentation, field procedure and application.

Practicals:

Preparation of Mine plan; Diagrammatic representation of open cast and underground mining; Preparation and interpretation of geochemical anomalies maps; Problems based on statistical analysis of data obtained in geochemical exploration.
Calculation of average assay value of ore based on sampling data from bore holes and underground mine workings; Calculation of ore reserves; Preparation of vertical sections and level plans of ore deposit from bore hole data; Preparation of grade maps of mineral deposits based on sampling data;
Study of gravimeter, magnetometer and seismographs; Resistivity survey; Interpretation of underground structure on the basis of seismic data.

**Books Recommended:**

**Mining Geology and Mineral Exploration:**

McKinstry, H.E. (1972) Mining Geology, Pretice-Hall Inc.
Paper-IV (Optional)

1. Petroleum Exploration

Unit I:

Introduction to Petroleum geology, types of petroliferous basins and their relation to hydrocarbon potential; Global geographic and stratigraphic distributions of oil and gas; Classification and stratigraphy of petroliferous basins of India. Estimation of oil and gas reserves and resources; Basin mapping – structure and isopach contouring, lithofacies and biofacies maps; Petrophysics- rock fluid system and interaction, reservoir characteristics, reservoir heterogeneity and drive mechanisms of carbonate and clastic reservoirs.

Unit II:

Methods and techniques for petroleum exploration, surface indications and direct detection of hydrocarbons; Geochemical methods of Petroleum exploration; Sniffer surveys; Introduction to different biomarkers used in oil exploration; Significance of major microfossil groups such as foraminifers, calcareous algae, ostracods, dinoflagellates, pollen and spores in hydrocarbon exploration; Case studies of Indian sedimentary basins; Sub-surface exploration techniques: concept of potential, magnetic, gravity and seismic methods of geophysical exploration; Seismic data acquisition, processing and interpretation; Synthetic seismograms; Gas hydrates and CBM exploration.

Unit III:

Oil well Drilling methods, drilling equipments, drilling rig - its components and functions, rig sizing and selection, drilling fluids, wellheads, casing and cementing operations, principles of kick control, fishing jobs, drill stem test (DST); Types of offshore and onshore drilling operations; Well completion; Well logging: Formation evaluation, Archie’s formulae, principles, methods and application of logging tools including Spontaneous polarization, resistivity, microresistivity, induction, sonic, density, neutron techniques, hingle, pickett, MID, M-N cross plots, saturation estimation, natural gamma ray, gamma ray spectrometry, cement bond, variable density, caliper, dipmeter, formation microscanner and imager; Well log interpretation - quick lithology, porosity and permeability determination; Log interpretation case studies.

Unit IV:

Duties of a well-site geologist; Geotechnical order (GTO), coring and core analysis; Examination of well cuttings; Preparation of lithologs and composite logs; Principles of formation testing; Development geology, production and enhanced oil recovery (EOR) methods; Principles of petroleum economics.
Practicals:

Map projections of different oil horizons in Indian sedimentary basins, their stratigraphic order, and study of microfossils like foraminifers, calcareous algae, ostracods, dinoflagellates, pollen and spores in hydrocarbon exploration; Granulometric analysis, seismic facies analysis, seismic profile interpretation, preparation of different lithologs; Interpretation of different well log data from different sedimentary environment with the use of Electro-logging (SP, GR, resistivity, Neutron, Density, Dipmeter etc); Core sample studies (identifications of sedimentary structures, lithology, facies and paleoenvironment from core data); Time corrections applied to seismic data; Preparation of synthetic seismograms and calibration of well data; Laboratory analysis related to coal bed methane studies.

Books Recommended:


Paper-IV (Optional)

2. Elements of Mining and Drilling Techniques

Unit I:
Types of mines and the various mine workings; Method of breaking the rocks; Blast holes and their patterns; Blasting practices; Explosives used in mining; Subsidence and supporting of mine opening’s; Transportation-haulage and hoisting; Mining machinery; Mine drainage; Ventilation and illumination.

Unit II:
Mine development; Methods of shaft sinking; Underground mining methods for metallic and non-metallic minerals; Underground coal mining methods.

Unit III:
Surface mining methods; Choice of mining method; Alluvial mining methods; Miscellaneous methods including solution methods and leaching methods, Sea bed mining for manganese nodules and coal bed methane; Mine organization; Safety measures in open cast and underground mines; Rescue work, welfare measures.
Unit IV:

Fundamentals of drilling; Purpose and applications of drilling; Brief idea about various common drilling techniques such as rotary, percussive and diamond drilling and their use; Factors influencing drilling; Drilling equipments and their use; Drilling bits: Coring and non-coring, blade bits, roller-cutter bits and diamond bits; Drilling fluids (flushing media); Casing and casing-string design; Coring: rotary and wire line, diamond core drilling, reverse circulation drilling, cable tool drilling, chip coring; Preservation of cores; Problems encountered in drilling (surface and underground) and remedies; Fishing and fishing tools; Deviation in drill holes: their measurements and correction; Directional drilling; Cementing of holes.

Books Recommended :

Elements of Mining and Drilling Techniques:

Young, G.J. (1946) Elements of mining

Paper-IV (Optional)

3. Marine Geology and Oceanography

Unit I:

History of development of marine geology; Origin of ocean basins; A brief account of tectonic history of the oceans; Oceanic crust; Deep ocean-floor topography; Morphology of ocean margins; Marine sediments, sources and composition, sediment types and distribution; Oceanic sediments and microfossils; Deep sea sediments and their relation to oceanic processes such as productivity, solution and dilution.

Unit II:
Oceanic circulation - Surface, intermediate and deep ocean circulation; Forces that produce and effect
circulation patterns in world oceans; Important phenomena associated with surface circulation;
Formation and movement of deep and bottom waters; Sedimentation rates; Calcite and aragonite
compensation depth.

**Unit III**

Methods and instruments for exploring the ocean floor; Deep Sea Drilling Project (DSDP), Ocean Drilling
Programme (ODP) and Joint Global Flux Studies (JGOFS) and their major accomplishments. Integrated
Ocean Drilling Programme (IODP) and its aims and objectives; Sediment distribution in time and space as
related to tectonic models; Marine stratigraphy, correlation and chronology; Deep sea hiatuses and their
causes; Approaches to paleoceanographic and paleoclimatic reconstructions; Paleoceanographic
changes in relation to earth system history including impact of the oceans on climate change.

**Unit IV:**

Evolution of oceans through the Cenozoic; Ocean gateways and their role in controlling global climates;
Sea level changes during Quaternary with special reference to India; Reconstructing Quaternary climatic
and oceanographic history on shorter time scales using marine records; Mineral resources of the ocean
including polymetallic nodules; Hydrocarbons beneath the sea floor; Marine gas hydrates and their
economic potential; Marine pollution and interpreting marine pollution with the help of microfossils.

**Practicals:**

Sedimentary facies; Bio facies; Depth biotopes and estimation of paleodepth of the ocean using benthic
foraminiferal assemblages; Identification of modern and ancient surface water mass with the help of
planktic foraminiferal assemblages; Identification of benthic foraminifera characteristic of Low oxygen
environment; Identification of planktic foraminifera characteristic of warm and mixed layer, thermocline
and deep surface water of the modern oceans; Study of modern surface water, mass assemblages of
planktic foraminifera from Indian ocean, Atlantic ocean and Pacific ocean.

**Books Recommended:**