



# University of Rajasthan Jaipur

## SYLLABUS

### M.A./M.Sc. GEOLOGY

#### (Semester Scheme)

I & II Semester Examination 2021-22

III & IV Semester Examination 2022-23

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## M.Sc. Geology

### Course structure

#### Semester 1 -

S. No.	Course Code	Core Subjects	Course Category	Credit
1.	GEL 101	Mineralogy, Crystallography & Geochemistry	CCC	4
2.	GEL 102	Invertebrate & Vertebrate Palaeontology, & palaeobotany	CCC	4
3.	GEL 103	Principles of Stratigraphy & Precambrian Stratigraphy	CCC	4
4.	GEL 111	Lab.-I Mineralogy, Crystallography, Geochemistry, Palaeontology, Stratigraphy & Field Training*	CCC	6

\*Field Training is Compulsory, Student not taking part in the field training shall not be allowed to appear in the semester examination

S. No.		Electives Subjects	Course Category	Credit
1.	GEL A01	Sequence Stratigraphy	ECC	4
2.	GEL A02	Palaeoecology	ECC	4
3.	GEL A03	Geomorphology & Remote Sensing	ECC	4
4.	GEL A04	Lab.-I Remote Sensing, Palaeoecology & Geomorphology	ECC	6

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Semester 2

S. No	Course Code	Core Subjects	Course Category	Credit
1.	GEL 201	Crustal Evolution & Phanerozoic Stratigraphy	CCC	4
2.	GEL 202	Structural Geology & Tectonics	CCC	4
3.	GEL 203	Applied Palaeontology & Micropalaeontology	CCC	4
4.	GEL 211	Lab.-I Stratigraphy, Structural Geology, Palaeontology & Field Training*	CCC	6

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S. No.	Course Code	Electives Subjects	Course Category	Credit
1.	GEL B01	Isotope Geology	ECC	4
2.	GEL B02	Oceanography and Palaeoclimate	ECC	4
3.	GEL B03	Gemology & Dimension stones	ECC	4
4.	GEL B04	Lab.-I Gemology, Isotope geology & Palaeoclimate	ECC	6

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Semester 3 -

S. No.	Course Code	Core Subjects	Course Category	Credit
1.	GEL 301	Mineral exploration & Mining Geology	CCC	4
2.	GEL 302	Igneous Petrology	CCC	4
3.	GEL 303	Sedimentary Petrology	CCC	4
4.	GEL 311	Lab.-I. Igneous and Sedimentary Petrology & Field Training*	CCC	6

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S. No.	Course Code	Electives Subjects	Course Category	Credit
1.	GEL C01	Desert Geology	ECC	4
2.	GEL C02	Coal and Petroleum Geology	ECC	4
3.	GEL C03	Geotechnical Engineering	ECC	4
4.	GEL C04	Lab.-I Coal and Petroleum Geology & Desert Geology	ECC	6

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Semester 4 -

S. No.	Course Code	Core Subjects	Course Category	Credit
1.	GEL 401	Metamorphic Petrology	CCC	4
2.	GEL 402	Resource Geology	CCC	4
3.	GEL 403	Environmental Geology & Hydrogeology	CCC	4
4.	GEL 411	Lab.-I Metamorphic Petrology, Resource Geology, Environmental Geology & Field Training*	CCC	6

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S. No.	Course Code	Electives Subjects	Course Category	Credit
1.	GEL D01	Disaster Management	ECC	4
2.	GEL D02	Geoinformatics	ECC	4
3.	GEL D03	Ground water exploration & Management	ECC	4
4.	GEL D04	Lab.-I Groundwater exploration, Geoinformatics and Disaster Management	ECC	6

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Unit- I

Working principle of petrological microscope, Optical properties of minerals, Optical accessories and their use, Uniaxial and biaxial minerals, Interference figures

Unit- II

Chemical composition, crystal structure, P-T stability, physical and optical properties and mode of occurrence of pyroxene, amphibole, mica and feldspar group of minerals

Unit- III

Symmetry in crystals; 32 point groups (Symmetry classes). Stereographic projection, Introduction to X-Ray and its application in study of minerals, Bragg's Law, Rotation Method and Powder Method.

UNIT - IV

Concept and application of binary and ternary variation diagrams – Major, Trace and Rare Earth Elements and their application in provenance studies, tectonic environment and petrogenesis. Isotope geochemistry: Radiogenic and stable isotope.

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Unit-I

Geological history and application of Lamellibranchs (with functional morphology), Gastropods, Nautiloids, Ammonoides, Belemnites, Brachiopods (with functional morphology), corals and Sponges in stratigraphy and stratigraphic correlation/reconstruction of palaeoenvironment.

Unit-II

Application of the following groups of fossils in stratigraphy and stratigraphic correlation/reconstruction of palaeoenvironment: Trilobites, Monoplacophora, Graptolites, Hyoliths, Bryozoans, Echinoids (with functional morphology), Crinoides.

Unit -III

Palaeobotany: classification of Kingdom Plantae, Gondwana Flora: systematic study of important Gondwana Plants, Application bearing on palaeoclimate. Application of the following groups of fossils in stratigraphy/stratigraphic correlation/reconstruction of palaeoenvironment: Algae (Calcareous/Siliceous): Coccolithophore, Stromatolites, Dinoflagellates, Halimeda, Diatoms, Pollen grains and spores

Unit -IV

Outline of classification of vertebrates, significance of vertebrate palaeontology, sequence of vertebrates through geological ages. Evolutionary history of man, elephant and horse. Classification, significance and extinction of Dinosaurs.

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Unit-I

Code of stratigraphic nomenclature. Geochronology. Stratigraphic classification: lithostratigraphy, biostratigraphy and chronostratigraphy and their units. Sequence stratigraphy: concept and application. Magnetostratigraphy. Climastratigraphy. Seismic Stratigraphy. Event Stratigraphy. Graphic representation of stratigraphic data.

Unit II

Distribution, stratigraphic correlation, succession, geochronology and economic importance of Archean and Paleoproterozoic rocks of India; Dharwar Province, Eastern Ghat Province, Central Indian Province and Singhbhum-Orissa Province

Unit-III

Meso- and Neoproterozoic rocks in India; Cuddapah-Kurnool, Kaladgi, Bhima, Pakhal and Vindhyan basins: Distribution, stratigraphic correlation, succession and economic importance

Unit-IV

Precambrian geology of Rajasthan; Banded Gneissic Complex (Bhilwara Supergroup), Aravalli Supergroup, Delhi Supergroup, Marwar Supergroup, Vindhyan Supergroup and Malani Igneous Suite

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M. Sc. GEOLOGY FIRST SEMESTER

Practical

Gèl 111

Duration: 4 hours

Max. Marks 100

Mineralogy & Crystallography

30 Marks

1. Determination of axial ratio.
2. Identification of minerals in hand specimen.
3. Microscopic properties of minerals, identification of interference figures and optical sign, determination and measurement of 2V.
4. Graphical presentation and interpretation of geochemical data.

Palaeontology

20 Marks

Labeled sketches, classification, morphological description, and age/horizon and locality macro- and micro-fossil specimens. Study of index fossils in their chronological order.

Precambrian Stratigraphy:

10 Marks

1. Identification, description and geochronology of Indian Precambrian stratigraphic rocks.
2. Precambrian Stratigraphic maps of India.
3. Precambrian Palaeogeographic maps of India.
4. Graphical representation of stratigraphic sections (Lithology)

10 Marks

15 marks

15 Marks

Field Training Program : Geological Mapping Training – 10 days duration.

Field Training is Compulsory. Students not taking part in the field training shall not appear in the examination

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Unit- I

Basic principles of Geomorphology, Weathering and erosion pathogenesis; mass movement, erosion, transportation and deposition. Types of landforms: fluvial, glacial, Aeolian, coastal and karst. Tectonics and Landforms. Tectonic subdivision of India.

Unit- II

Geomorphic mapping- tools and Techniques, slope studies, drainage and basin analysis. Application of geomorphology in mineral prospecting, civil & defense engineering and environmental studies.

Unit - III

Fundamentals of remote sensing; Physical Basis of Remote Sensing, remote sensing systems; space platforms and orbit patterns; remote sensing sensors; thermal, radar and hyperspectral images; signatures of rocks, minerals and soils. Elements of Remote Sensing Interpretation.

Unit - IV

Fundamental principles and technology of aerial photography and its applications in geosciences. Photogrammetry, types & geometry of aerial photographs; factors affecting aerial photography; scale of aerial photography and factors affecting scale; relief displacement; vertical exaggeration; Stereoscopy; Elements of Photo Interpretation.

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M. Sc. GEOLOGY FIRST SEMESTER

Practical

Gel AO4

Duration: 4 hours

Max. Marks 100

**Sequence Stratigraphy**

Identification of sedimentary rocks (Rudstone, Shell-beds, sandstone, siltstone, Shale) and their probable assignment to different system tracks; TST, MFZ, HST. Determine sequence boundaries and Third order cycles in the given litho-log. Draw fence diagram based on different litho-logs of a sedimentary basin.

**Palaeoecology**

25 marks

Palaeoecological analysis: Quantitative and Taphonomic analysis : species diversity, trophic composition, cluster analysis. Interpretation of data

**Geomorphology**

25 Marks

Identification and description of various landforms, Morphometric analysis of drainage basins, Studies of drainage patterns and Exercises on Slope analysis.

**Remote Sensing:**

25 Marks

Scale and height of aerial photographs. Interpretation of aerial photographs. Visual interpretation of satellite imageries. Image analysis exercises. Applications using GIS software.

**Viva-Voce  
Record**

10 Marks

15 Marks

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Semester 2

S. No.	Subject Code	Course title	Course category	Credit	Contact hours per week	EoSE duration (Hrs.)
					L-T-P	Thy-P
1.	GEL 201	Crustal Evolution & Phanerozoic Stratigraphy	CCC	4	4-0-0	3-0
2.	GEL 202	Structural Geology & Tectonics	CCC	4	4-0-0	3-0
3.	GEL 203	Applied Palaeontology & Micropalaeontology	CCC	4	4-0-0	3-0
4.	GEL 211	Lab.-I Stratigraphy, Structural Geology, Palaeontology & Field Training*	CCC	6	0-0-8	3-0
Total credits in the semester				18		

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Semester 2 Electives

S. No.	Subject Code	Course title	Course category	Credit	Contact hours per week	EoSE duration (Hrs.)
					L-T-P	Thy-P
1.	GEL B01	Isotope Geology	ECC	4	4-0-0	3-0
2.	GEL B02	Oceanography and Palaeoclimatology	ECC	4	4-0-0	3-0
3.	GEL B03	Gemology & Dimension stones	ECC	4	4-0-0	3-0
4.	GEL B04	Lab.-I Gemology, Isotope geology, Palaeoclimatology & Field Training	ECC	6	0-0-8	3-0
Total credits in the semester				18		

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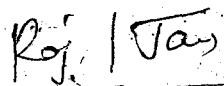
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Semester 2

S. No.	Course Code	Core Subjects	Course Category	Credit
1.	GEL 201	Crustal Evolution & Phanerozoic Stratigraphy	CCC	4
2.	GEL 202	Structural Geology & Tectonics	CCC	4
3.	GEL 203	Applied Palaeontology & Micropalaeontology	CCC	4
4.	GEL 211	Lab.-I Stratigraphy, Structural Geology, Palaeontology & Field Training*	CCC	6

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S. No.	Course Code	Electives Subjects	Course Category	Credit
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2.	GEL B02	Oceanography and Palaeoclimatology	ECC	4
3.	GEL B03	Gemology & Dimension stones	ECC	4
4.	GEL B04	Lab.-I Gemology, Isotope geology & Palaeoclimatology	ECC	6

  
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Unit- I

Early history of the earth, nature of primitive crust and evolution of early crust. Evolution of Granite- Greenstone and Granulite belts. Precambrian Chronostratigraphy and their units. Outline of tectonic subdivision and Precambrian provinces of India

Unit -II

Palaeozoic & Mesozoic stratigraphy of India: nomenclature, classification, distribution, structures, succession, sedimentary history, fauna, flora, age, Igneous intrusion, palaeogeography, palaeoclimate and regional correlation.

Unit -III

Gondwana Supergroup of India: nomenclature, classification, distribution, structures, succession, sedimentary history, fauna, flora, age. Deccan traps; age, duration of volcanism, infra & inter-trappeans sedimentary formations and their fossils. Precambrian- Cambrian, Permian- Triassic and Cretaceous - Tertiary (KT) boundaries.

Unit - IV

Cenozoic Stratigraphy of India: nomenclature, classification, distribution and regional correlation. Siwalik System: distribution, fossils and age.

Phanerozoic stratigraphy of Rajasthan: divisions and rock types.

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Unit- I

Earth as a dynamic system. Internal constitution of the Earth; heterogeneity of the Earth; seismic, gravity and magnetic characteristics. Continental drift, sea-floor spreading. Plate tectonics, Paleomagnetism and its application.

Unit- II

Seismicity and seismic belts of the Earth. Continental shield areas and mountain chains. Features associated with oceanic crust, mid-oceanic ridges, gravity and magnetic anomalies at mid oceanic ridges, Deep sea trenches, Island arcs and Volcanic arcs.

Unit- III

~~Stress, Strain, Stress-strain relationship of elastic, plastic and viscous materials.~~ Mechanical behavior of rocks. Measurement of strain in deformed rocks. Time ~~relationship between crystallization and deformations.~~ Lineation: Types, origin and deformation. Basic principles of structural analyses. Principles of geological mapping, projection diagrams.

Unit-IV

**Folds:** Mechanism of folding, classification. Superimposed folds: occurrence, recognition and geometric analyses. **Cleavage:** origin, mechanics and relationship with folding. **Faults:** Geometry, classification, mechanism of faulting. **Shear zones:** sense indicators, shear zone kinematics. **Joints:** Relation of joints and fractures to strain field.

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Unit - I

Origin of life. Theories, mechanism and evidences of evolution. Major events in the history of Paleozoic, Mesozoic and Cenozoic life. Evidences of life during Precambrian. Taxonomy: classification and species nomenclature. Migration, dispersion and extinction of animals and plants.

Unit - II

Palaeoecology: a) fundamentals, b) palaeoenvironment: physical parameters and various approaches of reconstruction, c) taphonomy, taphocoenosis, thanatocoenosis, time-averaging/condensation, shell-beds and biostratigraphy d) palaeoecological interpretation and its application.

Unit - III

Paleobiogeographic provinces. Collection, preparation and preservation of fossils. Application of the following groups of fossils in stratigraphy and stratigraphic correlation/ reconstruction of palaeoenvironment: Foraminifers, Radiolarian, Serpulids, Conodonts and Ostracodes

Unit - IV

Ichnology: definition, classification, description of common Ichnogenera, their application in the reconstruction of depositional environment, sequence-stratigraphy, stratigraphic correlation.

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M. Sc. GEOLOGY SECOND SEMESTER

Practical

Gel 211

Duration: 4 hours

Max. Marks 100

**Structural Geology:-**

**25 Marks**

1. Solving structural problems by stereographic and orthographic projections.
2. Identification of structural elements and their chronology in hand specimen.
3. Structural analysis with stereo net: S-pole and beta-pole diagrams; Fold axis and axial plane; Contour diagrams; Methodology and interpretation of patterns.
4. Interpretation of geological maps and drawing of cross sections.

**Palaeontology:**

**25 Marks**

Labeled sketches, classification, morphological description, and age/horizon and locality of available macro- and micro-fossil specimens. Study of index fossils in their chronological order.

**Phanerozoic Stratigraphy:**

**10 Marks**

Identification, description and geochronology of Indian phanerozoic stratigraphic rocks. Phanerozoic Stratigraphic maps of India. Phanerozoic Palaeogeographic maps of India. Graphical representation of stratigraphic sections (Litholog)

**Field Training**

**15 Marks**

**Work-Book**

**10 Marks**

**Record**

**15 Marks**

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Unit-I

Elements: atomic structure, formation, abundances, distribution in Earth and Solar System

Unit II

Radiogenic Isotopes: Radioactivity, Range of Isotopic Systems (Rb/Sr, Sm/Nd, U-Pb,  $^{40}\text{Ar}/^{39}\text{Ar}$ ), Applications to Geology (to trace source and reconstruct evolution),  $^{14}\text{C}$  dating.

Stable Isotopes: Fractionation, Range of Isotopic Systems (O, H, C), Application

Unit- III

Trace Elements: Definition, Types, Partition Coefficient and application of trace elements in petrogenesis and tectonic setting

Unit -IV

Applications: Sedimentary Rocks (Weathering, Diagenesis), Igneous Rocks (Partial Melting, Fractional Crystallization), Metamorphic Rocks (Metamorphic Reactions, P-T-t path)

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Unit-I

Introduction and overview of Oceanography. Introduction to climate, Global climate pattern, Climate controlling factors. Global Energy Balance and Faint Young Sun. CO<sub>2</sub>-Weathering Climate regulation. Greenhouse Earth: Cretaceous Climate/ Late Paleocene –Eocene Thermal Maximum (PETM).

Unit-II

Milankovitch and Monsoons. Milankovitch and Glaciation. Ice Core Records of Atmospheric Composition. Cenozoic Cooling and Glaciations

Unit-III

Last Glacial Maximum: Ice Sheets, Sea Level, Dating, Ocean Circulation. Reconstruction of paleoclimate based on rocks and fossils

Unit-IV

Rapid Climate Change – Records from Ice Cores and Land, Oceanic Records and Mechanisms. Holocene Climate. Climate change during the last millennium. A paleoclimate perspective on global warming

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Unit-I

Gemology-Definition and scope of Gemstones, Attributes of Gemstones, Characteristics and classification. Value of gemstones, Grading, Cutting and polishing.

Unit-II

Treatments applied to gemstones- Heat, Radiation, Waxing/oiling, Fracture filling. Synthetic gemstones. Physical, Chemical and Optical Properties of Gemstones. Healing properties of gemstones. Gem cutting instruments, Industrial applications of gemstones, Gem industrial centres in India and world, Gemstones of India – Distribution, geological setting and genesis.

Unit- III

Dimensional and decorative stones: Definition, Engineering properties of dimensional and decorative stones. Rock hardness/Polishing hardness, water absorption, texture, structure and color.

Unit- IV

Dimension Stone Mining; methods, blasting, diamond wire cutting, wedging and splitting, thermal cutting, polishing. Export potential of Dimension Stone.

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M. Sc. GEOLOGY SECOND SEMESTER

Practical

GEL BO4

Duration: 4 hours

Max. Marks: 100

Trace element & Isotope Data Interpretation

20 marks

Trace element based tectonic discrimination plots. Rb-Sr, Sm-Nd, Isochron diagrams, U-Pb Concordia plots. Age determination. Use of C, O and H isotopes in palaeoclimate reconstruction

Gemology and Dimension Stones

20 marks

Identification of Gem minerals: physical and optical property. Determination of Refractive Index, and distinction between natural and synthetic gemstone. Distribution and occurrence of Gemstone and Dimension Stone in India with special reference to Rajasthan. Gem cutting and polishing techniques.

Palaeoclimate

20 marks

Identification of fossils (flora and fauna), rocks and fossils for palaeoclimatic Interpretation

Field Training

15 Marks

Project in consultation with supervisor to be nominated among the faculty members on mutually agreed field work based topic. The candidate has to submit project report in form of a dissertation for evaluation and award of marks.

Project

10 Marks

15 Marks

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Semester 3 and IV

S. No.	Course Code	Core Subjects	Course Category	Credit
1.	GEL 301	Mineral exploration & Mining Geology	CCC	4
2.	GEL 302	Igneous Petrology	CCC	4
3.	GEL 303	Sedimentology & Sedimentary Petrology	CCC	4
4.	GEL 311	Lab.-I. Igneous and Sedimentary Petrology & Field Training*	CCC	6

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S. No.	Course Code	Electives Subjects	Course Category	Credit
1.	GEL C01	Desert Geology	ECC	4
2.	GEL C02	Coal and Petroleum Geology	ECC	4
3.	<del>GEL C03</del>	<del>Geotechnical Engineering</del>	<del>ECC</del>	<del>4</del>
4.	GEL C04	Lab.-I Coal and Petroleum Geology & Desert Geology	ECC	6

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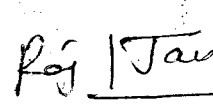
## Course structure

### Semester 3

S. No.	Subject Code	Course title	Course category	Credit	Contact hours per week	EoSE duration (Hrs.)
					L-T-P	Thy-P
1.	Gel301	Mineral exploration & Mining Geology	CCC	4	4-0-0	3-0
2.	Gel302	Igneous Petrology	CCC	4	4-0-0	3-0
3.	Gel303	Sedimentology & Sedimentary Petrology	CCC	4	4-0-0	3-0
4.	Gel311	Lab.-I. Igneous and Sedimentary Petrology & Field Training*	CCC	6	0-0-8	0-4
Total credits in the semester				18		

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Semester 3 Electives

S. No.	Subject Code	Course title	Course category	Credit	Contact hours per week	EoSE duration (Hrs.)
					L-T-P	Thy-P
1.	GEL C01	Desert Geology	ECC	4	4-0-0	3-0
2.	GEL C02	Coal and Petroleum Geology	ECC	4	4-0-0	3-0
3.	GEL C03	Geotechnical Engineering	ECC	4	4-0-0	3-0
4.	GEL C04	Lab.-I Coal and Petroleum Geology & Desert Geology	ECC	6	0-0-8	0-4
Total credits in the semester				18		

Total Credit in Semester I- 18 credit (CCC) +18 Credit (ECC)= 36 Credits

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Unit-I

Guides for locating mineral & ore deposits: structural, lithological, stratigraphic and physiographic guides. Surface prospecting methods: pitting and trenching sampling: various methods of sampling.

UNIT - II

Outline of geophysical prospecting; gravity, seismic, electrical and magnetic prospecting for mineral deposits & also oil and ground water. Brief outline of geochemical prospecting.

UNIT - III

Drilling, different types of drilling, use of diamond drilling in exploration; core-logging and assaying; sampling: various methods of sampling; explosives: types, storage and precautions in handling of explosives, blasting: various patterns of blast holes and methods of their charging and blasting.

UNIT - IV

Elements of mining: mining methods; various types of surface and underground mining methods; factors involved in selection of open cast and underground mining methods; salient features of bench-mining, sub-level stopping; shrinkage stopping, Cut & fill method, coal mining methods: room and pillar method, long wall method.

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Unit - I

Magma: Origin, composition and constitution. Magma emplacement and its relation to plate tectonics, Reaction Principle, magmatic crystallization, differentiation and assimilation. Igneous Rocks: intrusive and extrusive forms. Texture and Structures of Igneous rocks and their petrogenetic significance

Unit - II

Mineralogical and chemical classification of igneous rocks including IUGS systematics. Concept of tectonic classification of granite and basalt. Phase rule, crystallization process in silicate melts in light of experimental studies for following systems: Diopside - Anorthite, Albite - Anorthite; Albite - Orthoclase, Forsterite - Silica; Crystallization of Ternary system: Diopside-Forsterite-Silica.

Unit - III

Major, trace, REE and Isotopic compositions of igneous rocks and their implication in petrogenesis and tectonic setting. Mode of occurrence, nomenclature, classification and petrogenesis of the following rocks: Alkaline rocks, Ophiolites, Lamprophyres, Ultramafics and Carbonatites.

Unit - IV

Mode of occurrence, nomenclature, classification and petrogenesis of acid, basic and intermediate rock associations and pegmatites.

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Unit - I

Weathering & erosion: modes of sediment transport, fluid flow, transport types, movement of particles, settling velocity of sediments. Sedimentary environment - marine, marginal marine, non-marine; fluvial, lacustrine, palustrine. Walter's Law; vertical and lateral relationship.

Unit - II

Genesis & classification of sedimentary rocks: Siliciclastic rocks - conglomerate, breccia, sandstone, siltstone, claystone and shale. Carbonate rocks - limestone, dolomite, marl, evaporite, phosphorite, chert, iron and manganese rich sediments.

Unit - III

Structures and textures in sedimentary rocks and their significance. Application of ~~trace elements, rare earth elements and stable isotope geochemistry to~~ sedimentological investigation.

Unit - IV

Tectonics and sedimentation: classification of sedimentary basins, basin analysis; ~~stacking~~ pattern, sediment composition, paleocurrent analysis. Sedimentary basins of India.

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M. Sc. GEOLOGY THIRD SEMESTER

Practical

GEL 311

Duration: 4 hours

Max. Marks 100

**Igneous Petrology**

**30 Marks:**

Identification and description of Important igneous rocks in hand specimen. Petrographic studies of important igneous rocks. Preparation and interpretation of variation diagrams in relation to petrogenesis. Calculation of CIPW norms.

**Sedimentary Petrology:**

**30 Marks**

Identification and description of Important sedimentary rocks in hand specimen. Petrographic studies of important sedimentary rocks. Graphic representation of data and its interpretation.

**Field work**

**15 Marks**

**Viva-Voce**

**10 Marks.**

**Record**

**15 Marks**

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Unit-I

Deserts and Dryland Environments, characteristics and distribution around the world and causes of aridity. Hot and Cold Deserts. Desert Geology and Geomorphology: sand dunes, types and evolution, lakes and playás, inland drainage basins, ephemeral fluvial systems and nature of deposits. Mineralogy and Geochemistry of desert deposits. Rain Shadow zones.

Unit-II

Thar Desert in India: Regional geology and Quaternary geology. Strata-logs and correlations. Morpho-stratigraphy and Geomorphic processes and landscapes. Application of Remote Sensing and Photo geology in study of deserts. Geological evolution and aeolian landforms. Evolution of Thar deserts.

Unit-III

Soils, calcretes and gypcretes. Fauna and flora of dryland environments, conservation of natural resources. Mineral wealth and its utilization/ extraction (mining), water resources and health hazards. Indira Gandhi Nahar Pariyojna. Climate change and Palaeoclimatic studies. Impact of global warming. Geoaerchaeology, Radio Carbon and OSL Dating Techniques for desert deposits.

Unit-IV

Engineering Geology and Geohazards. Traditional knowledge in dryland management and combating desertification. Ground water resources. Wind and Sun as energy resource in the deserts.

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Unit-I

Coal and its properties: Different varieties and ranks of coal. Origin of coal. Coalification process and its causes. Lithotypes, microlithotypes and macerals: their physical, chemical and optical properties. Maceral analysis of coal: Mineral and organic matter in coal. Petrographical methods and tools of examination. Application of coal geology in hydrocarbon exploration.

Unit-II

Geology and coal petrography of different coalfields of India. Uses of coal for various industries e.g. carbonization, liquefaction, power generation, gasification and coal-bed methane production.

Unit-III

**Petroleum:** its different states of natural occurrence, chemical composition and physical properties of crudes in nature. Origin of petroleum, Maturation of kerogen; Biogenic and Thermal effect. Reservoir rocks: general attributes and petrophysical properties. Classification of reservoir rocks - fragmental reservoir rocks and chemical reservoir rocks. Migration of oil and gas

Unit-IV

**Hydrocarbon traps:** definition; anticlinal theory and trap theory, classification of hydrocarbon traps - structural, stratigraphic and combination; time of trap formation and time of hydrocarbon accumulation. Cap rocks - definition and physical properties. Classification of Indian basins. Plate tectonics and global distribution of hydrocarbon reserves. Hydrocarbon basins of Rajasthan.

**Unit-I**

Geo-technical engineering as a field science related to construction. Scope of geotechnical engineering. Ground investigations – Introduction, Types of ground investigation, Geological mapping for ground investigation.

Field investigations - Introduction, Excavations and boreholes - Shallow trial pits, Deep trial pits and shafts, Headings (adits), Hand auger boring, Light cable percussion drilling, Mechanical augers, Wash boring and other methods, Backfilling excavations and boreholes.

**Unit- II**

Sampling. Frequency of sampling. Sampling the ground - General principles, Sample quality. Disturbed samples from boring tools or from excavating equipments, Types of samplers - Open-tube samplers and samplers, Stationary piston sampler, Continuous soil sampling, Sand samplers, Rotary core samplers, Window sampler, Block samples. Handling and labelling of samples.

Field and lab tests Field tests. Geophysical surveying (Electrical resistivity, Gravity, Magnetic, Seismic methods. Laboratory tests on samples - Tests on soil - Classification tests - Moisture content/ water content determination, Liquid and plastic limits (Atterberg Limits), Particle size distribution (grading) by sieving. Soil strength tests

**Unit- III**

Rock Mechanics - Saturation moisture content (alteration index), Bulk density, Moisture content, Petrographic analysis, Hardness and abrasiveness, Carbonate test, Swelling test. Rock strength tests - Point load test, Uniaxial Compression, Direct tension test, Indirect tensile strength test (Brazil test).

**Unit -IV**

Logging - Description of soils and rocks. Description of soils - Mass characteristics of soils. Material characteristics of soils – Colour, Particle shape, grading and composition. Description and classification of rocks - General description - Strength of rock material, Structure, Colour, Texture, Grain size, State of weathering, Rock name. Total core recovery (TCR), solid core recovery (SCR), Rock Quality Designation (RQD).

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Practical

GEL CO4

Duration: 4 hours

Max. Marks 100

Coal and Petroleum Geology

40 Marks

Megascopic identification of different varieties of coal. Interpretation of geologic structures from surface geological maps and bore hole data; reconstruction of structural developments through different time planes. Panel and Fence diagram. Interpretation of sub-surface facies relationships from borehole data.

Preparation of structure contour and isopach maps of reservoir facies and drawing oil/water contact from bore hole data. Problems on porosity and permeability Problems on deviation drilling Calculation of oil reserves in defined structure.

Desert Geology

20 Marks

Identification and description of desert related geomorphological features

Project work

15 Marks

Project in consultation with supervisor to be nominated among the faculty members on mutually agreed topic. The candidate has to submit project report in form of a dissertation for evaluation and award of marks.

Viva-Voce

10 Marks

15 Marks

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## Course structure

### Semester 4

S. No.	Subject Code	Course title	Course category	Credit	Contact hours per week	EoSE duration (Hrs.)
					L-T-P	Thy-P
1.	Gel401	Metamorphic Petrology	CCC	4	4-0-0	3-0
2.	Gel402	Resource Geology	CCC	4	4-0-0	3-0
3.	Gel403	Environmental Geology & Hydrogeology	CCC	4	4-0-0	3-0
4.	Gel411	Lab.-I Metamorphic Petrology, Resource	CCC	6	0-0-8	0-4
		Geology, Environmental Geology & Field Training*				
Total credits in the semester				18		

\*Field Training is Compulsory, Student not taking part in the field training shall not be allowed to appear in the semester examination

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Semester 4 Electives

S. No.	Subject Code	Course title	Course category	Credit	Contact hours per week	EoSE duration (Hrs.)
					L-T-P	Thy-P
1.	GEL D01	Disaster Management	ECC	4	4-0-0	3-0
2.	GEL D02	Geoinformatics	ECC	4	4-0-0	3-0
3.	GEL D03	Ground water exploration & Management	ECC	4	4-0-0	3-0
4.	GEL D04	Lab.-I Groundwater exploration, Geoinformatics and Disaster Management	ECC	6	0-0-8	0-4
Total credits in the semester				18		

Total Credit in Semester I- 18 credit (CCC) +18 Credit (ECC)= 36 Credits

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Semester 4

S. No.	Course Code	Core Subjects	Course Category	Credit
1.	GEL 401	Metamorphic Petrology	CCC	4
2.	GEL 402	Resource Geology	CCC	4
3.	GEL 403	Environmental Geology & Hydrogeology.	CCC	4
4.	GEL 411	Lab.-I Metamorphic Petrology, Resource Geology, Environmental Geology & Field Training*	CCC	6

\* Field Training is Compulsory, Student not taking part in the field training shall not be allowed to appear in the semester examination

S. No.	Course Code	Electives Subjects	Course Category	Credit
1.	GEL D01	Disaster Management	ECC	4
2.	GEL D02	Geoinformatics	ECC	4
3.	GEL D03	Ground water exploration & Management	ECC	4
4.	GEL D04	Lab.-I Groundwater exploration, Geoinformatics and Disaster Management	ECC	6

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## Unit - I

Agents and kinds of metamorphism; metamorphic zones; grades; metamorphic facies; Fabric of metamorphic rocks formed under regional, dynamic and thermal metamorphisms; Classification of regional metamorphism based on P/T ratio. Thermodynamics: principle and application in kinetics of metamorphic reactions

## Unit - II

Mineralogical phase rule. Diagrammatic representation of mineral paragenesis in ACK, AKF and AFM diagrams. Study of metamorphic facies: zeolite facies; pumpellyite-prehnite facies; glaucophane schist facies; green schist facies; amphibolite facies; granulite facies, eclogite facies; albite-epidote hornfels facies; hornblende-hornfels facies; pyroxene-hornfels facies; sanidinite facies.

## Unit - III

~~Principles of metasomatism and metamorphic differentiation, petrogenetic grids,~~ pressure, temperature, time paths; mineralogical and textural changes accompanying progressive regional metamorphism of mafic, ultramafic, pelitic and carbonate rocks.

## Unit - IV

Anatexis and formation of migmatites and origin of granitic magma; petrographic and petrogenetic studies of charnockite, migmatite and amphibolite; metamorphism in relation to magma and orogeny; metamorphism in relation to plate tectonics.

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## Unit-I

Plate tectonics and ore genesis. Ore bearing fluids, movement of ore bearing fluids, deposition of ores, sulphur and chloride complexes, deposition of Fe-O, Cu-S, Cu-Fe- Systems, Structures and textures of ores, wall rock alteration, controls of mineralization, classification of ore deposits, geothermometry and isotope studies

## Unit-II

Deposits related to mafic igneous rocks, oceanic crust and intermediate to felsic intrusions. Deposits related to sub-aerial volcanism and submarine volcanism. Deposits related to chemical sedimentation, clastic sedimentation, weathering, metamorphism and solution remobilization

## Unit-III

Study of the following metallic deposits in India with reference to their geographic and geologic distribution mode of occurrence and origin: iron, manganese, aluminum, chromium, gold, copper, lead, zinc and atomic minerals.

## Unit-IV

Study of the following minerals in India with reference to their geographic and geologic distribution, mode of occurrence origin and uses: fertilizer minerals, refractory minerals, glass and ceramic minerals, abrasives, gemstones, cement, building stones, energy & fuel minerals: Coal and petroleum deposits: their distribution, classification, origin and potentialities; Important coal and petroleum basins of India.

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Unit - I

Environmental Geology: definition and concept; green house effect, depletion of ozone layer, acid rain; global warming and climate change, mitigation and adaptation. Environmental impact of urbanization; air and noise pollution: causes, impact and remedial strategies.

Unit - II

Environmental impact of mining activities; concept of eco-friendly mining; laws governing protection of environment and control of pollution; environmental impact assessment (EIA); Environmental Management Plan (EMP)

Unit - III

Ground water: Genetic types, hydrological cycle. Occurrence and distribution of ground water. Aquifer and its hydrological properties. Water table, water table contour maps; hydrological properties of rocks - specific yield, specific retention, porosity, hydraulic conductivity, transmissivity, storage coefficient.

Unit -IV

Groundwater flow in porous media - Darcy's Law and its application; determination of Permeability. Physical and chemical properties of ground water; quality criteria for different uses; groundwater contamination. Saline water intrusion in coastal areas. Groundwater development; artificial recharge: need and benefits, methods of artificial recharge. Ground water provinces of India with special reference to Rajasthan.

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M. Sc. GEOLOGY FOURTH SEMESTER

Practical

GEL 411

Duration: 4 hours

Max. Marks 100

**Metamorphic Petrology:**

20 Marks

Identification and description of important metamorphic rocks in hand specimen. Petrographic studies of important metamorphic rocks. Graphic construction of ACF, AKF and AFM diagrams.

**Resource Geology :**

20 Marks

Identification and description of important fuel minerals in hand specimen. Distribution of fuel deposits (oil, coal & radioactive minerals) in India.

**Environmental Geology & hydrogeology**

20 Marks

Analysis of different parameters of air, water and noise. Interpretation of air, water and noise data. Preparation of iso-concentration maps of water quality parameters.

Calculation and exercises on groundwater quality, exploration, yield, recharge, water table fluctuation etc.

**Field work**

15 Marks

**Viva-Voce**

10 Marks

**Record**

15 Marks

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Unit-I

Objectives and scope-Natural and non natural disasters. Land slides; causes of landslides-hazards pertaining to land slides and management planning for landslide disaster. Soil erosion-process of formation of soil, soil horizon, soil properties, soil classification, causes of soil erosion, effects of soil erosion, strategies to prevent soil erosion. Floods; causes, effects and disaster management techniques.

Unit- II

Earthquakes; causative factors, seismic waves, distribution of seismicity in India, hazards related to earthquake, earthquake disaster management planning. Volcanoes; causes, effects and hazard management methods. Tsunamis- origin, significance and prediction

Unit- III

Environmental problems associated with human activities; Impact of sand mining on environment. Impact of mining on environment. Problems inflicted by granite mining. Coastal erosion- effects and remedial measures.

Unit- IV

Pollution; surface water and subsurface-ground water pollution-strategies for reducing pollution. Impact of radioactive waste disposal on environment. Effects of urbanization, and Impact of population explosion. Landfill waste management.

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## Unit I

Modern Personal Computer – Specifications – RAM, CPU and clock speed, Hard disk capacities, network card and data transfer rates, mother boards, Newer multimedia devices – Pen drives, ipods, mobile phones, RFID devices, playstations, external hard disk, zip drives, DVD drives. Laptop-Palm top.

## Unit II

Different operating systems – Windows: NT, XP and Vista – Linux: Ubuntu, Fedora etc. Office packages, Internet browsers. Wikipedia, Scribd, podcasts, bit torrents etc as learning tools. Plagiarism – what constitutes it. Introduction to GPS. Basic idea of GPS. GPS satellites. Control centres. Types of GPS receivers. Uses of GPS. Worldwide digital network GPS.

## Unit III

Types and nature of spatial data in geology and hydrogeology. Introduction to GIS. History of the development of GIS. GIS related softwares, Map info- Vertical maps. The structure of GIS. Data representation in GIS – points, lines, polygons. Popular GIS Initiatives: Google maps, Google earth.

## Unit IV

Data entry into GIS. GIS vector data. GIS raster data. GIS layers. Data , extraction from GIS by simple querying. Basic map generation. Introduction to GIS packages: Free GIS – GRASS and gvSIG. Commercial GIS – ArcGIS. Case studies in ground water table, geological mapping, contour map either water level contour map or elevation contour map. Applications of GIS in water quality, land use and soil pollution etc. Creation of buffer.

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Unit-I

Origin- meteoritic, juvenile and connate waters. Hydrological cycle, occurrence; ground water occurrences in igneous, sedimentary and metamorphic rocks- vertical distribution of ground water, movement; classification and types of aquifers, definition of porosity, permeability, specific yield, specific retention, storage and transmissibility.

Unit-II

Groundwater detection; surface methods-geomorphological, structural and biological evidences. Surface geophysical methods; principles, field procedures, electrode arrangements, instruments and interpretations involved in electrical resistivity method of ground water exploration. Brief account of role of remote sensing in ground water targeting.

Unit-III

Well design and well development; brief introduction about dug wells, tube wells, jetted wells, infiltration galleries and collector wells, well screening and artificial packing. Well development through surging and acidizing. Methodology and need for pump test.

Unit-IV

Water quality; Quality of water in various rock types, water quality parameters and their standards proposed by WHO and BIS. Physical parameters of water quality. Chemical parameters and determining methods. Diseases and virological aspects of ground water and remedial measures. Ground water management; zoning of water shed and river basins. Ground water provinces of India. Artificial recharge and ground water harvesting techniques.

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M. Sc. GEOLOGY FOURTH SEMESTER

Practical

GEL DO4

Duration: 4 hours

Max. Marks 100

**Ground water exploration & Management**

**30 Marks**

1. Preparation and Interpretation of water table contour maps and depth to water level contour maps.
2. Study, preparation and analysis of hydrographs for differing groundwater conditions.
3. Water potential zones of India (map study) including saline water zones.
4. Graphical representation of chemical quality data and water classification (C-S and Trilinear diagrams).

**Disaster Management**

**30 Marks**

Seismic maps of World, India and Rajasthan. Exercises on slope failure and landslides.

**Field work**

**15 Marks**

**Viva-Voce**

**10 Marks**

**Record**

**15 Marks**

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