

Teaching and Examination Scheme

M.Sc. (Final) Geology – 2022

Scheme

per No.	Theory paper (Nomenclature)	Theory Hours per week	Practical Hours per week	Exam. Hours	Maxi. Marks
V	Igneous & Metamorphic Petrology	6	6	3	75
VI	Sedimentology & Petroleum Geology	6	6	3	75
VII	Environmental Geology, Hydrogeology & Remote sensing	6	6	3	75
VIII	Mining Geology & Engineering Geology	6	6	3	75

Minimum Passing Marks in theory: – 108 out of Total 300 Marks.

DISTRIBUTION OF MARKS AND TIME DURATION FOR PRACTICAL EXAMINATION

(Practicals: Exam Duration- 16 Hours, distributed in 2 Parts in 4 days.)

Max Marks: 150

Min Pass Marks: 54

Distribution of marks and time duration for practical examination

Part-I	- Igneous & Metamorphic Petrology - Mining Geology & Engineering Geology - Mining Training Camp and Report there on.	8 Hrs.	60Marks
Part-II	- Sedimentology & Petroleum Geology and Environmental Geology Hydrogeology & Remote Sensing - General Geological Tour and Report there on.	8 Hrs.	60Marks
Part III-	Field Based Case Study related to theory papers, presented in handwritten form		30 Marks

Practical : Minimum Passing Marks - 54, Out of Total 150 Marks

M.Sc. (Final) – 2022

Paper V – Igneous and Metamorphic Petrology

Note: – Each Theory paper is divided into 5 units. The question paper is divided into three parts, Part A, Part B and Part C. Part A (20 Marks) is compulsory and contains one question containing 10 parts, two from each unit, each question is of 2 marks (Answer limit 50 Words). Part B (25 Marks) is compulsory and contains five questions with internal choice, one from each unit. Candidate is required to attempt all five questions, each question is of Five marks each (Answer limit 200 words). Part C (30 Marks) contains five questions one from each unit, Candidate is required to attempt three questions; each question is of 10 Marks (Answer limit 500 hundred words).

Unit-I

Composition, constitution & behaviour of magma. Magma types and their classification. Origin of magma. Differentiation and assimilation of magma. End-stage crystallisation of magma. Magma generation and its relation with plate margins. Fabric study of plutonic and volcanic rocks. Classification of Igneous rocks. Petrographic provinces of India.

Unit-II

Crystallisation process in silicate melts including system: Albite- Anorthite, Albite-Anorthite-Orthoclase, Foresterite- Silica, Leucite-Silica, Diopside- Anorthite-Albite, Diopside- Foresterite-Silica, Nepheline-Kaliophyllite-silica, Foresterite- Faylite-Silica; Reaction principles. Forms, structure and textures of igneous rocks.

Unit-III

Petrography, mode of occurrence and petrogenesis of the following rock groups and associations: Basic and Ultrabasic plutonic association; Granite and Granodiorite plutonic association; Nepheline Syenite, Ophiolites and cumulates, Anorthosite and Pegmatite; Tholeites and alkali Olivine basalt. Dacite and Rhyolite association of Orogenic regions.

Unit-IV

Element analysis of rocks and minerals. Principles and geological applications of cathodoluminescence, thermoluminescence, atomic absorption spectrophotometry, XRF spectrometry and XRD.

Working knowledge of AAS, Flame- photometer, DTA, ICP spectrometer, UV- IR spectrophotometer and working techniques.

Metamorphism: concept, factors and types. Texture and structure of metamorphic rocks. Phase rule.

Concept of the depth zone, zone of progressive metamorphism. Retrogressive metamorphism; stress and anti stress minerals. Anatexis and migmatites. ACF, AKF, & AFM diagrams and their significance.

Unit- V

Detailed study of facies of contact and regional metamorphism. Paired metamorphic belts.

Mineralogical and textural changes accompanying progressive regional metamorphism of mafic and ultramafic rocks, pelites and carbonate rocks. Metasomatism and metamorphic differentiation.

Petrographic and petrogenetic study of important metamorphic rocks; granulites, charnockites and eclogites etc; Ultra-high temperature, ultra-high pressure and ocean floor metamorphism and their significance.

Suggested Readings:

1. Bowen, N.L. – Evolution of Igneous rocks (Princeton University Press)
2. Jackson – Text book of Lithology
3. Best – Igneous and Metamorphic Petrology (CBS)
4. Winkler H.G.F. - Petrogenesis of Metamorphic Rocks (Springer-Verlog)
5. Miashiro – Metamorphism and metamorphic Rocks (George Allen University)
6. Moorehouse – A study of Thin Sections (CBS)
7. Ghose, M.K. – Igneous Petrology (World Press Pvt. Ltd., Kolkata)
8. Chatterjee, S.C. – Igneous & metamorphic Rocks
9. Johanneson, A – A Descriptive Petrology of Igneous Rocks –Vol. I-IV (University of Chicago Press).

10. Turner, F.J. - Metamorphic Petrology. Mc Graw Hill.
11. Philipots, A. - Igneous and Metamorphic Petrology. Prentice Hall.
12. Mason, Brian - Principles of Geochemistry.
13. Hutchinson, C.S. - Laboratory Hand Book of Petrographic Techniques. John Wiley.
14. Mason, B. and Moore, C.B. - Introduction to Geochemistry. Wiley Eastern.
15. Krauskopf, K.B. - Introduction to Geochemistry. McGraw Hill.
16. Faure, G. - Principles of Isotope Geology. John Wiley.
17. Govett, G.J.S. - Hand Book of Exploration Geochemistry. Elsevier.

Paper VI– Sedimentology & Petroleum Geology

Note: – Each Theory paper is divided into 5 units. The question paper is divided into three parts, Part A, Part B and Part C. Part A (20 Marks) is compulsory and contain one question containing 10 parts, two from each unit, each question is of 2 marks (Answer limit 50 Words). Part B (25 Marks) is compulsory and contains five questions with internal choice, one from each unit. Candidate is required to attempt all five questions, each question is of Five marks each (Answer limit 200 words). Part C (30 Marks) contains five questions one from each unit, Candidate is required to attempt three questions; each question is of 10 Marks (Answer limit 500 hundred words).

Unit-I

Introduction, scope, history of development of sedimentology.

Processes of sedimentation. Post depositional changes in sediments. Surface processes and rock weathering. Mineral stability. Provenance sources of sediments.

Mineral composition: quartz, feldspar, rock fragments, clay minerals, heavy minerals, carbonates, cement and matrix. Soil forming processes, soil profile. Identification of clay minerals by X-Ray diffraction method.

Texture and structures of sedimentary rocks. Trace fossils—introduction, classification, identification and description.

Unit-II

Transportation of sediments. Settling velocity of spheres. Stock's law. Impact law. fluid flow movements of particles, suspension and traction transport, saltation movement, selective transportation, particle weathering during transport, sediment maturity.

Deposition of clastic and non-clastic sediments. Classification of sedimentary rocks.

Study of common sedimentary rocks: Clastic sedimentary rocks – deposits of gravels, conglomerates, breccia, sandstone, graywacke, shale, siltstone etc.

Non-clastic sedimentary rocks— limestone, dolomite, evaporites. Organic sediments.

Unit-III

Sedimentary environment and facies: continental alluvial- fluvial, lacustrine, desert – Aeolian and glacial sedimentary systems. Shallow coastal clastics. Marine and continental evaporates. Shallow water carbonates.

Deep sea basins. Volcanoclastics: onland and marine. Tectonics and sedimentation. Stratigraphy and sedimentation; Reconstruction of palaeoenvironment. Basin analysis.

Unit-IV

Petroleum- chemical and physical properties. Origin of Petroleum. Migration and accumulation of Petroleum. Reservoir rock: Classification – fragmental, chemical & bio-chemical and micellaneous rocks; well logs; marine & non-marine reservoir rocks.

Reservoir Pore Space: Porosity; permeability; Classification & origin of pore space; relation between Porosity & permeability.

Reservoir fluids (water, oil & gas): Fluid content – source of data, distribution of gas, oil & water, classification of waters, character of oil-field water, oil field brine; Oil – measurement, chemical & physical properties; Gas - measurement, composition, impurities.

Reservoir Traps: Anticlinal theory; classification; structural traps; stratigraphic traps (primary & secondary); fluid traps; combination traps; salt domes.

Reservoir pressure and temperature. Reservoir mechanics.

Types of reservoirs of oil and gas, oil and gas traps.

Unit- V

Principles and techniques of petroleum exploration.

Application of subsurface mapping in Petroleum exploration – Structural maps & sections, isopach maps, facies maps, paleogeologic & subcrop maps, geophysical maps, geochemical maps; Dry Holes.

Elements of well drilling and logging. Various types of drilling in petroleum.

Geology of the petroliferous basins of India.

Prospects of new discoveries of petroleum in the Indian mainland and the adjoining seas.

Distribution of Petroleum deposits of the World.

Suggested Readings:

1. Sengupta, S.M. – Introduction of Sedimentology (Oxford & IBH)
2. Pettijohn, F.J. – Sedimentary Rocks (CBS)
3. Slley, R.C. – Introduction to Sedimentary Rocks (Academic Press London)
4. Folk, R.L. – Petrology of Sedimentary Rocks (Hemphill Pub. Co.)
5. Allen – Sedimentary Structures
6. Thomson – Sedimentary Structures
7. Green smith – Sedimentary Petrology(CBS)
8. Krumbein and Sloss – Stratigraphy and Sedimentation (W.H. Freeman & Co.)
9. Reineck and Singh – Depositional Environments.
10. Landes, K.K. – Petroleum Geology (Robert, Kraieger Pub. Co.).
11. Kinghorn, R.R.F. – An Introduction to the Physics and chemistry of Petroleum (J. Wiley & Sons).
12. Levorson – Petroleum Geology
13. Selley, R.C. - Elements of Petroleum Geology. Academic Press.

Paper VII – Environmental Geology, Hydrogeology & Remote Sensing

Note: – Each Theory paper is divided into 5 units. The question paper is divided into three parts, Part A, Part B and Part C. Part A (20 Marks) is compulsory and contains one question containing 10 parts, two from each unit, each question is of 2 marks (Answer limit 50 Words). Part B (25 Marks) is compulsory and contains five questions with internal choice, one from each unit. Candidate is required to attempt all five questions, each question is of Five marks each (Answer limit 200 words). Part C (30 Marks) contains five questions one from each unit, Candidate is required to attempt three questions; each question is of 10 Marks (Answer limit 500 hundred words).

Unit -I

Fundamental concepts of Environmental Geology. Geologic Cycles-Tectonic cycle, hydrologic cycle, rock cycle. Earth materials- minerals, rocks, soils, water, and air. Environmental Degradation. Pollution- types, Factors. Air pollution.

Wastes: Solid wastes, Hazardous Chemical wastes, Radio-active wastes, Liquid- Semi liquid (sewerage & waste water) Wastes and their disposal. Environmental Impact Assessment (EIA).

Hazardous Earth Processes: River flooding: Nature & extent of hazard: Perception of River flooding.

Landslides: Identification, prevention and correction (control) of LS; Snow Avalanche; Subsidence; Perception of LS hazard. Earthquakes: Perception to EQ. Volcanoes: Perception of Volcanic Hazard.

Desertification and environmental impact.

Anthropogenic Impact and Environmental planning to open cast mining & quarrying, river valley projects, urbanization & urban air environment, global climatic change.

Unit- II

Hydrogeology- Introduction: scope, historical background and utilization of groundwater.

Hydrological cycle. Sources of groundwater; Rock properties affecting groundwater; Porosity and Permeability. Vertical distribution of groundwater; Aquifers and their types. groundwater Basins.

groundwater movement. Darcy's law. Coefficient of permeability. Measurement of permeability.

Tracing groundwater. movement and dating; flow lines.

Water wells: their types and construction methods; collector wells and infiltration galleries.

groundwater level fluctuation. Hydrogeologic characteristics of common rock types.

Ground water quality: Measures of water quality; physical, chemical & bacteriological analysis; water quality criteria for drinking, irrigation & industrial purposes. Groundwater Pollution and Restoration; collection of water samples, analysis of groundwater. Groundwater monitoring, Basin wide groundwater development: Safe yield & overdraft.

Unit -III

Equations of hydrologic equilibrium. Data collection for basin investigation; method of computing safe yield; variability of safe yield. Conjunctive use of surface & groundwater Reservoirs.

Groundwater Exploration: Geologic and hydrogeologic methods; Geophysical exploration; Test drilling.

Hydrogeologic and geophysical well logging.

Artificial recharge: need and benefits, methods of artificial recharge: induced recharge, recharge well method, recharge through pits and shafts.

G.W. Development & Potentials in India. G.W. Potentials of Rajasthan.

Unit –IV

Introduction to Photogeology & Remote sensing. Remote sensing from air and space. Electromagnetic spectrum, emission range, films and filters, multispectral sensors and scanners,

Maps and aerial photographs; Aerial photographs- types, errors and distortion. Instruments used in Photo interpretation, plotting & measurements from aerial photographs. Rectification. Vertical exaggeration and its estimation.

Flight procedure and computation of flight lines, mosaic, preparation of base map by radial triangulation methods.

Geometric characteristics of aerial photograph. Simple relative orientation, displacement in single photograph and in stereo-pairs and their corrections. Stereoscopic vision, pseudoscopic vision, measuring instrument and their uses, calculation of height of an object by parallax method. Remote sensing. Aero visual survey. Infrared photography, multiple band photography. Imageries.

Unit – V

Types of satellites. Satellite remote sensing and its limitations. Global and Indian space missions.

Advantages, limitations and factors affecting photo interpretation.

Application of aerial photographs in the interpretation of geomorphology, geological structures/ lithologies, soils, mineral exploration, petroleum exploration and ground water exploration.

Application of Remote sensing in the interpretation of geomorphology, geological structures/ lithologies, soils, mineral exploration, petroleum exploration and ground water exploration.

Geographic Information System (GIS): Principles and Applications. Vector and Raster Analysis

Remote sensing and GIS.

Suggested Readings:

1. Todd, D.K. – Ground Water Hydrology (J.Wiley & Sons)
2. Karanth, K.R. – Ground water Assessment
3. Garg, S.P. – Ground water & Wells.
4. Arogyaswami, R.N.P. – Courses in Mining Geology (Oxford & I.B.H.).
5. Mckinstry, H.E. – Mining Geology (Asia Publishing House).
6. Haekes R. & Webb – Geochemistry in Mineral Exploration (Academic Press).
7. Levinson – Introduction to Exploration Geochemistry (Applied Publishers).
8. Robinson and Courch – Basic exploration Geophysics.
9. Sinha, R.K. and Sharma, N.L. – Mineral Economics (oxford & IBH).
10. Chatterjee, K.K. – An introduction to mineral economics (willey eastern).Gaudin- Ore dressing.
11. Miller, V.C. – Photogeology. (McGraw Hill)
12. Pandey, S.N. – Principles of Photo interpretation and Remote Sensing. (McGraw Hill)
13. Allum – Photogeology & Regional Mapping.
14. Jhanwar, M.L and Chouhan, T.S. – Remote sensing and photogrammetry (Vigyan Prakashan).
15. Ray. R.G. - Aerial Photographs in Geologic Interpretations. (USGS)

16. Sabbins, F.F. - Remote sensing- Principles and Applications. (Freeman)
17. Drury, S.A. - Image Interpretation in Geology. (Allen and Unwin)
18. Lilesand, T.M. and Kieffer, R.W., - Remote sensing and Image Interpretation. (John Willey)
19. Gupta, R.P. - Remote sensing Geology. (Springer Verlag)

Paper VIII– Mining Geology & Engineering Geology

Note: – Each Theory paper is divided into 5 units. The question paper is divided into three parts, Part A, Part B and Part C. Part A (20 Marks) is compulsory and contains one question containing 10 parts, two from each unit, each question is of 2 marks (Answer limit 50 Words). Part B (25 Marks) is compulsory and contains five questions with internal choice, one from each unit. Candidate is required to attempt all five questions, each question is of Five marks each (Answer limit 200 words). Part C (30 Marks) contains five questions one from each unit, Candidate is required to attempt three questions; each question is of 10 Marks (Answer limit 500 hundred words).

Unit- I

Exploration and its types. Surface exploration.

Topographic surveying – chain, compass and tape, plane table, theodolite; leveling and contouring. Geologic mapping- reconnaissance and detailed surface mapping- Base map and topo sheet, mapping techniques for lithologies, field data collection. Subsurface mapping.

Guides to ores: Targets, loci, regional guides. Classification of guides; geochemical guides; physiographic guides; mineralogical guides; stratigraphic and lithologic guides; structural guides- fractures, folds, faults.

Persistence of ore in depth. Sampling and tonnage: Sampling and types; average assays.

Unit -II

Geochemical prospecting: geochemical processes- primary and secondary; pathfinder; anomalies; geochemical field techniques and analysis; geobotanical surveys; Subsurface exploration: drilling and types, bore hole problems, bore hole samplings. Preservation and sampling of cores.

Geophysical prospecting- electrical, gravity, magnetic, seismic, radio active method, well logging, aerial geophysical survey.

Unit- III

Methods of Estimation of Reserves: Classification of Reserves (International & National); sampling; Spacing of pits, trenches, bore holes & grooves; Assay; Processing & interpretation of Sampling data; reserve calculation; Estimation of reserve by exploratory mining; Economic consideration in Reserve estimation;. Feasibility study. Explosives.

Mining: Mining terminology. Classification of mining methods: Alluvial mining; open cast mining; under ground mining and coal mining.

Unit- IV

Principles & Methods of Mineral dressing: approach; preparation; methods- gravity separation, magnetic separation, electrostatic separation, flotation; reagents; Collectors; Frothers; Modifiers; Agglomeration; miscellaneous processes- amalgamation, thickening, filtration, dewatering, drying.

Phases of mineral processing, mineral dressing and hand picking, crushing, grinding, sizing, classification, air sizing, blending, concentration, washing, gravity separation – jigging, tabling, vanners and miscellaneous floatations.

Flow sheets for Chromite, Gold, Copper, Lead, Zinc, Manganese, Gypsum, Clay and Coal.

Unit- V

Application of Geology in Civil engineering.

Engineering properties of rocks. Rocks as construction material.

Importance and stages of geological exploration; including Subsurface & Subsurface exploration for important engineering projects.

Dams: Terminology, Classification & types of Dams, Problems related to Dams, geology of damsite, Foundation & abutment competency; Reservoirs: Reservoir site, Reservoir problems, geology of Reservoir site; Geological Investigation of Dam & Reservoir.

Tunnels: Terminology, Classification of Tunnels; Geologic Parameters & Problems Earth Tunneling; Geologic Parameters & Problems Rock Tunneling;

Suggested Readings:

1. Singh & Sahni – Advanced Surveying (IBH)
2. Krynine & Judd – Principles of Engineering Geology and Geotectonics (McGraw Hill)
3. Parbin Singh – Engineering and General Geology
4. SathyaNarayan swami, B.S. – Engineering Geology (Dhanpat Rai & Co.)
5. Blyth – Geology of Engineers (ELBS)
6. Keller, E.A. – Environmental Geology (CBS)
7. Valdiya K.S. – Environmental Geology. Tata MGH
8. Coates, D.R. – Environmental Geology
9. Flames, P.T. – Environmental Geology, Conservation land use planning and Resource Development.
10. Cooke and Drunkamp – Geomorphology in Environment Pollution.
11. Horn, B. & Scott, M. – Geological Hazards (Springer Verlag)
12. Tank, R.W. – Focus on Environmental Geology (Oxford)
13. Savindra Singh – Environmental Geography. Prayag Pustak Bhawan.
14. Pratap Singh – Sustainable Development with Renewable Energy Resources. (Yash Publi; Bikaner)
15. Abbasi & Abbasi - Renewable Energy Resources & their Implication. (Prentice Hall India)

M.Sc. (Final) Practicals

Part-I	- Igneous & Metamorphic Petrology - Mining Geology & Engineering Geology - Mining Training Camp and Submission of Report & Viva voce	8 Hrs.in 2 days	60 Marks
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Igneous and Metamorphic Petrology

20 Marks

1. Description and identification of Igneous and Metamorphic rocks in Hand Specimens and under microscope.
2. Petrographic methods and calculation of CIPW norms and Niggli values and their plotting.

3. Petrochemical calculations and representation (ACF & AKF diagrams)

Mining Geology & Engineering Geology

15 Marks

1. Calculation of assay value & Ore reserve estimation.
2. Study of flow sheet for ore beneficiation.
3. Lab calculation related to mining and exploration.
4. Survey with chain and tape, compass and plane table.
5. Study of Important Indian Dams, Tunnels and other engineering projects

Practical Record

5 Marks

Viva Voce

5 Marks

**Mining Training Camp of Two weeks duration and
Submission of Report there on**

15 Marks

Part-II - Sedimentology and Petroleum Geology & Environmental Geology,
Hydrogeology &, Exploration
- General Geological Tour and Report there on

8 Hrs.

60 Marks

Sedimentology & Petroleum Geology

15 Marks

1. Study of common sedimentary rocks in hand specimens and in thin section.
2. Graphic representation of grain size data, histograms, cumulative curve, frequency curves, rose diagram etc.
3. Palaeocurrent analysis and their representations.

Environmental Geology Hydrogeology & Remote Sensing

15 Marks

1. Diagrammatic representation of Geologic cycles- tectonic, hydrological, rock & geo chemical cycles.
2. Laboratory problems related to environmental geology.
3. Application of geological data for environmental purposes.
4. Graphical representation of geo-environmental data etc
5. Geomorphic surveys, leveling and contouring.
6. Interpretation of aerial photographs with the help of stereoscope.
7. Photogrammetric exercises.
8. Study and interpretation of satellite imageries

Practical Record

5 Marks

Viva Voce

5 Marks

- Submission of Report & Viva voce on Compulsory General Geological Field

5 Marks

Training Programme of Two weeks duration.

**Part III- Field Based Case Study on the topics related to Petrology/ Mining/ Environmental
Geology/ Structural Geology/ Applied Geology/Groundwater etc. Presented in
original manuscript (handwritten)**

30 Marks