**M.Sc. Geology Syllabus (2017- 2018)**

**SEMESTER I**

 **Paper Geol. 101: Mineralogy**

***Unit – I***

Introduction to Periodic table. Co-ordination number and bonding in Minrals; Crystallographic concepts: Crystal forms, Symmetry elements, Unit cell, Introduction to Bravais lattices and space groups; Crystal imperfections: defects, zoning and Twinning.

***Unit – II***

Crystal systems and their 11 symmetry classes; Structural classification of silicates. Isomorphism, polymorphism and Pseudomorphism.

***Unit – III***

Polarized light, Refractive Index, Double refraction, birefringence and Nicol prism. Study of orthoscopic and conoscopic properties of minerals. Dispersion in minerals, sign of elongation, determination of fast and slow vibrations and accessory plates. Uniaxail and biaxial indicatrix and interference figures.

***Unit - IV***

Silicate mineralogy: structure, mineral chemistry, P.T. stability, Physical and optical properties and mode of occurrence of Quartz (Silica), Feldspar, Feldspathoid, Garnet, Epidote, and Aluminosilicates.

***Unit – V***

Silicate mineralogy: structure, mineral chemistry, P.T. stability, Physical and optical properties and mode of occurrence of Pyroxene, Amphibole, Mica and Olivine. Physical and optical properties of following Minerals: Chlorite, Calcite, dolomite, Apatite, corundum, zircon, scapolite and sphene.; Clay Minerals: Properties and occurrences. Bragg’s Law.

**Paper Geol. 102: Structural and Field Geology.**

***Unit – I***

Structural behavior of igneous rocks, Diapirs and salt Domes. Cleavage: Types, origin, mechanics and relationship with folding. Lineation: Types, origin and deformation. Basic principles of structural analyses.

***Unit – II***

Principles of geological mapping, methods of contact mapping, Field equipments and toposheets, map reading, mapping in multigeneration folded terrain, Method of measuring strike and dip in the field and plotting of cross sections.

***Unit - III***

Concept of petrofabrics and symmetry; Types of fabrics, fabric elements, π and β diagrams; Thrust geometry. Mechanical principles and properties of rocks; Rock theory and methods. Concept of stress and strain; Stress and its components, stress in two and three dimensions; Types of strain ellipses and ellipsoids, their properties and geological significance ; Mohr diagrams; Varities of deformative forces.

***Unit - IV***

Folds: Geometry, classification, mechanism of folding and projection diagrams. The dynamic factor conditioning in the formation of folds. Recognition of fold in the field.

***Unit - V***

Faults: Geometry, classification, mechanism of faulting. Recognition of faults in the field. Unconformities and basement-cover relations. Shear zones, Shear sense indicators, shear zone kinematics. Role of fluids. Mylonites and cataclasites, their origin and significance. Behaviour of minerals and rocks under deformation conditions. Time relationship between crystallization and deformations.

**Paper Geol. 103: Geomorphology and Global Tectonics.**

***Unit I***

Concepts of Geomorphology, soilk, soil profile and climatic characteristics. Geomorphic land forms and processes, Agradational processes: Volcano – Types, causes and products. Degradational Processes: Weathering, Erosion and mass wasting. Streams and their geological work, Drainage patterns, Morphometric basin analysis. Erosion by stream: Deepening, widening, headward and base level of erosion stages of rivers. Erosion, transportation and deposition landforms. River capture and river pieracy. Palaeodrainages.

**Unit - II**

Geomorphological divisions of India. Morphological zones and origin of Himalaya. Indogangetic alluvium, Peninsular India, Indian Rivers, mountains, glaciers, lakes, islands and coasts. Earthquakes and Seismic zones of India. Geological work and landforms of Glaciers, Groundwater Wind.

**Unit - III**

Concept of Continental drift. The Theory of Plate Tectonics, Type of Plates. Causes of Plate movements, Rate of Plate movement. Triple junction and opening of Sea. Mid-Oceanic Ridges. Subduction Zone and Benioff zone. Deep Sea Trenches, Island and Volcanic Arcs. Mantlr Plume and Plume mechanism. Palaeomagnetism.

**Unit- IV**

Applied Plate Tectonics for Seismisity, Mountain building, Fuel and Mineral exploration, Igneous rocks and Metamorphism. Applied Geomorphology for mineral prospecting, Civil Engineering projects, Environment studies and Terrain evaluation for strategic purposes. Geomorphological indications of Neotectonics: Stream drainages, Drainage modification, fault reactivation, vertical movement in stable sand at coasts and Deserts.

**Unit- V**

Introduction to Oceanography, Geological work of Sea, Morphology of Ocean bottoms, Littoral zone, continental shelf, continental slope and Abyssal zone, Deep Sea Trench,, Coral Reefs, island, Coastal morphology, Temperature, Salinity, Density and Ice in Sea. Ocean waves, Tides and currents, El Nino and La Nino. Marine Resources: Organic and carbonate deposits, polymetallic Nodules, Gashydrates and off shore Petroleum resources. Morphology of Indian Ocean.

**Paper Geol. 104: Sedimentology.**

**Unit I**

Earth surface system: weathering, erosion, process of transportation, deposition and post depositional changes and Diagenesis. Sedimentary textures: grain size and their classification. Granulometric Analysis and interpretation of grain size data with the help of graphic measures and Stastical parameters. Grain shape and their classification. sorting, packing and orientation. Imlications and significance of textures. Mineralogical characteristics and Mineral stability. Heavy minerals : heavy mineral Suites and significance of Heavy minerlas.

**Unit II**

Sedimentary structures: Mechanical, chemical and Biogenic and Biochemical sedimentary structures. Deformed bedding structures. Significance of Sedimentary Structures. Sedimentary Environments and Facies: Non- Marine ( Aquous) Sedimentary Environments: continental alluvial-fluvial, lacustrine and glacial sedimentary system.

**Unit III**

Sedimentary environments and Facies: Non- Marine Sedimentary Environments - continental Desert-Aeolion sedimentary system. Deltaic Sedimentary Environments. Marine Sedimentary Environments: Shallows coastal, Beach, shelf and deep Marine Sedimentary Environments. Mixed Sedimentary Environments: Barrier Islands, Environments.

**Unit IV**

Sedimentary Petrology: Characterstics and Petrogenesis of important Clastic Sedimentary Rocks: conglomerate, Breccia, pebbly sandstone, sandstone, quartz arenites, arkose, grawack, siltstone, shale bone bed. Non Clastic Sedimentary Rocks: micritic, microsparitic and sparitic limestone, dolomites, bedded phosphorite, and biogenic Sedimentary Rocks ( stromatoloitic limestone and phosphorite, oncolitic phosphorite, fossiliferous limestone, coqunoidal limestone).

**Unit V**

Classification of Rudaceous, Aranaceous and Argillaceous Clastic Sedimentary Rocks. Folk and Dunham's classification of Non-Clastic Sedimentary Rocks. Palaeocurrent and tools of paleocurrent. Palaeocurrent analysis for palaeoenvironmental and basin analysis. Definations and Elimentary idea of sedimentary Basins.

**PRACTICAL:**

 **Geol. 105: Mineralogy, Structural and Field Geology.**

1. Identification and Physical properties of common minerals.
2. Identification and optical properties of minerals under petrological microscope
3. Identification of crystal forms in models and their axial, symmetrical and notational characteristics.
4. Identification of common features in Geological Maps.
5. Outcrop completion maps.
6. Preparation of Cross Section of Geological Maps, dealing with simple contacts, unconformities and their combinations.
7. Structural Problems related to stereographic projections.
8. Extensive Structural Geological Field study and camp\* at one **/** various locations for Geological Mapping, Preparation of report and viva voce exam

**Note**\* Structural Geological Field study and camp is essiential part of the syllabus.

**PRACTICAL:**

 **Geol. 106 : Geomorphology, Global Tectonics and Sedimentology.**

1. Draw tectonomorphic divisions of India in map of India
2. Identification and description of various landforms in models and drawings.
3. Grain size analysis and granulometric analysis: Graphical representation: Histogram and cumulative frequency distribution curve of grain size data. statistical representation: computation of statistical parameters such as median, mean, standard deviation, skewness and kurtosis etc. and their interpretation for paleoenvironments.
4. Identification, characteristics and Petrogenesis of important sedimentary rocks based on their megascopic characters: 1. clastic Sedimentary Rocks (Oligomictic conglomerate and Polymictic conglomerate, Breccia, pebbly sandstone, Fine grained sandstone, medium grained sandstone and coarse grained sandstone, quartz arenites, arkose, grawack, siltstone, shale, bone bed; 2. non clastic Sedimentary Rocks ( micritic limestone, microsparitic limestone and sparitic limestone, dolomite, bedded phosphorite, and 3. biogenic Sedimentary Rocks ( stromatoloitic limestone and stromatoloitic phosphorite, oncolitic phosphorite, fossiliferous limestone, coqunoidal limestone ).
5. Identification and Petrography of important clastic and non-clastic sedimentary rocks based on their microscopic characters: shale, siltstone, Fine grained sandstone, medium grained sandstone, coarse grained sandstone, quartz arenites, arkose, graywack, pebbly sandstone, bone bed, micritic limestone, microsparitic limestone and sparitic limestone, bedded phosphorite, stromatolitic limestone and phosphorite and fossiliferous limestone etc.

**Geol. 107(Any One): SKILL DEVELOPMENT COURSE:**

1. **Topographic Survey.**
2. Principles of surveying. Survey equipments.
3. Radial method of plane table survey.
4. Plane table survey with intersection methods.
5. Pace/Tape and compass methods survey with theodolite with various applications.
6. **Field Geology.**
7. Field study of Igneous, Metamorphic and Sedimentary Rocks.
8. Observation of attitudes of Planar Structures.

**SEMESTER III**

**Geol. 301 : Hydrogeology.**

**Unit I**

Groundwater: origin and types of water. Hydrological cycle and its components. Vertical distribution of water. Water table and Piezometric surface. Hydrographs, Flownets, Water table fluctuation and contour maps. Hydrogeological properties of rocks: porosity, permeability, specific yield and specific retention etc**.** Transmissivity and Storage Coefficient. Aquifers and their classification. Geological formations as aquifers.

**Unit II**

Ground water quality – physical and chemical properties of water, quality criteria for different uses (domestic, irrigation and industrial purposes). Groundwater pollution and contamination – Geogenic and Anthropogenic.  Salt water intrusion in coastal aquifers and its prevention. Ground water quality in India and Rajasthan**.**

**Unit III**

Well hydraulics: Darcy's Law and its application. Confined, unconfined, steady, unsteady and radial flow conditions. Pumping test methods, data analysis and interpretation. Evaluation of aquifer parameters of confined, semi-confined and unconfined aquifers – Thies, Thiem, Jacob and Walton methods.

**Unit IV**

Surface and subsurface geophysical methods of groundwater exploration. Role of Remote sensing in groundwater exploration and hydrogeomorphic mapping. Radioisotopes in hydrogeological studies. Types of water wells and water well drilling methods, construction, design, development and maintenance of wells.

**Unit –V**

Ground water assessment/estimation. Problems of Groundwater in over-exploitated areas. Ground water problems in urban areas. Rainwater harvesting & Artificial recharge: need and benefits, methods/techniques of artificial recharge. Conjunctive use of surface and groundwater. Hydrogeology of wetlands and arid zones of India with special reference to western Rajasthan. Groundwater provinces/scenario & resources of India. Groundwater scenario & resources of Rajasthan. Groundwater legislation in India. Ground Water Management in India.

**Geol 302 : Ore Genesis and Mineral Deposits.**

**Unit I**

Brief history of development of economic Geology and modern concept of ore genesis. Spatial and temporal distribution of Ore deposit in the World. Material of mineral deposits and their formation. Principle ore mineral groups. Methods of goethermometery and geobarometry in Ore Geology. Ore texture, Paragenesis and zoning of Ore and their significance.

# Unit II

Chemical composition of Ores and host rock: bulk chemistry, major, minor, trace and rare earth elements. Stable and radiogenic isotopes. Ore microscopy: Optical principle and properties of Ore minerals. Fluid inclusion in ores: Principle, applications and limitations. Earths evolutionary history and evolutionary trends of Ore deposits. Precambrian and present Plate tectonics and genesis of Ore deposits. Classification of Ore forming processes.

**Unit III**

Ore forming processes of igneous associations with possible Indian example, Magmatic deposits associated with acidic, basic and ultra basic rocks. Mineralization associated with Komatiite (Gold), Kimberlite (Diamond), Carbonates (R.E.E), Peridotites (Cr, Ni and PGE), Granite (W and Sn) and Pegmatite’s (mica, uranium, gems and R.E.E), Cyprus type Cu-Zn deposit and Kuroko type Pb-Zn-Cu deposit. Porphyry copper.

Pegmatites: As a rock and economic deposit forming process. Simple and complex pegmatite and their genesis. Indian pegmatite belts.

Skarn and greisens deposits, contact metasomatism: role of invaded and intrusive rock. Characteristic of the deposits. Hydrothermal process and deposits. Origin and nature of hydrothermal solutions. Wall rock alteration, crustification and comb structures. Cavity filling and metasomatic replacement type of deposits. Hypo-, Meso-, Epi-, Tele-, Xeno and Lepto thermal deposits.

Volcanogenic process and deposits: characteristics, mode of occurrence and genesis of Mn nodules. Metamorphosed deposits and metamorphism as Ore forming process.

**Unit IV**

 Economic mineral deposit forming process of sedimentary association (with possible Indian examples) Sedimentation: Chemical and Clastic sedimentation, chemical precipitation of iron and Manganese deposit. Factors controlling economic concentration and their mutual dependence.

Residual concentration: characteristic of the process and controlling factors. Bauxite, classification and Indian deposits of bauxite. Blue dust Ore. Residual Cr and Ni /Au profiles.

Mechanical concentration: Eluvial, Alluvial, Wind and Beach placers, Placer gold, diamonds and thorium.

Oxidation and Supergene Sulphide enrichment: formation of solvent, dissolution migration and deposition of metals. Gossans: Type and importance.

Biogenic deposits and process.

Stratiform and Strata bound Ore deposits (Mn, Fe and Base metals).

Contemporary Ore forming systems: black and white smokers, mineralized crust, Mn nodules and Red sea.

**Unit – V**

Geology and genesis of important metallic deposits of India: iron, manganese, chromium, nickel, tin, tungsten, gold, lead, zinc, copper and aluminum deposits.

**Geol. 303: Metamorphic Petrology and Geochemistry.**

**Unit I**

Agents and kinds of metamorphism; metamorphic zones; Evolution of the Becke-Grubenmann concept of depth zone, grades; iso-grades; metamorphic facies; Fabric of metamorphic rocks formed under regional, dynamic and Cataclastic metamorphisms.

 Studies of metamorphic facies: Glucophane schist facies; amphibolite facies; granulite facies, Eclogite facies.

**UNIT – II**

Principles of thermodynamics; Mineralogical phase rule; Graphical representation and plotting of different compositions in equilateral triangle, Representation of mixture and minerals consisting of two and three components, tie lines, Diagrammatic representation of mineral paragenesis in: ACF and A’KF diagrams, its merits and demerits.

**UNIT – III**

Factors of metamorphism; temperature, pressure and composition of fluid phase, role of H20and Co2, Equilibrium curves formation at different XCo2,

Principles of metasomatism and metamorphic differentiation; Petrogenetic grids, pressure, temperature, time paths, Petrological studies of Charnockite and Migmatite, paired metamorphic belts.

 **UNIT – IV**

Origin of elements in the Solar system, abundance of elements in the Earth crust, mantle, core and its constituents, Special properties of transition and rare earth elements.

**UNIT – V**

Geochemistry of atmosphere, hydrosphere and biosphere; geochemical cycles: Carbon cycle, Nitrogen cycle, Water cycle, Fundamentals of isotope geochemistry.

**Geol. 304: Tectonics, Stratigraphy and Sedimentation.**

**Unit I**

Tectonics and sedimentation: Sedimentary Basins: Geosynclinal Concept, Plate Tectonics Concept, Plate Movements and Sedimentary Basin Formation. Basins in extensional settings, Basins in compressional settings, Basins in stike slip and transform fault zones.

**Unit II**

Tectonics and sedimentation: Basin classification and Description: Downwarp Basin, Rift Basins, Interior Basins, Foreland Basins, Subduction Basins, Pull apart Basins, Delta type Basins and composite Basins.

**Unit III**

Stratigraphy and sedimentation: Classical Concepts in Stratigraphy, Estimation of Geological time, Dual Hierarchy in stratigraphy, Vertical and lateral relationship and cyclicity in sedimentary sequences. Elimentary idea of Lithostratigraphy, Biostratigraphy, Sequence Stratigraphy, Magnetostratigraphy, Chemostratigraphy and Seismic Stratigraphy.

**Unit IV**

Basin and Basin Analysis: Basins and its lithic fill, Paleoslope and paleocurrent, Deposional environments in sedimentary Basin, Diagenesis and Maturation of sediments. Basin Evolution and Tectonics.

**Unit V**

Sedimentary Basins of western Rajsthan: Lithology, stratigraphy, Paleontology, Sedimentary environment and Economic Geology of Nagaur - Ganganagar Basin ( Marwar Basin), Jaisalmer Basin and Barmer Basin.

**PRACTICAL**

**Geol. 305**: **Hydrogeology, Ore Genesis, Mineral Deposits and Groundwater training.**

Physical properties, mode of occurrence and genesis, economic use and Indian location of important metallic minerals.

Ore microscopic study of Ores minerals textures and paragenesis.

Geological problems related with groundwater.

Collection of surface and Ground water samples from different sources and localities (Part of ground water field training).

Measurement of PH and EC of surface water and ground water using PH and EC meters respectively in the Laboratory and their interpretation for water quality.

Field training related with Economic Geology and Hydrogeology: Extensive Field study at various locations in Geological tour\* of Economic Geology, Preparation of report and viva voce exam.

**Note**\* Geological tour is an essential part of syllabus.

**Geol. 306: Metamorphic Petrology, Geochemistry and Sedimentary Exercises:**

1. Identification and characteristics of metamorphic rocks in handspecimen.
2. Identification of metamorphic rocks under petrological microscope.
3. Graphic construction of ACF AKF and AFM Diagrams
4. Study of primary, secondary and biogenic sedimentary structure in hand specimens in photographic atlas, field photography and wherever possible on the outcrops.
5. Exercise related to analysis and interpretation of Lithologs and depositional sedimentary environments using actual case histories from western Rajasthan stratigraphic record.
6. Field and laboratory techniques in sedimentology: preparation of lithologs from western Rajasthan sedimentary Basins. Thin section preparation of Sedimentary Rocks and staining techniques for carbonate rocks.
7. Demarcation of geological boundaries of important sedimentary Basins of Rajasthan.

**Geol. 307 (Any One): Skill Development Course:**

**A. Remote Sensing**

 1. Principles of remote sensing.

 2. Tool and techniques to study with areal photographs/Imageries.

 3. Study of topography with areal photos/ Imageries.

 4. Study of structural features with areal photos/ Imageries.

 5. Study of rock types with areal photos/ Imageries.

**B. Ore Reserve Estimation.**

Ore reserve estimation, calculation of all category of proved, probable and possible estimation of ores reserves including all type of deposits – bedded, load, veins etc.