## Course structure of M. Sc. Applied Geology

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Total Credits to be accumulated 60 Minimum Credits 12

**Note:** Minimum of 72 credits need to be earned for completion of the M. Sc. Course.
EASC-411 ADVANCED MINERALOGY


Rock and Ore forming minerals: Structure, P-T stabilities, paragenesis and mode of alteration of silicates, oxides, carbonates, phosphates, sulphates and halides.

Text Books

EASC-412 STRUCTURAL GEOLOGY

Stress and Strain: Mechanical properties of rocks. Concept of stress and strain. Two dimensional stress and strain analyses. Mohrs circle. Types of strain ellipsoids and their geological significance. Strain analysis of naturally deformed rocks.

Folds

Faults and Shear zones

Joints

Unconformity
- Types of unconformity, their recognition criteria. Importance of unconformity in tectono-stratigraphic correlation.

Foliations and Lineations

Structural analysis: Principles and elements of structural analysis. Geometrical analysis of simple and complex structures on mesoscopic to macroscopic scale.

Text Books:
**EASC-413 APPLIED PALEONTOLOGY**

Definition and Scope.

Invertebrate paleontology: An overview. Morphology, classification, evolutionary trend, composition and structure of shells of selected groups of organisms - Porifera, Bryozoa, Mollusca, Brachiopoda. Geological history, geographical distribution and description of more important genera of Trilobita, Echinoides, Coelenterata and Graptoloidea.

Micropaleontology: Sampling methods and sample processing techniques. Types of microfossils. Calcareous Microfossils - Foraminifera - major morphologic groups; Benthic Foraminifera; depth biotopes, value in paleobathymetric determination. Larger foraminifera - their utility in Indian stratigraphy. Planktonic foraminifera and calcareous nanofossils. Ostracoda - outline morphology, paleoecology & geological history. Brief knowledge about pteropods, calpionellids and calcareous algae.


Phosphatic Microfossils: Conodont - outline morphology, paleoecology and geologic significance.

Organic Walled Microfossils: Brief account of dinoflagellates and acritarchs.

Palynology: General morphology of spores and pollen, their geological significance.


Vertebrate paleontology: Succession of vertebrate life through geologic time. Broad classification and study of some characteristic Indian vertebrate genera. Indian pre-Tertiary vertebrate - their distribution and paleogeographic implication; extinction of dinosaurs. Indian Tertiary vertebrate - Siwalik mammals; phylogeny - Equidae & Proboscidae. Indian fossil Hominoides and modern theories regarding human evolution.

Text Books:

EASC-414 ADVANCED GEOLOGY LAB – I

Part 1: Mineralogy (1 credit)

Identification of minerals in hand specimen. Study of optical properties of minerals in transmitted light and their identification in thin section. Identification of minerals from X-ray diffractogram. Indexing and calculation of cell parameters of minerals in isometric, tetragonal and orthorhombic systems. Calculation of chemical formula of minerals from analytical data.

Part 2: Structural Geology (2 credits)

Interpretation of geological maps and drawing sections. Fold analysis by dip isogon method. Strain analysis from deformed objects. Structural problems concerning mineral deposits. Elementary structural analysis by stereographic methods.

Part 3: Paleontology (1 credit)

Techniques of separation of microfossils. Study of important benthic and planktonic foraminifera useful in bottom and surface water oceanography. Study of larger foraminifera important to the Indian stratigraphy.
Soft Core Course 3 Credits

EASC-415 BASIC GEOCHEMISTRY

Origin of chemical elements, abundance of elements in cosmos, solar system and earth. Distribution of elements in core, mantle, crust, hydrosphere and atmosphere.

Nuclides and atoms. Electronic configuration of atoms, arrangement of atoms in periodic table, electronegativity, ionization potential, chemical bonding.

Crystal Structure and classification of silicate structures, controls on crystal growth and transformations. Thermodynamics and thermodynamic control on distribution of chemical species (between co-existing phases). Thermodynamics of mixing and solutions. Kinetics and metastability.

Geochemistry of igneous and metamorphic processes. Distribution coefficients and determination of Pressure and Temperature conditions. Trace element geochemistry.

Geochemistry of weathering, transportation and deposition. Study of Eh-pH diagram.

Radioactivity. Decay of radioactive atoms and growth of radiogenic atoms. Application of radioactivity in geochronology and in understanding geological processes.

Application of Geochemistry in mineral exploration and in solving environmental problems.

Text Books

1. B. Mason : Principles of Geochemistry
2. K.B. Krauskopf : Introduction to Geochemistry
3. P. Henderson : Inorganic Geochemistry
4. H. Jaffe : Introduction to Crystal Chemistry
EASC-417 COMPUTER APPLICATIONS IN EARTH SCIENCES

Introduction to computers: PC configuration, CPU, I/O, memory, networking and peripheral devices. Operating system, BIOS, drivers and application software.

DOS platform: Boot sequence, system files, internal and external commands, file structure and commands. Brief exposure to DOS programs and utilities for geoscience applications.


Linux platform: Common Linux features, file structure and commands, security features. Working with Red Hat Linux, text mode and desk top environments, installing and running geoscience applications.

Text Books:

EASC-421 IGNEOUS AND METAMORPHIC PETROLOGY


Classification of igneous rocks. Definition, geochemistry, phase equilibria studies and paragenesis of basaltic rocks, lamprophyres, rocks of nepheline-carbonatite association, peridotites, kimberlites, ophiolites, granites and rhyolites, gabbro and anorthosite.


Mineralogical phase rule of close and open system. Concept and classification of metamorphic facies; description of each facies of low pressures, medium to high pressures and very high pressures. Mineral assemblages, metamorphic reactions and P-T conditions of metamorphism. P-T time path.


Text Books

EASC-422 STRATIGRAPHY

Stratigraphic principles and practices. Classification and code of stratigraphic nomenclatures. Stratification and stratigraphic column.

Lateral variation and facies. Graphic representation of stratigraphic data.

World stratigraphy: Brief description of the principal, stratigraphic units of the world in type areas. Paleogeographic reconstruction.

Indian stratigraphy: Physiographic subdivisions, structures and tectonic history of the Indian subcontinent. Study of the various geological formations of Precambrian, Paleozoic, Mesozoic, Tertiary and Quaternary Eras: distribution, geological succession, classification, correlation, paleogeography and life of each periods.


Boundary problem of Precambrian - Cambrian; Permo-Triassic; Mesozoic - Tertiary.

Text Books

Ravindra Kumar 1978. Historical Geology and Stratigraphy of India.
EASC-423 GEOMORPHOLOGY


Rock weathering and soils: physical and chemical weathering. Karst topography, soil profile, classification of soils.


Hillslopes: forms relation to lithology and structural weakness in rock, environmental; control and mass movement, modification by overland flow of hillslopes.

Desert: erosion, transportation and deposition by wind.

Oceans: waves, tides and currents, costal erosion and submergence.


Lakes: Classification and mode of formation.

Geomorphological features of India: Extra-Peninsular region, Indo-Gangetic plain and Peninsula - their geomorphic evolution.

Environmental geomorphology: elementary concept.

Text Books

**EASC-424 INTRODUCTION TO REMOTE SENSING & GIS**


Application of mineral and groundwater exploration, engineering geology.


Text Books
EASC-425 ADVANCED GEOLOGY LAB II

Part 1: Igneous & Metamorphic Petrology (2 credits)

Study of igneous rocks and metamorphic rocks of different facies mineral assemblage, texture and structure) in hand specimen and in thin sections. Calculations of CIPW norms of igneous rocks. Plotting chemical data in various diagrams and trace element modeling to infer petrogenetic conditions. Graphic representation of metamorphic mineral assemblage in ACF and AFM diagrams.

Part 2: Geochemistry (2 credits)

Introduction to methods of sampling in field, and sample preparation. Lab protocols and safety. Understanding of basic principles of geochemical methods for the analysis of rocks, soils, and aqueous fluids. Hands on training of solution preparation for analysis. Introduction to key aspects of data presentation, analysis and interpretation. Principles and hands-on application of the major analytical tools necessary to characterize the geochemistry of natural systems including: Spectrophotometer, Flame photometer, AAS and ICP-AES.
EASC-426 ADVANCED FIELD TRAINING – I

Geological field training on lithological and structural mapping in sedimentary, igneous and metamorphic terrains. Study of igneous, metamorphic and sedimentary rocks and fossil occurrences in the field. Total duration of the training will be about three weeks in the field.
EASC-427 ISOTOPE GEOLOGY

Discovery of radioactivity, stable and radiogenic isotopes. Literature on isotope geology.

Nuclear structure, atomic weights, nuclear stability and abundance.

Theory and mechanism of decay, particles emitted, positron, negatron and alpha decay, effect of mineral/crystal structures, growth and retention of daughter isotopes in earth systems.

Abundances of unstable nuclides in earth, core, mantle, crust, oceans and different rock types; their decay schemes, radioactive elements as major elements, minor elements and trace elements and their geochemical behaviour.

Mass spectrometer: Instrumentation, chemical separation, isotope dilution and ratio analysis.

Methods of dating: Isochron method, model/mineral ages, Fission track, 40Ar-39Ar, U and Th disequilibrium, choncordia method, 14C, Be and Al. Interpretation and geological significance of ages.

Isotope systematics of K-Ar, Rb-Sr, Sm-Nd, U-Th-Pb in igneous, metamorphic and sedimentary rocks and in evolution of ocean, crust and mantle.


Isotopes in mineral exploration, petroleum exploration, paleo-climate evaluation, health and environmental aspects.

Text Books

EASC-428 GLOBAL TECTONICS

Introduction


Plate Tectonics

Concept of plate tectonics. Types of plate boundaries. Characteristic features of accretionary, conservative and destructive boundaries.

Accretionary Plate Boundary

Physiography, structure, distribution, magmatism and metamorphism along Mid-oceanic ridges. Sea-floor spreading. Continental rifting.

Conservative Plate Boundaries

Physiography, structure and types of transform faults. Their relation to slipping rates.

Consuming Plate Boundaries


Global Tectonics and Mountain Building


Tectonic Activity within Indian plate


Text Books

Le Pichon, and J.Francheteau. Plate tectonics.
EASC-429 COMPUTER APPLICATIONS IN GEOSCIENCES

Introduction to computers:

Hardware components: CPU, I/O devices, information storage, storage media. Software components: computer programs; stored program concept; operating system; use of DOS and WINDOWS.

Basic:


Numerical Analysis:

Programming examples to handle following methods of numerical analysis in geosciences: matrix inversion, eigen values and eigen vectors; analysis of variance; linear/polynomial regression; rend surface analysis; elements of multivariate analysis; factor analysis, discriminant function analysis.

Use of Software Packages in Geosciences:

Data-base and spread-sheet applications in geosciences. Graphical representation of data.

Illustrative Project:

Independent exercise on computer application in any aspect of geosciences. Suggested topics include: calculation of structural formula of minerals from chemical composition; calculation of unit cell parameters from XRD chart; CIPW norm calculation and projection of rock composition in petrological diagrams; trace element modelling of partial melting, fractional crystallisation and assimilation processes; inversion of rare earth element abundance data; fitting of isochrons and age determination using isotope data; modelling isotope evolution of Sr, Nd and Pd in mantle; analysis of recurrence of geological events; correlation of bore hole data and modelling of subsurface geological characteristics; spatial distribution of data and recognition of anomalies; ore reserve calculation; modeling contaminant migration in groundwater.

Text Books

EASC-511 GEOLOGY OF MINERAL DEPOSITS


Nature and origin of mineral deposits associated with different rocks and their Indian examples: magmatic deposits in ultramafic, mafic and felsic association; post-magmatic deposits; sedimentary deposits; syn-sedimentary deposits; deposits formed in near surface environment by residual concentration, infiltration and supergene enrichment; metamorphic and metamorphosed deposits.

Text Books
Hard Core Course 2 Credits

EASC-512 SEDIMENTOLOGY

Sedimentary processes: weathering, sediment transport by fluids. Simple fluid flow concept.

Textures of clastic and non-clastic rocks. Sedimentary structures: classification, genesis and significance. Use of structures and textures in basin studies.

Sedimentary environment: physical and chemical properties of depositional environment and its classification. Lithologies, structures and vertical sequences formed in fluvial, deltaic, coastal, deep sea, glacial, aeolian and carbonate depositional environments.

Provinance: light minerals, heavy minerals and insoluble residue in provinance studies and correlation of sedimentary rocks.


Text Books

EASC-513 GEOHYDROLOGY


Text Books

Hard Core Course  

EASC-514 SOLID EARTH GEOPHYSICS

Introduction

The earth and the solar system Important physical parameters and properties of the panet earth: gravitational, electrical, magnetic, thermal and chemical.

Seismology


Geodesy and Isostasy


Geomagnetism and Paleomagnetism


Heat Flow


Plate Tectonics

The concept of plate tectonics. Plate boundaries. Present-day plate motions. Reconstruction of past plate motions.

Text Books

Bullen and Bolt. Introduction to the theory of Seismology.
Bath, M. Introduction to Seismology.
McElhiry. Paleomagnetism and Plate Tectonics.
Le Pichan. Plate tectonics.
Verma, R.K. Gravity field, Siesmicity and Tectonics of Indian Peninsula and the Himalayas.
EASC-515 ADVANCED GEOLOGY LAB III

Part 1: Ore Mineralogy (2 credits)

Identification of economic minerals in hand specimen. Study of optical properties of opaque minerals in reflected light and their identification in polished block/thin section. Study of ore textures and interpretation of paragenesis.

Part 2: Sedimentology (1 credit)

Study of clastic and non-clastic rocks in hand specimen. Microscopic examination of important rock types. Separation of heavy minerals and study of their microscopic characteristics. Grain size analysis by sieving, plotting of size distribution data. Determination of roundness and sphericity of grains.
EASC-516 MARINE GEOLOGY AND OCEANOGRAPHY

Origin of seas and oceans. Ocean morphology, oceanic crust and ocean margin; sea bottom topography - continental margin, shelf, slope, submarine canyon; ocean basin floor; abyssal hills, plains and gaps; mid-oceanic rise; mid-oceanic ridges- origin, crust and flank province.


Text Books

EASC-517 QUATERNARY GEOLOGY

Quaternary Geology - an overview. Quaternary environments. Quaternary stratigraphy, lithology, genesis of quaternary deposits, fauna and flora, paleogeography and economic importance of Quaternary resources.

Major climatic changes during Quaternary period - Ice age, Pleistocene climate. Quaternary sea level changes and coastal geo-morphology. Atmospheric composition, ocean circulation and biological processes during Quaternary.

Quaternary fluvial, eolian and glacial systems. Paleoenvironments of Quaternary period in India. Evolution of Quaternary land forms in India. Study of lake deposits and laterites of India.

Text Books:

EASC-518 COAL AND PETROLEUM GEOLOGY

**Coal:** Origin of Coal, sedimentology of coal bearing strata, mode of occurrence of structures associated with coal seams, classification of coal, chemical analysis of coal.

**Coal petrology:** Study of Macroscopic and Microscopic constituents of coals. Elementary knowledge about the application of reflectance and fluorescence study of coal. Basic idea about the coal preparation, carbonization, coal forming epochs in the geological past. Coal deposits of India and depositional environment of some important coal fields of India. Methods of Coal prospecting and estimation of its reserves. Coal Industry in India.

**Petroleum:** Historical development of petroleum geology. Physical and chemical properties of petroleum and related substances. Surface and subsurface geographic and stratigraphic occurrence of petroleum.


**Text Books:**

Moor, E.S. (ed): Coal, its properties, analysis, classification, geology, extraction, uses and distribution. John Wiley & Sons.
Levorson, A.I. Geology of Petroleum.
Lanes, K.K. Petroleum Geology.
Russel, W.L. Principles of Petroleum Geology.
 Pirson, S.J. Oil Reservoir Engineering.
Lalicker, C.G. Principles of Petroleum Geology.
EASC-519  MINERAL ECONOMICS

Concept of mineral economics and its importance in national development. International mineral trade; peculiarities inherent in mineral industry. Mineral supply as a stock: assessment of world mineral supplies, reserves and resources, technology and price.


Future mineral consumption and world economy; energy demand and supply in future; marine mineral resources; developments in mineral exploration and exploitation.

Text Books


EASC-520 PROFESSIONAL TRAINING

Intensive field and/or laboratory training on any applied aspect of geology including exploration and mining practices, petroleum well logging and related well site operations, geotechnical and geo-environmental investigations etc. Training will be conducted through professional organisations engaged in above activities. Total duration of the training will be about three weeks in the field.
Part 1: Geological & Geochemical Exploration


Part 2: Geophysical Exploration


Text Books

Dorbin, M.B. Introduction to geophysical prospecting.
Parasnis, D.S. Principles of applied geophysics.
EASC-522 ENGINEERING GEOLOGY

**Introduction:** role of geology in planning, designing and construction of engineering structures. Mechanical properties of rocks, stresses in rocks, modulus of elasticity, deformation. Poisson's ratio, and their measurement.

**Design of engineering structures:** dams, tunnels, bridges, highways; influence of geological factors on these. Geological investigations for selection of sites for engineering structures, with Indian case histories.

**Landslides:** classification, analysis of slope stability, monitoring slope movements, hazard zonation mapping.

**Text Books**

Hard Core course

4 credits

EASC-523 PROJECT

Individual project work on applied aspects of current interest in geosciences. One faculty member of the Department will be assigned as the Supervisor. In case of inter-disciplinary project, one more faculty member from related discipline can be co-opted as the second Supervisor.
EASC-525 ADVANCED GEOLOGY LAB IV

Part 1: Geological & Geochemical Exploration (1 credit)


Part 2: Geophysical Exploration (1 credit)

EASC-526 ADVANCED FIELD TRAINING II

Study of various geological features of mineral deposits in working mines. Methods of mining. Underground mine mapping, quality control operations. Geological operations at exploration sites. Field work related to petroleum exploration, engineering and environmental geological studies. Total duration of the training will be about three weeks in the field.
EASC-527 ENVIRONMENTAL GEOLOGY


EARTH'S PROCESSES AND GEOLOGICAL HAZARDS: Earth's processes; Concept of residence time and rates of natural cycles. Catastrophic geological hazards. Study of floods, landslides, earthquakes, volcanism and avalanche, with a view to assess the magnitude of the problem, prediction and perception of the hazards.

MINERAL RESOURCES AND ENVIRONMENT: Resource and Reserves. Environmental impact of exploitation, processing and smelting of minerals.

ENERGY RESOURCES AND ENVIRONMENT: Environmental effects associated with each type of energy resource, viz. petroleum, natural gas, hydropower, nuclear, coal, solar and wind energy.


ENVIRONMENTAL LAW: Environmental legislation in India.

Text Books
EASC-528 MINING GEOLOGY

Orebody reevaluation. Appraisal of exploration data for exploratory mining. Exploratory development works for mineral deposits by open-cast and underground mining methods. Mine design, metallurgical design and planning.

Environmental baseline data needed for mine planning, its acquisition and documentation during different stages of mineral exploration. Nature and extent of environmental problems due to surface and underground mining.

Mine waste management.

Role of the geologist at operative mines. Grade control in open-pit and underground operations. Blending and stock-piling of ores.

Economic appraisal of mines.

Text Books

EASC-529 WELL LOGGING

Basic Concepts: Fundamentals of drilling, drilling mud, flushed zone, invaded zone and uncontaminated zone. Physical properties of reservoir rocks, porosity, formation factor, water saturation and hydrocarbon saturation.

Electrical Logging: SP log, cause of SP in bore hole, principles of measurement, factors affecting SP log and interpretation of SP log. Resistivity log, principles and interpretation of various resistivity logs and their specific uses. Induction log, theory, procedure and interpretation of shallow, medium and deep induction tools.

Radiation Logging: Nature and properties of Gamma rays. Gamma log, detection system, principle of measurement and interpretation. Gamma-Gamma log, physical principle, photo electric effect, Compton scattering and pair production, estimation of density and porosity of formations. Neutron log, Gamma-Neutron log and Neutron activation log, basic principles, the instruments and interpretation.

Temperature, Magnetic, Gravity and Sonic Logging: basic principles, logging devices and interpretation.

Applications: Various approaches for porosity estimations. Correlation of sub-surface structures and comprehensive interpretation from available logging data. Application of well logging for mineral and groundwater exploration. A few case histories.

Text Books

M.R.J.Wyllie: The fundamentals of well log interpretation.
EASC-530  ADVANCED  REMOTE SENSING & GIS

Mapping from ground, air and space - Principles and basic concepts of remote sensing - electromagnetic spectrum and spectral reflectance of earth's surface features - Fundamentals of image interpretation - Types of satellite imagery - Elements and techniques of visual interpretation - Principles of multi-spectral data analysis.

Principles and techniques of geological and geomorphological, hydrological and ecological mapping - Identification of tree species in forest type stratification - Identification of environmental changes and monitoring - Identification and mapping of degraded and salt affected soils - Identification of rock types and landforms for mineral/oil exploration, groundwater targeting, and drainage pattern analysis.

Need of integrated Geosphere - Biosphere - Atmosphere studies and Geographic Information Systems - Digitization of information and encoding - Vector and Raster Formats - Data compression and integration - Artificial Intelligence and Expert Systems.

Practical exercises on Study of different types of satellite data products; visual interpretation of satellite data on different scale for extraction of thematic information; digital image processing system and enhancement of data classification; exposures of PC ARC/INFO and PC-ERDAS softwares.

Text Books