Kazi Nazrul University

Syllabus for M.Sc.
in Applied Geology

Four Semester Course Under
Choice Based Credit System

Course Structure of M.Sc. in Applied Geology

FIRST SEMESTER

Sl. No.	COURSE NO.	COURSE	CREDIT POINTS	EXAM DURATION (HRS.)	MAXIMUM MARKS
1.	MSCGEOLC101	Mineralogy and Geochemistry	4	2	50
2.	MSCGEOLC102	Structural Geology	4	2	50
3.	MSCGEOLC103	Sedimentology	4	2	50
4.	MSCGEOLC104	Palaeontology	4	2	50
5.	MSCGEOLC105	Mineralogy and Structural Geology	2	3	50
6.	MSCGEOLC106	Sedimentologyand Palaeontology	2	3	50
		TOTAL	20		300

SECOND SEMESTER

Sl. No.	COURSE NO.	COURSE	CREDIT POINTS	EXAM DURATION (HRS.)	MAXIMUM MARKS
1.	MSCGEOLC201	Igneous Petrology	4	2	50
2.	MSCGEOLC202	Metamorphic Petrology	4	2	50
3.	MSCGEOLC203	Economic Geology	4	2	50
4.	MSCGEOLC204	Stratigraphy	4	2	50
5.	MSCGEOLC205	Igneous and Metamorphic Petrology	2	3	50
6.	MSCGEOLC206	Ore Petrographyand Stratigraphy	2	3	50
7.	MSCGEOLC207	Field Geology	2	-	50
8.	PGCBEDT 0205	Basic Conservation Biology (Extradepartmental Elective)	4	3	50
		TOTAL	26		400

THIRD SEMESTER

Sl. No.	COURSE NO.	COURSE	CREDIT POINTS	EXAM DURATION (HRS.)	MAXIMUM MARKS
1.	MSCGEOLC301	Geotectonics and Hydrocarbon Exploration	4	2	50
2.	MSCGEOLC302	Hydrogeology	4	2	50
3.	MSCGEOLC303	Mineral Exploration, and Mineral Beneficiation	4	2	50
4.	MSCGEOLC304	Coal Geology and Mining	4	2	50
5.	MSCGEOLC305	Hydrogeology	2	3	50
6.	MSCGEOLC306	Grand Viva-voce	2	-	50
		TOTAL	20		300

FOURTH SEMESTER

Sl. No.	COURSE NO.	COURSE	CREDIT POINTS	EXAM DURATION (HRS.)	MAXIMUM MARKS
1.	MSCGEOLC401	Remote Sensing & GIS and Engineering Geology	4	2	50
	MSCGEOLC402	Remote Sensing & GIS	2	3	50
2.	MSCGEOLME403	Elective Paper I (Theory)*	4	2	50
	MSCGEOLME 404	Elective Paper I (Practical)*	2	3	50
3.	MSCGEOLME405	Elective Paper II (Theory)*	4	1	50
	MSCGEOLME 406	Elective Paper II (Practical)*	2	3	50
4.	MSCGEOLC407	Industrial Training	2	-	50
5.	MSCGEOLC408	Dissertation Thesis (6) Viva-voce (2) Seminar (2)	10	-	100
		TOTAL	30		450

* To be opted from the list courses to be offered by the department

First Semester

Course No. MSCGEOLC101
Mineralogy and Geochemistry (Theoretical)

✧ **Full Marks: 50** ✧**CA+ESE Marks: 10+40**

✧ **Credit: 4** ✧**L - T –P : 4 - 0 - 0**

Group A : Mineralogy

1. The crystal structure of minerals: General idea; Bonding in crystal structures; Closed pack structures, CCP and HCP, body-centered cubic structure, Interstitial sites in close-packed structures; Structure types based on close packing; Structures built from polyhedra
2. Crystal structure of silicates; The [SiO_4] tetrahedron, generalized idea on silicate structure and composition; Effect of changing pressure, temperature and composition in silicate structures; Composition and generalized formula of different mineral groups and calculation of their structural formulae
3. Defects in crystal structure – Point, Line and Planar defects; Role and nature of defects in mineral behaviour
4. X-Ray Crystallography—Bragg's Law, Single Crystal and Powder Methods—Principle and application in determination of crystal structure

Group B: Geochemistry

1. Calculation of cation proportions; chemical formula, vacant site from chemical analysis.
2. Earth in relation to solar system and universe. Cosmic abundance of elements, Comparisons of planets and meteorites. Structure and composition of earth and distribution of elements. Trace element geochemistry.
3. Different types of radioactive decay; brief outline of dating by Rb-Sr, K-Ar, Sm-Nd, U-Pb and ^{14}C methods. Radioactive dating of single minerals and whole rocks. Application of oxygen, carbon and sulfur isotopes.
4. General chemical characteristics of sedimentary rocks; role of ionic potential, H-ion concentration and oxidation-reduction potential in sedimentation. Eh-pH diagrams of Mn-H_2O systems and Fe- H_2O systems with/without CO_2.
5. The evolution of atmosphere, constancy of atmospheric composition; evidences in favour of presence of oxygen in Archean atmosphere. Formation and destruction of ozone layer.

Course No. MSCGEOLC102
Structural Geology (Theoretical)

✧ **Full Marks: 50** ✧**CA+ESE Marks: 10+40**

✧ **Credit: 4** ✧**L - T –P : 4 - 0 - 0**

1. Rheology: Behaviors of rocks under stress; Rheological models; Flow law for steady state creep; factors influencing flow of rocks; Deformation mechanism; Estimation of paleostress;
2. Stress: Basic concept of stress; Analysis of stress in three dimensions; stress filed description; equilibrium condition; trajectory patterns and boundary condition.
3. Strain: Infinitesimal strain; measurement of strain; progressive deformation; Role of fluid in deformation; Rheology; Stress –Strain curves for elastic, viscous and plastic; poro-elasticity
4. Mechanism of folding and superposed folding; Interpretations of ductile structures: foliation, lineation, boudinage; Structural analysis of deformed terrain
5. Fracture mechanics; dynamics of faulting and jointing.
6. Shear Zones, Grain scale deformation mechanism and its manifestation in microstructure: Solid State Diffusion Creep. Granular flow and Superplasticity

Course No. MSCGEOLC103
Sedimentology (Theoretical)

✧ **Full Marks: 50** ✧**CA+ESE Marks: 10+40**

✧ **Credit: 4** ✧**L - T –P : 4 - 0 - 0**

1. Sedimentary basin: Concept and Definition, Mechanics of basin formation, Classification of sedimentary basins
2. Tectonics and sedimentation: Role of extrabasinal and intrabasinal factors in sedimentation pattern

3. Characteristics of modern sedimentary environments: Glacial, Fluvial, Aeolian, Lacustrine, Transitional and marine
4. Depositional system analysis: Sedimentary facies - Basic concept, architectural elements, concept of Bounding Surface Hierarchy,facies successions and facies models
5. Cyclic sedimentation: Basic concept, types of stratigraphic cycles and their controlling factors
6. Sequence stratigraphy: principles and applications

Course No. MSCGEOLC104
Paleontology (Theoretical)

✧ **Full Marks: 50** ✧**CA+ESE Marks: 10+40**

✧ **Credit: 4** ✧**L - T –P : 4 - 0 - 0**

1. Theories on origin of life, evidence of Precambrian life, Indian occurrences, Origin of hard part, Ediacaran fauna, Cambrian explosion, Burgess Shale fauna, SSF.
2. Evolutionary Systematics – Numerical Taxonomy, Cladistic Taxonomy.
3. Adaptation and Functional Morphology
4. Organic Evolution – theories, modes, patterns and trends, Ontogeny: patterns and its role in organic evolution.
5. Mass extinctions and their causes; rate of extinction and evolution
6. Biostratigraphy: Application of fossils in age determination and correlation. Important invertebrate fossils, vertebrate, fossils, plant fossils and microfossils in Indian stratigraphy. Conodonts and their role in biostratigraphy.
7. Microfossils: types, environmental significance of microfossils. Use of microfossils in interpretation of sea floor tectonism. Application of micropaleontology in hydrocarbon exploration. Oxygen and Carbon isotope studies of microfossils and their use in paleoceanographic and paleoclimatic interpretation.
8. Foraminifera: morphology and evolution.
9. Palynology: introduction, palynomorphs, morphology of spores and pollens, Wall Stratification of Spore and Pollen.
10. Major trends in vertebrate evolution
11. Siwalik Fauna: their origin and occurrences
12. Trace Fossil: Classification and its application

Course No. MSCGEOLC105
Mineralogy and Structural Geology (Practical)

✧ **Full Marks: 50** ✧**CA+ESE Marks: 30+20**

✧ **Credit: 2** ✧**L - T –P : 0 - 0 - 4**

Group A: Mineralogy

1. Determination of optic sign from oriented and random sections of different minerals.
2. Determination of relation between optical directions and the crystallographic directions of a few rock-forming minerals.
3. Study of pleochroism and absorption scheme of a few rock-forming minerals.

Group B: Structural Geology

1. Interpretation of outcrop patternsof deformed lithounits involving folding and faulting on flat and undulating topography.
2. Determination of the relation between major and minor structural elements of deformation through stereographic projection of orientation data.
3. Analysis of stress orientation on the basis of fracture data.
4. 2D and 3D strain analysis.

Course No. MSCGEOLC106
Sedimentology and Paleontology (Practical)

✧ **Full Marks: 50** ✧**CA+ESE Marks: 30+20**

✧ **Credit: 2** ✧**L - T –P : 0 - 0 - 4**

Group A: Sedimentology

1. Description and interpretation of primary, secondary and biogenic sedimentary structures in hand specimen.
2. Microscopic study of sandstones (with special emphasis on diagenesis and provenance) and limestones (with special emphasis on diagenesis).
3. Analyses of paleocurrent and granulometic data.

Group B: Paleontology

1. Study of ontogenetic growth patterns through biometric analysis
2. Numerical techniques to study populations
3. Phenetic and cladistic analysis
4. Functional morphological analysis of invertebrates and vertebrates
5. Study of microfossils

Second Semester

Course No. MSCGEOLC201
Igneous Petrology (Theoretical)

✧ **Full Marks: 50** ✧**CA+ESE Marks: 10+40**

✧ **Credit: 4** ✧**L - T –P : 4 - 0 - 0**

1. Phase equilibria studies in binary, ternary and quaternary silicate system with reference to petrogenesis; Cryoscopic equation.
2. Magma genesis and emplacement; relation of magma generation and global – plate tectonics.
3. Physical state, chemical and mineralogical composition of upper mantle; Partial melting processes in the upper mantle; Segregation and ascent of magma.
4. Mineralogy, geochemical characteristics, mode of occurrences, classification and origin of basalt, granite, peridotite and anorthosite.

Course No. MSCGEOLC202
Metamorphic Petrology (Theoretical)

✧ **Full Marks: 50** ✧**CA+ESE Marks: 10+40**

✧ **Credit: 4** ✧**L - T –P : 4 - 0 - 0**

1. Metamorphism and metamorphic facies: Introduction, types; Genetic classification – Grade, Zone, facies

2. Deformation and textures in metamorphic rocks: Metamorphic foliation/schistosity, porphyroblasts, Interpretation of porphyroblast – S_i – S_e relations
3. Graphical relations in metamorphic assemblages – Interpretation and representation of mineral assemblages; ACF, AKF and AFM diagrams; Schreinemakers' analysis for simple sytems
4. Application of chemical thermodynamics in heterogeneous phase equilibria – Solution, a-x relation; Thermobarometry
5. Granulites – Introduction, mode of occurrence, lithology, structure, P-T estimation in granulite, origin; Role of fluids in granulite petrogenesis
6. Crustal melting and migmatites – Fluid present and absent melting; Description and origin of migmatites
7. Plate tectonics and Metamorphism – Role of plate tectonics in metamorphism; Paired Metamorphic Belt; Pressure-Temperature-time path.

Course No. MSCGEOLC203
Economic Geology (Theoretical)

✧ **Full Marks: 50**	✧**CA+ESE Marks: 10+40**
✧ **Credit: 4**	✧**L - T –P : 4 - 0 - 0**

Group A : Metallic ore deposits

1. Spatial and temporal distribution of ore: Metallogenic Epoch, Metallogenic Province and ore mineralization in relation to plate tectonics.
2. Systematic study of ore deposits (Mode of occurrence and its importance, ore textures and their genesis, sulphide and oxide phase equilibria and its significance)
3. Important ore-associations and their genetic models, Applications of geochemistry in ore deposit modeling (Orthomagmatic ores of mafic-ultramafic association, Ores of silicic igneous rock association, Ores of sedimentary association: Sedimentary deposits, placer deposits, Ores of volcanic- Volcano-sedimentary association, Ores of metamorphic association, Ores associated with weathering surfaces)
4. Indian scenario of Fe, Mn, Cu, Pb, Zn, Cr, Ni, Sn and W deposits

5. Metamorphism of ores.

Group B: Non-metallic deposits

1. Mode of Occurrence, Lithoassociation, Genesis of the following non-metallic minerals (with Indian examples): diamond, graphite, barite, gypsum, phosphorite, mica and asbestos.
2. Specification of raw materials in the following industry: Iron and Steel, Glass and ceramic, Cement and Fertilizer.

Group C: Nuclear Fuel

1. Minerology, Geochemistry and mode of occurrence of radioactive minerals
2. Techniques of detection and measurements of radioactivity
3. Distribution of radioactive minerals in India
4. Radwaste disposal — geological constrains

Course No. MSCGEOLC204
Stratigraphy (Theoretical)

✧ **Full Marks: 50** ✧**CA+ESE Marks: 10+40**

✧ **Credit: 4** ✧**L - T –P : 4 - 0 - 0**

1. International Code of Stratigraphic Nomenclature
2. Basis of identification of different Archaean Cratons in Peninsular India; broad overview of the general characters of these Archaean Cratons in the light of evolution of the Indian shield
3. Concept of supercontinent cycle: Proterozoic mobile belts of India in context of global tectonic scenario
4. General characteristics of the Proterozoic Basins of India
5. Overview of Indian Phanerozoic stratigraphic architecture in the light of modern concepts of eustasy and global tectonics
6. Comparison and correlation of the Phanerozoic successions in different parts of the extra- Peninsular India
7. Boundary problems and their critical evaluation in the context of Indian stratigraphy of the A-P, Precambrian-Cambrian, P-T, K-T boundaries

Course No. MSCGEOLC205
Igneous and Metamorphic Petrography (Practical)

✧ **Full Marks: 50** ✧**CA+ESE Marks: 30+20**

✧ **Credit: 2** ✧**L - T –P : 0 - 0 - 4**

Group A: Igneous Petrography

Study of common important igneous rocks and rock associations in hand specimen and in thin section with special reference to texture and structure.

Group B:Metamorphic Petrography
Detail study of some metamorphic rocks under microscope.

Course No. MSCGEOLC206
Ore Petrographyand Stratigraphy (Practical)

✧ **Full Marks: 50** ✧**CA+ESE Marks: 30+20**

✧ **Credit: 2** ✧**L - T –P : 0 - 0 - 4**

Group A:Ore Petrography

Study of ores under microscope with emphasis on mineralogy, texture, structure and paragenesis

Group B:Stratigraphy

Preparation of lithologfrom given data; correlation between lithologs and preparation of fence diagram; preparation of isopach map from core data

Course No. MSCGEOLC207
Field Geology (Practical)

✧ **Full Marks: 50** ✧**CA+ESE Marks: 30+20**

✧ **Credit: 2** ✧**L - T –P : 0 - 0 - 4**

1. Structural and petrological studies of a deformed terrain (for a minimum period of two weeks duration).
2. Study of an undeformed fossiliferous sedimentary terrain (one week duration).

Third Semester

Course No. MSCGEOLC301
Geotectonics and Hydrocarbon Exploration(Theoretical)

- ✧ **Full Marks: 50** ✧ **CA+ESE Marks: 10+40**
- ✧ **Credit: 4** ✧ **L - T –P : 4 - 0 - 0**

Group A: Geotectonics

1. The Interior seen by seismic waves, Earth's mass, shape and gravity field, Density from seismic wave velocities, Radial variations of density, pressure, temperature and composition,
2. Geomagnetic field, paleomagnetism, Polar wander and continental drift, geomagnetic field reversals, magnetic anomalies, seafloor spreading and age of ocean floor,
3. Plate motions and plate boundaries, earthquake focal mechanism, relative plate motions via seafloor spreading and earthquake focal mechanisms, satellite geodetic measurements of relative plate motions, reconstruction of past plate motions: finite rotations
4. Elements of Neotectonics

Group B: Hydrocarbon Exploration

1. Petroleum: Composition of petroleum and natural gas, Kerogen and their types

2. Origin of petroleum
3. Migration of natural hydrocarbons: Types and mechanisms
4. Petroleum system – source rock, reservoir rock, cap rocks; Traps : Structural, stratigraphic and combination traps
5. Petroleum exploration: Geological and Geophysical survey,
6. Oil well drilling
7. Source rock analysis
8. Well logging
9. Reserve estimation; Petroleum production;Petroliferous Basins of India
10. Coal Bed Methane: Occurrence, exploration, production, environmental issues
11. Gas Hydrates: Structure, Occurrence, exploration

Course No. MSCGEOLC 302
Hydrogeology (Theoretical)

✧ **Full Marks: 50** ✧**CA+ESE Marks: 10+40**

✧ **Credit: 4** ✧**L - T –P : 4 - 0 - 0**

1. Construction Design and Performance of Wells: Types of wells and methods of construction. Well Performance test. Pumping equipment
2. Saline water Intrusion: Salinity influxes in estuaries, Ghyben-Herzberg Relation; Slope, Shape and movement of interface; Identification of saline zones and interface; Prevention and control of saline water intrusion.
3. Groundwater Level Monitoring: Methods and stages of Groundwater Investigations; Data Collection, Water level measurements, Types of observation well networks, Timing and frequency of water level measurements, Typical length of data collection, Significance of water level mapping,
4. Groundwater Exploration: Surface geophysical methods — Electrical, Seismic, Magnetic, Gravity, Radiometric. Geophysical well logging
5. Groundwater pollution: Arsenic, Fluoride and Nitrate.
6. Groundwater Management and Development: Recharge and discharge areas; Groundwater legislation
7. Indian distribution of water resources

Course No. MSCGEOLC 303
Mineral Exploration and Mineral Beneficiation (Theoretical)

✧ **Full Marks: 50** ✧**CA+ESE Marks: 10+40**

✧ **Credit: 4** ✧**L - T –P : 4 - 0 - 0**

Group A: Mineral Exploration

1. Mineral exploration: Stages of mineral exploration — surface and subsurface methods of exploration.
2. Drilling methods (percussion, rotary, core drilling)
3. Geophysical prospecting – magnetic, gravity, electrical, seismic and radiometric methods. Brief outline of various well logging techniques.
4. Geochemical methods for mineral exploration- lithogeochemical, pedogeochemical, hydrogeochemical, biogeochemical and atmogeochemical methods
5. Geobotanical and photogeochemical methods.
6. Drilling, sampling methods and estimation of reserves.
7. Mineral economics: Specialties inherent in mineral industry; Strategic, critical and essential minerals; Reserve — resources classification; Conservation and substitution, National Mineral Policy.

Group B:Mineral Beneficiation

1. Beneficiation- necessity, importance, advantages
2. Crushing: Construction and operational features of primary and secondary crushers. Jaw and Gyratory crushers, cone and roll crushers.
3. Grinding theory, Ball and Rod mills- construction and operation.
4. Laboratory sizing and industrial screening, rake, spiral and hydrocyclone classifiers.
5. Size, specific gravity and surface property dependent beneficiation processes: gravity concentration — theory and practice of Jigging, heavy media separation and flowing film concentration. Froth flotation. Drying and dewatering.

Course No. MSCGEOLC 304
Coal Geology and Mining

✧ **Full Marks: 50** ✧**CA+ESE Marks: 10+40**

✧ **Credit: 4** ✧**L - T –P : 4 - 0 - 0**

Group A: Coal Geology

1. Origin of coal
2. Macroscopic and Microscopic constituents, concept of macerals and micro lithotypes
3. Physical properties and chemical characterization — Proximate and ultimate analysis
4. Rank and grade of coal, Indian and International classification
5. Biochemical and dynamo-chemical changes in coal formation
6. Distribution of coal in space and time with special reference to India

Group B: Mining

1. Methods of mining- Placer/alluvial, opencast and underground mining
2. Mining terminologies: Shaft sinking, drifting, cross-cutting, sloping, Mine subsidence, mine support, room & piller, top slicing, caving (sublevel caving & block caving), mining hazards, mine inundation, fire & rock blast.
3. Sampling, bench mapping, underground mine mapping, preparation of plans and sections
4. Planning, exploration and exploratory mining of surface and underground deposits.
5. Environmental impacts in mining industries.

Course No. MSCGEOLC 305
Hydrogeology (Practical)

✧ **Full Marks: 50** ✧**CA+ESE Marks: 30+20**

✧ **Credit: 2** ✧**L - T –P : 0 - 0 - 4**

1. Determination of Permeability of sand by Constant Head Permeability Test.
2. Interpretation of hydrogeological maps: Depth to water table maps, groundwater contour maps, water table fluctuation maps

MSCGEOLC 306
Grand Viva-voce

Each student has to appear before a board of Five Members (Comprising Internal Faculty Members and at least one External Subject Expert) for the viva-voce on all fields of Earth Sciences.

Fourth Semester

Course No. MSCGEOLC401
Remote Sensing &GISand Engineering Geology (Theoretical)

✧ **Full Marks: 50** ✧**CA+ESE Marks: 10+40**

✧ **Credit: 4** ✧**L - T –P : 4 - 0 - 0**

Group A: Remote Sensing & GIS

1. Remote Sensing: Definition, scope and purpose; Types of Remote Sensing (RS); Digital imagery vs. conventional photography
2. Electromagnetic spectrum (EM-spectrum): Fundamental concepts and theories;subdivisions of the EM-spectrum; Basic laws governing the behavior of the EM-radiation, and the interrelationships among these laws in view of remote sensing; The common wavelength bands used in RS and their characteristic purposes
3. Different interactions of energy or radiation with matter in different scales; Role of atmosphere in remote sensing; Concept of atmosphere windows
4. Remote Sensing data products, geometric and radiometric corrections; Thermal and microwave remote sensing; Space Missions and Indian Remote Sensing Satellites, Acquisition of RS data; Remote Sensing: data source, platforms and sensors

5. Aerial photography:Air-photos, scale, photomosaics, air-photo stereo-pairs, Stereoscopic vision and pseudoscopic vision; Types and geometry of aerial photographs; Elements of photogrammetry
6. Aerial photo-interpretation techniques; Recognition of photo-elements and terrain elements
7. Geographical Information System (GIS): Introduction, components, data presentation, digitization and scanning, vector and raster methods, input and output device, software and definition/description of equipments; Database designing and structure; Data analysis and cartographic modeling; Data representation and techniques of data intergration;Application of integrated GIS; Data updating and merging; Multilayer data products
8. Global Positioning System (GPS): Definition, scope and purpose; Advantage of GPS; Principles of GPS position determination, receiver types, and survey techniques, Geodetic implication; RS-GIS-GPS integration; Special discussion and practical demonstration of such integration in Geoscientefic arena and day-to-day socio-economic activities.

Group B: Engineering Geology

1. Various stages of engineering geological investigation for civil engineering projects. Engineering properties of rock & their measurements
2. Slope stability and mass movements, classifications, detailed study of landslides, factors influencing different mass movements in nature and their remedial measures.
3. Concept of Building materials/ dimension stones- its different properties; Study of occurrence of good building materials/dimension stones in different stratigraphic horizons of India
4. Dams and reservoir: different types of dams, different parts of dams and reservoirs, stability of dams and reservoir, seepage and leakage, factors responsible for dam and reservoir failure, and their remedial measures, criteria for selecting sites for construction of dams and reservoirs
5. Tunnels: Types, different parts of a tunnel, stability of tunnel, factors responsible for tunnel failure and their remedial measures, criteria for selecting sites for construction of tunnels

Course No. MSCGEOLC402
Remote Sensing & GIS (Practical)

✧ **Full Marks: 50** ✧**CA+ESE Marks: 30+20**

✧ **Credit: 2** ✧**L - T –P : 0 - 0 - 4**

1. Stereoscopic study of air-photos, parallax, vertical exaggeration and its various factors.
2. Elementary practical exercises on photogeological mapping
3. Photogrammetry, Use of parallax bar
4. Digital image interpretation using easily available packages and images (PC-mode). Application of RS techniques for: terrain analysis (Geomorphological). Land-use detection, litho-mapping, structural mapping, mineral exploration, environmental hazards assessment, groundwater prospecting.

Course No. MSCGEOLME 403and404
Electives Courses

✧ **Full Marks: 50** ✧**CA+ESE Marks: 30+20**

✧ **Credit: 2** ✧**L - T –P : 0 - 0 - 4**

The students have to opt for two elective courses from the list offered by the department out of the following courses.

Advanced Hydrogeology

Theory

1. Laws of groundwater movement: Piezometric head, Bernoulli's equation, Flow of viscous fluid: Laminar and turbulent flow, Darcy's Law, Reynold's Number, Laplace equation, discharge velocity, head and potential, flow nets, steady and unsteady flow: unsteady flow in unconfined and confined aquifer; steady flow in unconfined and confined aquifer

2. Radial Flow towards wells: Flow to a well, cone of depression, well loss aquifer loss, aquifer test, steady radial flow in an unconfined aquifer, unsteady radial flow in an unconfined aquifer, steady radial flow in a confined aquifer, unsteady radial flow in a confined aquifer: Theis method, Chow's method, Jacob's method and Theis Recovery method
3. Tube well design: well diameter, well depth, screen length and position, screen size, material for well screen. Well development. Flow in relation to groundwater contours, form of water table
4. Groundwater Modelling: Introduction to finite-difference and finite-element methods. Case studies

Practical

Term paper and presentation on a topic assigned by the Teacher(s)

Applied Geophysics

Theory

1. Gravity Method: Gravity and its variation over the surface of the earth. Principles of Gravimeters, Gravity field surveys; various types of corrections applied to gravity data; Preparation of gravity maps and their interpretation in terms of shape, size and depth.
2. Magnetic Method: Geomagnetic field and basic magnetic properties; Working principle of magnetometers; Field surveys and data reductions; Preparation of magnetic anomaly maps and their qualitative interpretation; Magnetic anomalies due to single pole and dipole; Determination of depth for single pole anomalies; Introduction to aeromagnetic survey
3. Electrical Method: Basic of electrical properties and principle; Resistively methods: basic properties, field procedures, electrode arrays and equipment; Interpretation of electrical profile and sounding curves Application of electrical methods in groundwater prospecting and civil engineering problems
4. Seismic Method: Fundamental principles of wave propagation; Refraction and Reflection seismic surveys for single interface both horizontal and dipping cases; Concept of seismic channel and multi-channel recording of seismic data; End-on-and split spread shooting techniques; CDP method of data acquisition, sorting, gather, stacking and record station. Seismic velocity and interpretation of seismic data
5. Brief outline of application and importance of various well logging methods; Principle of electrical logging and its application in petroleum, groundwater and mineral exploration

Practical

Term paper and presentation on a topic assigned by the Teacher(s)

Geostatistics

Theory

1. Geostatistics: Definition purpose and scope; Measurement Systems
2. Elementary Statistics: Population, Sample; Continuous Random Variables; Transformation of data; Central Limits Theorem: Measures of central tendency- Mean, median and mode; Measures of variability- variance, standard deviation; Correlation and regression- simple linear model
3. Concept of probability; Population distribution- normal, binomial and Poission; Principles of statistical tests and their use in geology; Chi-square test, F-test, t-test and Kolmogorov-Smirnov test; Analyses of variance (ANOVA and TWOVA)
4. Basic Matrix Algebra: Elementary Matrix Operations; Eigenvalue and Eigenvector – geological applications
5. Analysis of Sequences of Data: Markov Chains; Least-Squares Methods and Regression Analysis; Autocorrelation and Cross-correlation; Semivariograms; Spectral Analysis
6. Spatial Analysis: Geologic Maps and distribution of points; Distribution of Lines; Analysis of Directional Data: Testing hypotheses about circular directional data; Testing hypotheses about spherical directional data; Trend surface analysis and Kriging
7. Analysis of multivariate data: discriminant functions, Cluster Analysis, Principle Component Analysis, factor analyses— geological application

Practical

Term paper and presentation on a topic assigned by the Teacher(s)

Oceanography

Theory

1. Oceanic circulation, Oceanic currents – types and controlling factors
2. Waves: Classification and dynamics
3. Tides: Types and controlling factors; The equilibrium and dynamic theory of tides
4. Coasts and estuaries: classifying coasts, features of primary and secondary coasts, coasts formed by biological activities; Beaches and estuaries; Lagoons and wetlands; Human interferences in coastal processes
5. Sea water chemistry: Major and minor constituents of sea water and their residence times; Processes controlling the composition of sea water, Dissolved gases in sea water-their sources and sinks; Interrelationships between ocean circulation, primary productivity and chemical composition of the atmosphere and ocean
6. Marine Geology; Morphological and tectonic domains of the ocean floor; Mid oceanic ridge systems; Hydrothermal vents and seawater— basalt interaction; Modes and rates of sedimentation in the oceans; Nature of deep sea sediments and processes regulating sedimentary composition
7. Marine Resources; Types of marine resources; Physical, energy, biological and non extractive resources; Laws of the sea
8. Environmental Concerns; Marine pollution; Pathways of transfer of various pollutants and their fates in the sea

Practical

Term paper and presentation on a topic assigned by the Teacher(s)

Isotope Geochemistry

Theory

1. Introduction: Internal structure of atoms; Decay mechanism of radioactive atoms; Radioactive decay and growth
2. Mass Spectrometry: Basic principles; Equations of motion of ions; Ion Microprobe and Electrostatic Tandem Accelerators; Isotope Dilution Analysis
3. Radiometric Dating: Principles and methodology for: K-Ar method, $^{40}Ar/^{39}Ar$ method, Rb-Sr method, Sm-Nd method, Lu-Hf method, Re-Os method, U-Pb method, Th-Pb method, Pb-Pb method
4. Fission-track dating: Methodology; Derivation of age equation; Zeta calibration; Concept of annealing temperature and its application
5. U-Series disequilibrium method of dating
6. Stable isotope geochemistry

Practical

Term paper and presentation on a topic assigned by the Teacher(s)

Quaternary Geology

Theory

1. Quaternary Geology: Definition, scope and methodology
2. Tectonic Geomorphology: Landscape evolution and interactions between tectonic, climatic, and geomorphic processes
3. Global climate pattern, Climate controlling factors and Milankovitch Hypothesis, Quaternary Environments
4. Quaternary Sea-level changes; Oxygen isotope chronostratigraphy
5. Outline of significant fossil records of the Quaternary; Pollen analysis, Mammalian fauna, Deep sea Biostratigraphy
6. Quaternary Stratigraphy: Amino acid Diagenesis; Glacial varves; Dendrochronology; Tephrochronology,Climatostratigraphy, Magnetostratigraphy
7. Quaternary stratigraphy of India:Neotectonic, stratigraphic, sedimentologic and geomorphic evolution of Quaternary terrains of India.
8. Paleoclimatic reconstruction; Pleistocene Glacial-Interglacial cycles
9. Anthropocene; Effect of Anthropogenic activity on Global climate

Practical

Term paper and presentation on a topic assigned by the Teacher(s)

Environmental Geology

Theory

1. Fundamental concepts of environmental geology. Problems and issues of environment – local, regional and global.
2. Water scarcity and water resource management; Pollution: air, water and land. Global climate change, deforestation, soil degradation.
3. Hazardous geological processes: Types, prediction and warning, disaster management.
4. Mineral resources: Mineral consumption on reserves, conservation of mineral resources, impact of mining activity on the environment, environmental management in mining.
5. Nature and effects of air and water pollution, disposal of solid wastes and nuclear wastes.
6. Concepts of E I A: Geological and environmental considerations for construction of dams, roads, tunnels and bridges.

Practical

Term paper and presentation on a topic assigned by the Teacher(s)

Climatology

Theory

1. Climatology: Introduction, basis of climatology
2. Energy Balance: Solar Radiation; Temperature and Moisture; Atmospheric Motion; Oceanic circulation; Global circulation
3. Synoptic circulation and weather; Weather Modification and their Implications
4. Extreme Climate Phenomena
5. Regional Climates; Tropical Climates; Mid-latitude Climates
6. Climate changes: Past, present and future
7. Global warming: causes and effects, anthropogenic contributions
8. Changes in Atmospheric Chemistry

Practical

Term paper and presentation on a topic assigned by the Teacher(s)

Phase Equilibria in Metamorphic Petrology

Theory

1. Application of Schreinemakers' analysis in complex systems; Multivariance, Construction of petrogenetic grids; Introduction to pseudosection analysis.
2. Role of fluid in metamorphism – P-V-T behaviourof fluids, Thermodynamics of mineral reactions involving fluids; Reaction progress and fluid infiltration
3. Material transport during metamorphism – Introduction, Fluid flow, Diffusion, Mechanical dispersion; Mass transfer mechanism, Metasomatic zonation; Estimation of fluid flux during metamorphism
4. Heat flow during metamorphism – Introduction; Fourier's law, Heat flow equations, Steady state geotherm and its calculation; Calculation of P-T-t paths
5. Metamorphism at extreme condition — Ultrahigh temperature and ultrahigh pressure metamorphism

Practical

Term paper and presentation on a topic assigned by the Teacher(s)

Paleobiology

Theory

1. Vendobionts – Lost life forms of Precambrian
2. Morphodynamics: Patterns of morphological changes in fossil lineages.
3. Palaeoecology: The Ecological Architecture of Major Events in the Phanerozoic
4. History; Stability in Ecological and Paleoecological Systems: Variability at Both Short and Long Timescales.
5. Paleobiogeography and plate tectonics; Phylogenetics and Biogeography;
6. Cladistic biogeography: Quantitative Approaches to Reconstruct the HistoricalBiogeography of Individual Clades; Dispersal-Vicariance Analysis.
7. Diversification of life through ages

Practical

Term paper and presentation on a topic assigned by the Teacher(s)

Vertebrate Paleontology

Theory

1. How to study fossil vertebrates
2. Vertebrate taphonomy, habitats and niches, palaeoecology and modern concepts on functional morphology
3. Basic vertebrate body plan; organic evolution through time—major changes in vertebrate morphology and functions
4. Phylogenetic systematics and cladogram
5. Numerical methods in Palaeontology, Morphometry, Shape and Outline analysis
6. Major vertebrate bearing horizons of India

Practical

Term paper and presentation on a topic assigned by the Teacher(s)

Course No. MSCGEOLC 404
Industrial Training

✧ **Full Marks: 50** ✧ **CA+ESE Marks: 30+20**

✧ **Credit: 2** ✧ **L - T –P : 0 - 0 - 4**

An onsite industrial training for a minimum period of two weeks

Course No. MSCGEOLC 405
Dissertation

Each student has to work on a specific problem in any branch of Geology under the supervision of member/members of faculty.The problem must be addressed based on field and/or laboratory studiesor theoretical studies, and a thesis is to be submitted(in duplicate) within the notified period.

Course No. MSCGEOLCED 200
Extradepartmental Elective to be offered to the students from other discipline(s)

Remote sensing & GIS(CREDIT POINTS 4)

1. Remote Sensing: Definition, scope and purpose. Types or classification of Remote Sensing (RS). Digital imagery vs. conventional photography.
2. Electromagnetic spectrum (EM-spectrum): Fundamental concepts and theories. Subdivisions of the EM- spectrum. Basic laws governing the behavior of the EM-radiation, and the interrelationships among these laws in view of remote sensing. The common wavelength bands used in RS and their characteristic purposes.
3. Different interactions of energy or radiation with matter in different scales. Role of atmosphere in remote sensing. Concept of atmosphere windows.
4. Thermal and microwave remote sensing. Space Missions and Indian Remote Sensing Satellites, Acquisition of RS data. Remote Sensing: data source, platforms and sensors.
5. Geographical Information System (GIS): Introduction, components, data presentation, digitization and scanning, vector and raster methods, input and output device, software and definition/description of equipment.
6. Global Positioning System (GPS): Definition, scope and purpose. Advantage of GPS: Principles of GPS position determination, receiver types.