The Maharaja Sayajirao University of Baroda, Vadodara- 390 002

SEMESTER WISE COURSES FOR M.Sc. IN GEOLOGY DEGREE

Semester – I

Course No.	Course Name	Credits
GEO-2101	Mineralogy & Crystallography	3.0
GEO-2102	Igneous Petrology	3.0
GEO-2103	Sedimentary Petrology	3.0
GEO-2104	Metamorphic Petrology	3.0
GEO-2105	Geomorphology	3.0
GEO-2106	Mineralogy Lab	2.0
GEO-2107	Igneous Petrology Lab	2.0
GEO-2108	Sedimentary Petrology Lab	2.0
GEO-2109	Metamorphic Petrology Lab	2.0
GEO-2110	Geomorphology Lab	2.0
	TOTAL CREDITS	25.0

Semester – II

Course No.	Course Name	Credits
GEO-2201	Structural Geology	3.0
GEO-2202	Remote Sensing	3.0
GEO-2203	Geochemistry	3.0
GEO-2204	Stratigraphy	3.0
GEO-2205	Paleontology	3.0
GEO-2206	Solid Earth System	2.0
GEO-2207	Digital Image Processing & GIS	2.0
GEO-2208	Structural Geology Lab	2.0
GEO-2209	Digital Image Processing & GIS Lab	2.0
GEO-2210	Geochemistry Lab	2.0
GEO-2211	Paleontology Lab	2.0
GEO-2212	Geological Fieldwork	2.0
	TOTAL CREDITS	29.0

Semester – III

Course No.	Course Name	Credits
GEO-2301	Exploration Geology	3.0
GEO-2302	Mining Geology & Mineral Economics	3.0
GEO-2303	Economic Geology	3.0
GEO-2304	Engineering Geology	3.0
GEO-2305	Global Tectonics	2.0
GEO-2306	Micropaleontology	2.0
GEO-2307	Marine Geology	2.0
GEO-2308	Quantitative Geology	2.0
GEO-2309	Micropaleontology Lab	2.0
GEO-2310	Computer Applications & Data Processing Lab	2.0
	TOTAL CREDITS	24.0

Semester – IV

Course No.	Course Name	Credits
GEO-2401	Environmental Geology	3.0
GEO-2402	Hydrogeology	3.0
GEO-2403	Sedimentary Environments & Basin Analysis	2.0
GEO-2404	Quaternary Geology	3.0
GEO-2405	Petroleum & Coal Geology	3.0
GEO-2406	Hydrogeology Lab	2.0
GEO-2407	Petroleum Geology Lab	2.0
GEO-2408	Dissertation	2.0
GEO-2409	Comprehensive Viva-voce	2.0
	TOTAL CREDITS	22.0

COURSEWISE SYLLABUS FOR M. Sc. (GEOLOGY)

Semester – I

GEO-2101 **Mineralogy & Crystallography** **3.0 Credits**

Structure of native elements, sulfides, sulfosalts, oxides, hydroxides, halides, carbonates, nitrates, borates, sulfates, chromates, tungstates, molybdates, phosphates, arsenate, vanadites, silicates.

Crystallographic Symmetry; 32 point groups, natural symmetry, (screw axes and glide planes), space lattice, derivation of 230 space groups. X-ray crystallography, Interference figure & indicatrix.

GEO-2102 **Igneous Petrology** **3.0 Credits**

Physics of magma generation in the mantle. Magma – Physical & chemical properties, Mechanisms of magmatic intrusion. Physical processes related to the extrusive and intrusive forms of igneous bodies and cooling of magma. Classification of igneous rocks: mode and norms, CIPW norm calculation, IUGS classification of volcanic and plutonic rocks, Le Bas et al and Irvine-Baragar classifications. Thermodynamics – laws and Gibbs energy, phase equilibria in Binary System, Ternary system and Quaternary system. Role of fluids in magmatism, supercritical fluids, Magmatic processes - compositional variation, crystal settling, convection, cumulates, liquid immiscibility, diffusion, Pneumatolysis, Magmatic assimilation, mixing and trace element fractionation. Petrographic provinces and associations - tectono-magmatic environments.

GEO-2103 **Sedimentary Petrology** **3.0 Credits**

Textural elements of terrigenous rocks. Importance of structures and textures in basin studies. Sedimentary structures and Hydrodynamic condition. General classification of sediments. Sandstones- provenance and plate tectonic setting. Limestone- classification. Mud rock- classification. Digenesis and lithification.

GEO-2104 **Metamorphic Petrology** **3.0 Credits**

Metamorphism and metamorphic processes, mineralogical phase rule of closed and open systems. Textures and structures of metamorphic rocks. Contact and Regional metamorphism of important protoliths. Metamorphic zones and facies- systematic description and classification. Diagramatic representation of mineral reactions and Paragenesis : ACF, AKF, AFM Diagrams. Schreinmakers Rules. Metasomatism, Metamorphic differentiation, Paired metamorphic belts, Retrogressive metamorphism and ocean floor metamorphism. Role of fluid inclusions in metamorphism.

GEO-2105 **Geomorphology** **3.0 Credits**

Theories of landscape evolution, Erosional and depositional landforms,

Weathering and soils, Use of soils in reconstructing geomorphic evolution and interpreting palaeoclimates, Role of tectonics, climate and sea level changes in geomorphic development, Concept of morphostratigraphy. Morphometric analyses of drainage basins, Geomorphic processes on slopes and mechanics of slope segment production, Role of geomorphology in civil engineering, environmental and landuse planing.

GEO-2106 **Mineralogy Lab** **2.0 Credits**

Optics of rock forming minerals using optical accessories.

GEO-2107 **Igneous Petrology Lab** **2.0 Credits**

Microscopic study of igneous rocks and interpretation of their petrogenesis.

GEO-2108 **Sedimentary Petrology Lab** **2.0 Credits**

Petrography of clastic and chemical sedimentary rocks. Staining techniques of mineral identification. Detailed study of diagenetic features in thin sections. Exercises related to palaeocurrent data.

GEO-2109 **Metamorphic Petrology Lab** **2.0 Credits**

Microscopic study of metamorphic rocks of different facies. Time relationship between deformation and recrystallisation. Graphic construction of ACF, AKF and Kohler Raaz diagrams. Interpretation of reaction textures.

GEO-2110 **Geomorphology Lab** **2.0 Credits**

Identification of various landforms from topographical maps, satellite images and aerial photographs. Preparation and interpretation of geomorphic maps. Morphometric analysis of drainage basins.

Semester – II

GEO-2201 **Structural Geology** **3.0 Credits**

Kinematic and dynamic analysis. Importance of primary and secondary structures. Stress and strain in deformational domains. Classifications and mechanism of folding. Applications of linear and planar features. Shear zones. Mechanical aspects and classification of faults, Anderson's theory, Strike-slip and thrust fault systems, Fault propagated folding, Balanced cross sections. Classification and orientation analysis of joints. Crystallization and deformation: pre-, para- and post-crystalline deformations.

GEO-2202 **Remote Sensing** **3.0 Credits**

Introduction to electromagnetic remote sensing of earth resources, energy sources and radiation principles, energy interaction in the atmosphere, energy interaction with earth surface features, data acquisition and interpretation, elements of visual image interpretation, reference data, characteristic of real remote sensing, geological applications of remote sensing. Across track Thermal and Multispectral scanner and their applications. Concept of micro-wave remote sensing, SLAR system operation.

GEO-2203 **Geochemistry** **3.0 Credits**

Origin of elements, abundance of elements in different cosmic, solar and earth systems, models on the geochemical evolution of the earth, Geochemical data related to lithosphere, hydrosphere, atmosphere and biosphere. Trace elemental chemistry of minerals, thermodynamic control on distribution of chemical species during mineral fractionation and other mineral formation processes. Geological processes (igneous, metamorphic, weathering, sediment transportation and deposition) and geochemical differentiation. Stability field diagrams. Partition of elements, importance with special reference to trace elements, Henry's law and Raolt's law, distribution coefficient and its applications in geological problems. Important mineral reactions and application of thermodynamics to understand various P-T-X, parameters involved in the reactions. Radioactivity, stable and radiogenic isotopes. Nuclear structure, atomic weights, nuclear stability and abundance. Decay-growth relationship of parent-daughter nuclides and decay modes. Mass spectrometry, instrumentation, techniques of chemical separation, isotope dilution and ratio analysis. K-Ar, Ar-Ar, Rb-Sr, Sm-Nd, U-Th-Pb systematics. 14C, Be and Al dating and applications. Stable isotopes of O, C, H, N and S, their geological applications.

GEO-2204 **Stratigraphy** **3.0 Credits**

Changing concepts in stratigraphy; International Code of Stratigraphic Nomenclature; Sequence stratigraphy, Stratigraphic maps, Stratigraphic relations. Palaeogeographic and Palaeoecologic reconstruction of the standard type sections of the Cryptozoic and Phanerozoic Eons. Stratigraphic boundary problems.

GEO-2205 **Paleontology** **3.0 Credits**

Precambrian fossil record and origin of Metazoan. Preservation and fossil record; Species concept; Describing a single specimen; Ontogenic variation; The population as a unit; The species as a unit; Grouping of species into higher categories. Adaptation and functional morphology. Principles of Biostratigraphy, Paleoecology and Paleobiogeography Organic evolution and fossil records. Trace fossils. Evolution of Vertebrates. General account of the Gondwana and cretaceous vertebrates, and Siwalik Mammals. Evolution of Man. Origin and distribution of plant life. Floral Provinces. Study of important world flora with special reference to pre-Gondwana, Gondwana, Intertrappean and Tertiaries of India. Applications of palaeobotany with particular reference to Stratigraphic Correlation and Palaeoclimates.

GEO-2206 **Solid Earth System** **2.0 Credits**

Meteorites, Origin of solar system, Thermal model of solar nebula, chemical composition of Earth and Moon, thermal history of Earth and Moon, Lunar models, Continental crust, Oceanic crust, Mohorivic discontinuity, Low velocity zone, Geophysical characteristics of upper mantle and transition zone, 410 km discontinuity, 670 km discontinuity, Lower mantle and core, Origin of crust and mantle, Mechanism for continental growth.

GEO-2207 **Digital Image Processing & GIS** **2.0 Credits**

Introduction to DIP, geometric correction, radiometric correction, noise removal, gray level thresholding, level slicing, contrast stretching, spatial filtering, edge enhancement, fourier analysis, spectral ratioing, principal component analysis, supervised classification, classification stage, minimum distance to means classifier, parallelepiped classifier, Gaussian maximum likelihood classifier, unsupervised classification. Principles of GIS, elements of GIS, spatial and non spatial data, vector model, raster model, data representation, applications of GIS.

GEO-2208 **Structural Geology Lab** **2.0 Credits**

Preparation and interpretation of geological maps and sections. Calculation of strain parameters

GEO-2209 **Digital Image Processing & GIS Lab** **2.0 Credits**

Marginal Information of IRS data. Identification of elements of visual interpretation from IRS data. Visual interpretation of IRS data for,

lineament, geomorphology, hydro geomorphology and landuse pattern. Visualizing image data, georeferencing and reprojection of the data, image reading, import & export, to set brightness & contrast, to see the histogram, to edit LUT, to apply filter, to see the profile, to subset an image, unsupervised classification, supervised classification, digitization and managing attribute, generate map lay out.

GEO-2210 **Geochemistry Lab** **2.0 Credits**

Determination of elemental composition of minerals and rocks by flame photometer and AAS. Calculation of mineral formulae from oxide data. Weathering indices in soil and sediments and presentation of analytical data.

GEO-2211 **Paleontology Lab** **2.0 Credits**

Identification of species. Morphology and Palaeoecology of the important fossils. Functional Morphology, Distributions of fauna and flora through the Indian Paleozoic, Mesozoic and Cenozoic Era. Trace Fossils. Correlation problems.

GEO-2212 **Geological Fieldwork** **2.0 Credits**

Semester – III

GEO-2301 **Exploration Geology** **3.0 Credits**

Gathering and presenting geological data, Geological guides to mineral search, Designing a reconnaissance project, Mapping surface geology, Geological mapping in underground mines, Sampling methods, Exploration geochemistry-methods and applications, Methods of drilling and recovering samples. Principles and techniques of geophysical exploration: Gravity, Magnetic and Seismic-prospecting, Electrical - Radiometric prospecting.

GEO-2302 **Mining Geology & Mineral Economics** **3.0 Credits**

Terminology, types of mining, Meaning and specialties of mineral deposits. Mineral resource and its estimation, Classification and economic consideration of Mineral resources. Infrastructure, production, processing, co-product and by-product. Mineral legislation of India. Mineral inventory. Internal and external trade, Price, monopoly and stock pile, consumption and substitution, demand analysis and market survey. National Mineral Policy.

GEO-2303 **Economic Geology** **3.0 Credits**

Temporal and spatial distribution of mineral deposits. Genetic relationship with igneous, sedimentary, metamorphic and weathering processes. Nature of mineralizing fluids, Eh-pH fields and other physico-chemical parameters. Ore genesis using isotopic, fluid inclusion and thermodynamic data. Estimation of P-T-X parameters. Understanding of different tectonic settings of ore mineralization. UNCF classification of economic and energy minerals.

GEO-2304 **Engineering Geology** **3.0 Credits**

Role of geology in planning, location, design, construction and performance of major civil engineering structures. Rock mass classification (BGD). Rock mass as foundation for engineering structures and as material for construction. Important engineering properties of rocks in laboratory and in situ conditions, Influence of geological factors on engineering properties. Soils as foundation and construction material. Geological and engineering classification of soils. Engineering properties of soils. Geotechnical aspects of engineering projects: Stages of Geotechnical investigation of engineering projects; concepts, planning, prefeasibility, feasibility, construction post construction monitoring. Surveillance. Geotechnical studies of Dams and Reservoirs; Geotechnical studies of tunnels alignment; Geotechnical aspects of other major engineering projects like canals, aquaducts, ports, townships, industrial complexes etc. Environmental impact assessment of engineering projects.

GEO-2305 **Global Tectonics** **2.0 Credits**

Plate Plate boundaries, Geomagnetism and and polar wander path, Plate motion direct and indirect methods, Mid Oceanic ridges (morphology and spreading rate, median rifts, upper mantle below MOR, petrology and geochemistry of MOR, origin of oceanic crust, propogation of MOR), Continental rifts (characteristic, structure and origin), transform and transcurrent faults (class, origin, ocean fracture zones, continental strike slip), Subduction zone : Island arc (morphology, geophysical signature, thermal structure of Benioff zone, metamorphism, oceanic trench, accretionary prism, volcanic and plutonic activity, marginal sea), Mountain ranges (oceanic-continent continent-continent and arc-continent collusion), Mechanism of plate tectonics (contracting earth hypothesis, expanding earth hypothesis, mantle convection, driving mechanism of plate tectonics), Implication

of plate tectonics (continental splitting, Wilsonian cycle, vertical movements associated with plate tectonics, Palaeozoic plate tectonics, Precambiran plate tectonics, plate tectonics and economic geology)

GEO-2306 **Micropaleontology** **2.0 Credits**

Surface and sub-surface sampling methods, processing of samples. Morphology, classification and evolution of foraminifera; detailed study of major morphologic groups, morphology and biometrics of important larger foraminifera; stratigraphy of foraminifera with special reference to India; palaeoenvironmental interpretation using microfossils. Stable isotopic study of foraminifera and interpretation of palaeoecology. Morphology and geological distribution of ostracoda, radiolaria, conodonts, calcareous algae and calcareous nannofossils. Spores and Pollens. Role of micropaleontology in hydrocarbon exploration. Deep-sea records with reference to Indian Ocean.

GEO-2307 **Marine Geology** **2.0 Credits**

Origin of oceans. Physico-chemical characteristics of Ocean waters. Ocean morphology – Ocean bottom topography, Ocean margins, continental margin, shelf slope, submarine canyon, ocean basin floor, abyssal hills, plains and gaps; Mid oceanic rise and ridges.

Ocean circulation, turbidity currents, submarine sedimentation. Depth distribution of temperature, salinity and nutrients. Oceans and climate – Processes and interlinks, deep sea records.

GEO-2308 **Quantitative Geology** **2.0 Credits**

Importance of generation and analysis of quantitative data in geology. Basics of applied mathematics and applied statistics. Basics of trigonometric functions, integral and differential calculus and its applications in geology. Probability and its distribution. Statistical parameters and its significance. Statistical hypotheses and errors. Parametric and non-parametric hypothesis tests. Correlation and regression – concepts and applications. Computers – History, organization & architecture, hardware, software and firmware, input-output devices. Applications in geological data management and analysis.

GEO-2309 **Micropaleontology Lab** **2.0 Credits**

Processing of samples, picking and mounting of fauna, study of - morphological characters of selected microfossils; preparation of oriented sections of foraminifera. Exercises in biometry. Stable

isotopic analysis or interpretation of existing isotopic data for palaeotemperature and palaeoenvironment reconstructions.

GEO-2310 **Computer Applications & Data Processing Lab** **2.0 Credits**

Operating system and application softwares. Basics of MS Office. Applications of MS Office in geological data management, analysis and documentation. Demonstration of available application softwares in geology.

Semester – IV

GEO-2401 **Environmental Geology** **3.0 Credits**

Environmental geosciences-Fundamental concepts. Biodiversity. Earth's processes and Geological hazards. Environmental implication of floods, landslides, earthquakes, volcanism, and avalanche, Environmental health-Biogeochemical factors in environmental health, trace elements and health. Environmental law- environmental legislation in India. Resources and Environment: Minerals and population. Environmental impact of exploitation. Energy Resources - Energy crisis. Consumption and production trends of energy resources. Environmental effects associated with various types of energy resources. Greenhouse effect, Ground water pollution. Land use planning; Soil surveys land use impact. Methods of site selection and evaluation - cost/benefit analysis versus physiographic determinate. Waste Disposal : Solid, liquid and gases. Radioactive waste management.

GEO-2402 **Hydrogeology** **3.0 Credits**

Elements of surface hydrology: Precipitation causes and types, computation of average precipitation. Methods of determination of evaporation and evapotranspiration. Elementary theory of groundwater flow; Darcy's law and its range of validity. Steady and unsteady flows. Well hydraulics: Determination of aquifer characteristics from pumping tests. Groundwater development: Water well drilling, design and construction. Secular changes in groundwater levels. Groundwater exploration techniques and its implications. Groundwater levels fluctuations and causes.

Fresh and salt water relationship in coastal areas; Ghyben-Herzberg principle and its modification, prevention and control of sea water intrusion, Hydrogelogical categarisation. Water balance studies, Groundwater recharge: artificial and natural, Groundwater provinces of India. Basin wise groundwater development. Aspects of chemical

hydrology and quality. Graphic presentation of hydrochemical data. Groundwater facies.

GEO-2403 **Sedimentary Environments & Basin Analysis** **2.0 Credits**

Depositional environments; with classical examples of alluvial, deltaic, shorelines and deep sea sediments. Carbonate environments. Sedimentary Basins (Overview); Basin developments and classification, Cratonic basins, Divergent margin basins, Convergent margin basins, Downwarp basins, Tertiary Deltas, Basin types. Basin analysis including facies analysis. Case studies of the above types.

GEO-2404 **Quaternary Geology** **3.0 Credits**

Nature of Quaternary period, Quaternary stratigraphy and Stratigraphic principles, Quaternary environments and climatic records. Tectonogeomorphology. Role of neotectonism in sculpturing the landscapes and drainage patterns. Tectonism and Paleoseismicity. Quaternary Terrains of India, Economic aspects of the Quaternary deposits.

GEO-2405 **Petroleum & Coal Geology** **3.0 Credits**

Origin; occurrence migration and accumulation of hydrocarbons. Petroleum traps; Reservoir rocks and Reservoir conditions. Geological, geophysical and geochemical methods of petroleum exploration. Drilling rigs, Drill holes, Different methods of drilling; Coring; Casing and Cementation; Drilling fluids. Functions of Petroleum Geologist. Formation evaluation - Geologging and well logs - Electric, Radioactive and Acoustic. Well Completion and Stimulation; Reservoir mechanisms. Origin of peat swamps, Development of the Coal Facies, Diagenesis of Peat and Coalification. Classification, Coal petrology, Coal bed methane. Coal exploration techniques.

GEO-2406 **Hydrogeology Lab** **2.0 Credits**

Groundwater exploration data interpretation – Subsurface profiles based on borehole data; resistivity data interpretation; Groundwater quality data interpretation for drinking, irrigation, genetic classification, groundwater facies analysis; pumping test data analysis. Groundwater contour maps – Seasonal and secular changes; spatial distribution pattern of chemical content. Tube well design; rainfall and flood data analysis, construction of hydrographic and related

numerical problems. Water balance studies and realated problems.
Study of seismic and flood-prone areas in India. Evaluation of environmental impact of air pollution, groundwater and surface water pollution, landslides, deforestation, cultivation and building construction in specified areas.

GEO-2407 **Petroleum Geology Lab** **2.0 Credits**

Well log interpretation (Caliper, SP, Gamma Ray, Resistivity, Neutron, and Density): (i) Prediction of Lithology (ii) Calculating petrophysical properties - Porosity, Permeability and Water saturation etc. (iii) Well log correlation (iv) Depositional environment prediction and Facies analysis.

GEO-2408 **Dissertation** **2.0 Credits**

GEO-2409 **Comprehensive Viva-voce** **2.0 Credits**