

SYLLABUS

M.Sc. Geology

Syllabus Semester and Credit based
Effectuated from Session 2026 - 2027

Scheme of Evaluation

Distribution of Marks Component:

- Internal Evaluation – 30 marks
- End-Semester Examination – 70 marks

- ❖ **Internal Evaluation – 30 Marks**

➤ **For Affiliated Colleges**

The internal assessment shall consist of the following components:

First Internal Test	–	10 Marks
Second Internal Test	–	10 Marks
Hand written Assignment	–	05 Marks
(to be written in approximately 500 words)		
Attendance	–	05 Marks
Total	–	30 Marks

➤ **For University Departments**

The concerned Department shall devise its own scheme for Internal Assessment and intimate the same to the University Examination Section.

Both the University Department and the Affiliated Colleges shall submit the consolidated Internal Assessment marks (out of 30 marks) to the Examination Section within the prescribed time.

The detailed records and supporting documents relating to Internal Assessment shall be maintained by the respective Departments/Colleges in accordance with the Standard Operating Procedure issued by the University Examination Section.

❖ **End Semester Examination – 70 Marks**

There shall be a Terminal Examination at the end of each Semester carrying **70 marks**. The question paper shall comprise three sections Section A, Section B and Section C.

Section A

Section shall be of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions shall be compulsory. The examiner shall set the question paper choosing at least 3 questions from each unit.

Section B

Section shall be of **30 marks** and consist of 9 questions 3 question from each unit carrying 5 marks each to be answered in approximately *250 words* each. A Candidate shall attempt any six questions at least 1 question from each unit. The examiner shall set the questions ensuring that at least three questions are drawn from each Unit.

Section C

Section shall be of **20 marks** and consist of three questions carrying 10 marks each to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

Note:

- I. For Non- Collegiate Students, there shall be only One Terminal Examination of 100 containing the Section A, B and C. (Theory Paper will be of 70 Marks, the marks obtained from 70 Marks will be proportionately upgraded to as marks obtained from 100 Marks and will be awarded in Mark sheet.
- II. The examiner shall ensure adequate coverage of the prescribed syllabus while setting the question paper and, maintain a balanced representation of all Units.
- III. The Teacher concerned, shall upload the marks online and submit awards in 3 Copies, One will be retained by the Head / Principal and Two Copies of awards duly signed both by the Head/ Principal and the Teacher concerned shall be sent to the University Examination Section.
- IV. A Copy of the Proforma shall be sent every college/ department by the University Examination Section.
- V. The student has to qualify both the Internal Assessment and External Assessment separately. The minimum qualifying marks in both shall be 40 percent.

MASTER'S PROGRAMME IN GEOLOGY
Credit Score and Scheme

TABLE 1: STRUCTURAL FRAMEWORK OF THE TWO YEARS M.SC. PROGRAM UNDER NEP-2020

SEMESTER	SEM-I	SEM-II	SEM-III	SEM-IV
Core Courses	GEOL DCC-01-Th (4 Cr) GEOL DCC -02 Th (4 Cr) GEOL DCC -03 Th (4 Cr) GEOL DCC -04 Th (4 Cr) GEOL DCC -05 Pract. (4 Cr)	GEOL DCC -06-Th (4 Cr) GEOL DCC -07 Th (4 Cr) GEOL DCC -08 Th (4 Cr) GEOL DCC -09 Pract. (4 Cr)	GEOL DCC -10-Th (4 Cr) GEOL DCC -11 Th (4 Cr) GEOL DCC -(12) Pract. (4 Cr)	GEOL DCC -13-Th (4 Cr) GEOL DCC -(14) Th (4 Cr) GEOL DCC -(15) Pract. (4 Cr)
Discipline Specific Elective (DSE)		GEOL DSE – 01 Th (4 Cr)	GEOL DSE-(02) Th (4 Cr) GEOL DSE-(03) Th (4 Cr)	GEOL DSE-(04) Th (4 Cr) GEOL DSE-(05) Th (4 Cr)
Total No. of Credits	20 + 0 = 20	16 + 4 = 20	12 + 8 = 20	12 + 8 = 20
	60 (DCC) + 20 (DSE) = 80			

- Duration of examination of each course shall be 3 hours (for Theory courses) and 4 hours (for Practical courses).
- Each Core (Except Practical) and Elective course will be of 100 marks.
- It is mandatory to clear Theory and Internal Assessment courses separately. The minimum qualifying marks in both shall be 40 percent. The semester wise details of Master's Course are given below.

2.0 SCHEME OF TWO YEARS POST GRADUATE M.Sc. DEGREE PROGRAM IN GEOLOGY

Programme Code:

Programme Faculty: SCIENCE

Programme Name: TWO YEAR POST-GRADUATE DEGREE PROGRAM IN GEOLOGY

SCHEME AND WEIGHTAGE OF COURSES

S. No.	Course Category	Title of the Course	Credits			Credits earned	Evaluation			Remarks
			L	T	P		IA	ESA	Total	
SEMESTER - I										
1	GEOL DCC – 01	GEODYNAMICS	4	0	0	4	30	70	100	All Courses re compulsory Courses
2	GEOL DCC – 02	STRUCTURAL GEOLOGY	4	0	0	4	30	70	100	
3	GEOL DCC – 03	GEOMORPHOLOGY	4	0	0	4	30	70	100	
4	GEOL DCC – 04	MINERALOGY AND GEOCHEMISTRY	4	0	0	4	30	70	100	
5	GEOL DCC – 05	PRACTICAL	0	0	4	4		100	100	
SEMESTER - II										
6	GEOL DCC – 06	IGNEOUS AND METAMORPHIC PETROLOGY	4	0	0	4	30	70	100	
7	GEOL DCC – 07	SEDIMENTOLOGY	4	0	0	4	30	70	100	
8	GEOL DCC – 08	STRATIGRAPHY OF INDIA	4	0	0	4	30	70	100	
9	GEOL DSE– 01A	PALAEONTOLOGY	4	0	0	4	30	70	100	Student may opt any one
	GEOL DSE – 01B	MICROPALAEONTOLOGY AND PALYNOLOGY	4	0	0	4	30	70	100	
10	GEOL DCC – 09	PRACTICAL	0	0	4	4		100	100	

SEMESTER - III										
11	GEOL DCC – 10	MINERAL EXPLORATION	4	0	0	4	30	70	100	
12	GEOL DCC – 11	ENGINEERING GEOLOGY	4	0	0	4	30	70	100	
13	GEOL DSE – 02A	ORE GEOLOGY	4	0	0	4	30	70	100	Student may opt any one
	GEOL DSE – 02B	APPLIED GEOLOGY					30	70		
14	GEOL DSE – 03A	PHOTOGEOLOGY AND REMOTE SENSING	4	0	0	4	30	70	100	Student may opt any one
	GEOL DSE – 03B	ADVANCED REMOTE SENSING AND GIS					30	70		
15	GEOL DCC – 12	PRACTICAL	0	0	4	4		100	100	
SEMESTER - IV										
16	GEOL DCC – 13	FUEL GEOLOGY	4	0	0	4	30	70	100	
17	GEOL DCC – 14	MINING AND MINERAL DRESSING	4	0	0	4	30	70	100	
18	GEOL DSE – 04A	HYDROGEOLOGY	4	0	0	4	30	70	100	Student may opt any one
	GEOL DSE – 04B	GROUNDWATER EXPLORATION AND MANAGEMENT					30	70		
19	GEOL DSE – 05A	ENVIRONMENTAL GEOLOGY	4	0	0	4	30	70	100	Students may opt any one
	GEOL DSE – 05B	CLIMATOLOGY					30	70		
20	GEOL DCC – 15	PRACTICAL	0	0	4	4		100	100	
		Total							2000	

Note:

Course Categories: DCC–Discipline Core Course; DSE–Discipline Specific Elective;

Contact Hours: Lecture-1 Credit=1Hour/ Week

Practical-1 Credit=2 Hours / Week

SEMESTER – I

1	GEOL DCC – 01	GEODYNAMICS	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are be compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Earth's surface features. Seismology: waves, intensity and isoseismic lines, earthquake belts, earthquake zones of India, seismograph, causes of earthquake. Internal structure of the earth. Crust: Composition, seismic, gravity and magnetic characters. Crustal types: shields. Platforms, mountain chains, rift valleys, mid oceanic ridges, trenches, island arcs and ocean basins.

UNIT-2

Volcanism: types and causes of volcano eruptions. World distribution of volcanoes. Migration of volcanoes. Palaeo-magnetism. Isostasy: Development of the concept, isostatic anomalies, Isostatic models, evidences. Geosynclines: classification and evolution of geosynclines causes of subsidence and upliftment.

UNIT-3

Continental drift: Development of the concept, Taylor's and Wegner's theories of continental drift. Evidences of continental drift and polar wandering. Sea floor spreading. Morphological features of ocean floor. Concept of plate tectonics: types of plate boundaries. Features of convergent and divergent boundaries. Ophiolite suites, Arch-trench system, volcanic mountain chains. Triple junction and their stability, causes of plate motion. Origin of Himalayas.

References:

- Holms, Doris and Arthur: Holme's Principles of Physical Geology. Wiley
- Wyllie, Peter J: The dynamic Earth. Wiley
- Wyllie, Peter J: The way the Earth works. Wiley
- Hodgson, J H: Earthquake and Earth's structures. Prentice Hall.
- Martin H P Bott: The interior of the Earth. Edward Arnold.
- Condie K C: Plate tectonics and crustal evolution.
- Straheler: Earth sciences.
- Gutenberg Beno: Internal constitution of the Earth. Dover.

2	GEOL DCC – 02	STRUCTURAL GEOLOGY	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are be compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Rock failure: Mechanical principals of rock deformation, factors controlling behavior of material. Concept of stress and strain analysis in two and three dimensions. Progressive deformation. Moh's circles. Symmetry concepts in deformation. Unconformities: types, significance and recognition.

UNIT -2

Geometry of fold surface: Single and multi-layered. Classification of folds. Types of folds. Effects of folds on outcrops. Super-imposed folding. Geometry of faults. Classification and types of faults. Slips, separation, recognition of faults, causes of faulting. Mechanics of folding and faulting.

UNIT -3

Origin, kinds and their relation to other structure; fracture and joints, lineation, foliation, rock cleavages and schistosity. Tectonic fabrics. Magma tectonics: Emplacement of plutons, origin of Ring Dykes and Cone Sheets.

References:

- Bayly B: Mechanics in structural Geology. Springer Verlag
- Davis G H: Structural Geology of Rocks and regions. John Wiley
- Ghosh S K: Structural Geology fundamental of modern developments
- Hubert M K: Structural Geology. Hafner Publ.
- Moore E and Twiss R J: Tectonics. Freeman Pergamon Press
- Price N J and Cosgrove J W: Analysis of Geological Structure. Cambridge university
- Hobbs, Means and Williams: An Outline of Structural Geology.
- Badgeley P C: Structural Geology for Exploration Geologist.
- Fairhurst: Rocks Mechanics. Pergmon Press Whitten
- E. H. T: Structural folded Rocks.

3	GEOL DCC – 03	GEOMORPHOLOGY	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Concept of geomorphology-principles and significance. Cycle of erosion, Davis's and Plank's cycle of erosion. Soil forming processes: soil types, soil profile and classification of soils. Landslides, soil creep and solifluction. Major geomorphic divisions of India: their characteristics and evolution.

UNIT -2

Fluvial agency: Types of rivers, Valley development, Base level and its varieties, graded streams, Cross profile of valleys. Drainage patterns and their significance. Erosional landforms and depositional landforms of streams. Glaciers: Types of glaciers, regimes of glaciers, nourishment of glaciers, wastage of glaciers. Major features resulting from glacial erosion and glacial deposition. Glacio-fluvial features. Aeolian agency: Topographic effects of wind erosion. Landforms of Aeolian deposition. Piedmonts and piedmont problems. Arid cycle of erosion.

UNIT -3

Karst topography: Important areas of Karst, Conditions essential for development of Karst, features characteristic of karst region. Origin of limestone caverns. Karst geomorphic cycle. Marine erosion: Topographic features resulting from marine erosion and marine deposition. Classification of coasts.

References:

- Holms, Doris and Arthur: Holme's Principles of Physical Geology.
- Wiley Thornbury, W D; Geomorphology. Wiley.
- Small, RJ: Study of Landforms. Cambridge.
- Von Engelen, O D: Geomorphology- Systematic and regional. MacMillan.
- Savinder Singh: Geomorphology.
- Mathew Fontain Maury: The Physical Geography of Sea. Harward Univ. Press.
- David Lang; The Earth system. Brown Publishers.
- Hallis J R: Applied Geomorphology.

4	GEOL DCC – 04	MINERALOGY AND GEOCHEMISTRY	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each.

Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Crystallography: Basic concepts of Crystallography, Crystal symmetry and symmetry elements. Crystal projections- Spherical, Gnomonic and Stereographic projections. Classification of crystals into crystal systems and crystal classes, Derivation of 32 crystal classes. Twinning. X-Ray crystallography- Bragg's equation. Rotation method and powder method. Principles of Optics. Double refraction. Optical classification of minerals. Determination of refractive index. Uniaxial and Biaxial indicatrix. Determination interference colors and interference figures. Optic sign and its determination.

UNIT -2

Classification silicate structures. Isomorphism. Polymorphism and pseudo morphism. Ex solution. Atomic structure, mineralogical properties and mode of occurrence of the following:-Sulphides (AX,A₂X and AX₂Types), Oxides (XO ,X₂O,XO₂,X₂O₃ and XY₂O₄ types), Sulphates (anhydrous and hydrous), Carbonates (Calcite, Dolomite and Aragonite groups). Atomic structure, chemistry, physical and optical properties of the following rock forming mineral groups: Epidote, Chlorite and allumino-silicates. Precious and semi precious stones.

UNIT -3

Atomic structure, chemistry, physical and optical properties of the following rock forming mineral groups: Garnet, Olivine, Pyroxene, Amphibole, Mica, Feldspar, Feldspathoid and Quartz. Geochemical classification of elements. Radioactive decay scheme of U-Pb,Rb-Sr,K-Ar and Sm-Nd. Laws of Thermodynamics. Concept of Geochemical cycle. Principles of ionic substitution in minerals. Composition of the

References:

- Gribble, C D: Rutley's Elements of Mineralogy.
- Phillips W R and Griffin D T Optical Mineralogy. CBS
- Klein, Cand Haurbut, C S;l Mannual of Mineralogy. John Wiley.
- Mason: Principles of Geochemistry.
- Hoefs, J: Stable Isotope Geochemistry. Springer Verlag.
- Andeson: Geochemistry.
- Dana: Textbook of Mineralogy.

5	GEOL DCC – 05	PRACTICAL	4 Credit
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Duration: 4hrs

Maximum Marks: 100

Practical based on theory papers

SEMESTER – II

6	GEOL DCC – 06	IGNEOUS AND METAMORPHIC PETROLOGY	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are be compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of 20 marks, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in 500 words each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Origin of magma. Factors affecting magma composition. Evolution of magma by differentiation and assimilation. Phase equilibria of monary (Silica), Binaary (Mixed and eutectic Ab-An, Leu-Si) and Ternary (Ab-An-Di, Fo-Fa-Sil) Silicate systems. Magmatism in relation to plate tectonics. Forms , structures and textures of igneous rocks and interpretration of crystallization. Layered igneous structures. Classification of igneous rocks including IUGS system. Reaction principle and reaction series .

UNIT -2

Origin of Granite: Magmatic and granitisation processes. Petrogenesis. Petrography and Indian occurrences of Basic and Ultrabasic plutonic association; Granite –Granodiorite association; Tholeiite and alkali olivine basalt; Basalt-Dacite-Rhyolite association; Nepheline syenites, Ophiolites, Cummulsates, Anorthosites and Pegmatites

UNIT -3

Agents of metamorphism , kinds of metamorphism, types of metamorphism. Structures and textures of metamorphic rocks. Metamorphic differentiation. Concept of metamorphic zones in contact aureole. Metamorphic grades facies and facies series, facies classification. Metasomatism and their types .Types and origin of migmatites. Metamorphism of carbonates, pelites and mafic rocks. Charnockites, Khondalites, Eclogites. Paired metamorphic belts.

References:

- Best MG; Igneous and metamorphic belts. CBS.
- Bose, MK: Igneous petrology. World Press.
- Bucher, K and Frey, M. Petrogenesis of metamorphic rocks .Springer Verlag.
- Kretzs, R: Metamorphic crystallization. John Wiley.
- McBerney, AR: Igneous petrology. Jones and Bartlet.
- Phillipots, A. Igneous and metamorphic petrology. Prentice Hall.
- Turner, FJ. Metamorphic Petrology. McGraw Hills.
- Yaardley, BW; An introduction to metamorphic petrology. Longman.

- Winkler, HGF: Petrogenesis of metamorphic rocks. Springer Verlag.
- Miyashiro, A: Metamorphism and metamorphic rocks.
- George Allen & Unwin. Wyllie PJ: Ultramafic rocks. PJ Heffer.
- Huand, VJ. Petrology.

7	GEOL DCC – 07	SEDIMENTOLOGY	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are be compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Introduction to basic concepts: Origin of sediments; Fluid flow: Types of fluids, Laminar vs. turbulent flow, Reynolds number, Froude Number; Mode of transport of sediments; Classification of common sediments (rudites, arenites, argillites); Description and classification of sedimentary rocks; Classification of sandstones, limestones and Dolomites; Diagenesis: physical and chemical, processes and evidences of diagenesis in sandstones, mud rocks and carbonate rocks.

UNIT -2

Structure and texture of sedimentary rocks: Origin, classification and significance of primary, secondary and organic sedimentary structures; Palaeocurrent analysis. Texture: Grain size scale, particle size distribution, statistical treatment of particle size data, particle shape and fabric. Sedimentary facies.

UNIT 3

Types of depositional environments: Continental (Fluvial, Lacustrine, Aeolian and Glacial), Transitional and Marine environments. Types of sedimentary provenance. Heavy minerals: Their separation and utility in the provenance analysis. Tectonic framework of sedimentation (Kaay's classification of tectonic elements).

References:

- Allen, P; Earth surface processes. Blackwell.
- Davis, RA; Depositional systems.
- Prentice Hall. Einsel, G; Sedimentary basins. Springer Verlag.
- Miall, AD; Principles of sedimentary basin analysis. Springer Verlag.
- Nichols, G; Sedimentology and stratigraphy. Blackwell.
- Reading, HG; Sedimentary environments. Blackwell.
- Pettijohn, FJ; Sedimentary rocks.
- Pettijohn, Potter & Seiver; Sand and sandstones.

8	GEOL DCC – 08	STRATIGRAPHY OF INDIA	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are be compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Criteria for the stratigraphic classification and correlation. Litho, Bio and chronostratigraphic units. Magnetostratigraphy. Sequence stratigraphy. Geological time scale. Orogenic cycles in Indian stratigraphy. Tectonic framework of India. Geological column of the Indian stratigraphy.

UNIT -2

Ice ages in Indian stratigraphy. Precambrian, Permo-Carboniferous and Pleistocene ice ages , their evidences. Archaean (Azoic) History of India: Distribution and stratigraphy of the Archaeans of South India, Madhya Pradesh, Rajasthan, Jharkhand and Orissa. Precambrian (Proterozoic) History of India: Distribution and stratigraphy of the Cuddapah and Vindhyan Supergroups. Palaeozoic history: distribution and stratigraphy of Salt Range and Spiti, Origin and age of Saline formations. Precambrian-Cambrian boundary problem. Precambrian and Paleozoic stratigraphy of Rajasthan.

UNIT -3

Mesozoic history: Distribution and stratigraphy of Triassic of Spiti , Jurassic of Cutch (Kutchh) and Cretaceous of South India. Bagh beds, Lameta Beds. Deccan Traps. Permo -Triassic Boundary. Palaeoclimate, classification, distribution and stratigraphy of the Gondwana Supergroup. Cenozoic history: Tertiary of Assam and Rajasthan, its economic importance. Siwalik and its vertebrate fossil record. K-T boundary.

References:

- Boggs Sam, JR: Principles of sedimentary and strstigraphy, Prentice Hall.
- Krishnan, MS: Geology of India and Burma. Higginbothams Madras.
- Ravindra Kumar: Historical geology and Stratigraphy of India.
- John Wiley. Wadia, DN: Geology of India. McMillan.
- Doyel and Brennet MR: Unlocking the Stratigraphy: Concepts and Application. Prentice Hall.

9	GEOL DSE– 01A	PALAEONTOLOGY	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are be compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Introduction to fossils; fossilization processes (taphonomy) and modes of preservation; Uses of fossils; Species concepts; Methods of description and naming of fossils; Code of systematic nomenclature; Origin and diversity of life. Palaeoecology: principles and methods; application of fossils in the study of palaeoecology, palaeobiogeography and palaeoclimate.

UNIT -2

Invertebrate palaeontology: Classification, evolution and geological history of following groups; Trilobites, Graptolites, Echinoides, Corals, Brachiopods, bivalves, Gastropods and Cephalopods. Vertebrate Palaeontology: Origin of vertebrates; Succession of vertebrate life through the geological time; origin, evolution and extinction of dinosaurs. Evolutionary history of Man, Elephant and horse.

UNIT -3

Micropalaeontology: Classification and separation of micro fossils, Applications of microfossils in fossil fuel exploration. Ichnology: classification of trace fossils and their utility in palaeo environmental reconstructions. Palaeobotany: Plant life through ages, Characteristic features of Gondwana flora, role of plant fossils in palaeoclimatic reconstructions. Palynology: introduction to palynology, application of palynology in hydrocarbon exploration.

References:

- Moore, Lalicher and Fisher. Invertebrate fossils.
- Woods, H: Invertebrate paleontology.
- Clarkson, ENK: Invertebrate paleontology and evolution. Blackwell.
- Stearn CW and Carrol RL: Paleontology – The record of life. John Wiley
- Smith, AB: Systematics and fossil record –Documenting evolutionary pattern. Blackwell.
- Prothero, DR: Bringing fossils to life: An introduction to Paleobiology. McGraw hill.
- Ananthraman and Jain: Textbook of Paleontology.
- Banner, FT and Lord AR: Aspects of micropaleontology.
- Roger, AS: Vertebrate paleontology.
- Jones DJ: Microfossils.
- Glassener, MP: Principles of micro paleontology.
- Haq, BU and Boersma: Introduction to marine micro palaeontology.
- Andrew: Palaeontology.

10	GEOL DSE– 01B	MICROPALAEONTOLOGY AND PALYNOLOGY	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are be compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT-1

Definition and scope of the subject; Modern field and laboratory techniques in the study of microfossils; Classification of microfossils; Types of Microfossils; Calcareous Microfossils: (i) Foraminifera - outline of morphology, significance in biostratigraphy and paleoceanographic, paleoclimatic interpretations (ii) Calcareous nannofossils - outline of morphology and their application in biostratigraphy and paleoclimatic reconstructions (iii) Ostracoda - outline of morphology and wall structure, their significance in biostratigraphy and palaeoenvironment reconstruction (iv) Pteropoda - a brief introduction, application of pteropods in reconstruction of palaeoclimate; A brief introduction of calcareous algae.

UNIT-2

Siliceous Microfossils: Radiolaria, diatoms and silicoflagellate - outline of morphology, their environmental significance and application in biostratigraphy. Phosphatic Microfossils: Conodonts - outline of morphology, paleoecology and geological significance. Introduction to Organic walled microfossils and their biostratigraphic and palaeoenvironmental significance.

UNIT-3

Palynology: Pollen and Spores; Morphology, Classification and geological history. Application of Palynology in hydrocarbon exploration. Application of Micropalaeontology in petroleum exploration, in determination of age of the stratum, local and regional correlation of subsurface succession of Oil Wells.

References:

- Pratul Kumar Saraswati, M.S. Srinivasan: Micropaleontology. Principles and Applications. Springer.
- P.K. Kathal. Micropaleontology and its Applications. Scientific Publishers.
- J.M. Jenkins. Applied Micropalaeontology. Springer-Science+ Business Media, B.V.
- IGNOU e-content: <https://egyankosh.ac.in/bitstream/123456789/69612/1/Unit-10.pdf>

11	GEOL DCC – 09	PRACTICAL	4 Credit
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Duration: 4hrs

Maximum Marks: 100

Practical based on theory papers

SEMESTER - III

12	GEOL DCC – 10	MINERAL EXPLORATION	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are be compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT-1

Geological exploration: Mode of occurrence of ore deposits. Geological criteria (Ore guides) for mineral prospecting. Methods of geological exploration: Geological mapping; Base map and toposheets, reconnaissance and detailed mapping, exploratory grids, pits, trenches, core sampling, well logging in evaluation of deposits. Sampling methods. Assaying by channel sampling and placer sampling, underground sampling. Calculation of ore reserves. Classification of ore reserves.

UNIT-2

Classification, principles and brief idea of geophysical methods. Electric method, instruments used in electric prospecting, application in mineral prospecting. Magnetic methods: Magnetic properties of rocks and minerals, magnetometers. Gravity method; Earth's gravity field, regional and local gravity anomalies, pendulum torsion balance of gravimeters, interpretation of gravity anomalies for mineral deposits. Seismic methods: Elastic properties of rocks, types of elastic waves (P, S & L waves). Refraction and reflection methods, time distance relation for horizontal interface, seismic instruments- geophones.

UNIT-3

Geochemical exploration: Geochemical cycle, mobility of elements, path finder elements, mode of occurrence of trace elements, primary dispersion pattern of deep seated origin, syngenetic and epigenetic diffusion. Sampling technique for geochemical exploration.

Reference:

- Arogyaswamy, RNP: Courses in mining geology. Oxford IBH.
- Dobrin, MB: Introduction to geophysical prospecting. McGraw Hills.
- Hawks, H and Wobb, JS: Geochemistry in minerakl exploration. Harper NY.
- Ginzburg, II: Principles of geochemical prospecting. Pergmon.
- Holson, GD and Tiratsoo, EN: Introduction to petroleum geology. Gulf Publ.

- Howel, CH: Introduction to geophysics.
- Milton and Dobrin: Introduction to geophysical prospecting. McGraw Hills.
- PaarasnsiAa, DS: Principles of applied geophysics.
- Rao, MBR: Outline of geophysical prospecting. Sharma, PV: Geophysical methods in geology. Elsevier.

13	GEOL DCC – 11	ENGINEERING GEOLOGY	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are be compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Importance of geology in civil engineering. Merits and demerits of civil engineering in fold, faults and joints affected areas. Engineering properties of rocks. Testing of engineering properties of rocks used as foundation sites, building stones, aggregates and ballasts.

UNIT -2

Dam and its parts, types of dams, geological consideration for the selection of a dam site. Reservoir: geological consideration, Its capacity, Water tightness and influencing factors, silting and desilting of reservoir.

UNIT -3

Geological consideration in major engineering projects: construction of tunnels, highways, bridges and canals. Landslides: causes, effects and prevention. Consideration of civil engineering in seismic areas. Geo-Hazards: mitigation and management.

References:

- Bell, FG: Geological hazards. Route Ledge.
- Blyth, FCH: Geology for Engineers. Arnold Ltd.
- Kesavulu, NC: Textbook of engineering geology. McMilan.
- Khurmi, RS: Fundamentals of engineering geology. Dhanpat Rai and Sons.
- Krynine and Judd: Principles of engineering geology and geotectonic. McGraw.
- Parbeen Singh: Engineering geology. Katson Publ.
- Ramnathan, RM: Engineering geology. Anuradha Agency TN.
- Richey, JE: Elements of engineering geology. Sir Issac Pitman & sons.
- Sumit, K: Environmental hazards. Routledge.

- Trefethen, NC: T B of geology and engineering geology. Mc Milan.

14	GEOL DSE – 02A	ORE GEOLOGY	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are be compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Relation of magma to mineral deposits. Geological thermometers. Ore genesis. Control of ore deposits. Para genesis and zoning in mineral deposits. Classification of processes of mineral deposits .Metallogenic epochs and provinces. Processes of mineral deposits: Magmatic concentration. Sublimation. Pegmatites. Contact metasomatism. Hydrothermal, metamorphic. Volcano genetic deposits and carbonatites.

UNIT -2

Processes of mineral deposits: Sedimentary, placers, residual, evaporation, oxidation and supergene enrichment. Ore microscopy: Textures and structures of ores. Stratiform and stratabound ore deposits.

UNIT -3

Origin, mode of occurrence, association, uses and Indian occurrences of metallic mineral deposits; Iron manganese, chromium, nickel, copper, lead, zinc, aluminium, tin, tungsten titanium, beryllium, molybdenum, gold and silver. Origin, mode of occurrence, association, specification and grades for use in industries and Indian occurrences of non-metallic mineral deposits; Mica asbestos, gypsum, ochre, precious and semi-precious stones. Minerals used in fertilizers and cement industries.

Reference:

- Bateman: Economic mineral deposits. Wiley.
- Deb, S: Industrial minerals.
- Evans,JM: Ore geology and industrial minerals.Blackwell.
- Halloway: Simulating the earth.
- Krisnaswamy: Mineral resources of India.
- Lamey,CA: Metallic and industrial minerals.
- Mookherjee, A: Ore genesis-A holistic approach.Allied
- Mukerjee: Non fuel mineral deposits of India. Allied.

- Stanton, RL: Ore petrology. McGraw Hills.
- Umeshwer Prasad. Economic geology. Cbs

15	GEOL DSE – 02B	APPLIED GEOLOGY	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are be compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Ore Genesis: Hydrothermal, magmatic, and sedimentary ore-forming processes. Prospecting Methods: Geological, geochemical, and geophysical exploration techniques. Mining & Estimation: Core sampling, reserve calculation, and open-cast/underground mining.

UNIT -2

Engineering Geology & Rock Mechanics, Rock Properties: Porosity, permeability, and unconfined compressive strength. Civil Projects: Geological site selection for dams, tunnels, and bridges. Geohazards: Landslide mechanisms, slope stability analysis, and mitigation steps.

UNIT -3

Hydrogeology & Remote Sensing Groundwater Dynamics: Aquifer properties, Darcy's law, and well hydraulics. Water Management: Groundwater quality assessment and artificial recharge methods. GIS Applications: Satellite image interpretation for structural mapping and resource targeting.

References:

- R. K. Keshav; A Textbook of Engineering Geology.
- Parbin Singh; Engineering and General Geology.
- A. M. Bateman; Economic Geology: Economic Mineral Deposits.
- John Ridley; Ore Deposit Geology.
- Charles J. Moon, Michael K. G. Whateley & Anthony M. Evans; Introduction to Mineral Exploration.
- A. K. Dey; Mining Geology.
- David K. Todd and Larry W. Mays; Groundwater Hydrology.
- C. W. Fetter; Applied Hydrogeology.
- Thomas M. Lillesand, Ralph W. Kiefer & Jonathan W. Chipman; Remote Sensing and Image Interpretation.
- Anji Reddy; Remote Sensing and GIS.

16	GEOL DSE – 03B	PHOTOGEOLOGY AND REMOTE SENSING	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Introduction to aerial photography. Multispectral photography. Types of aerial photographs . Geometric principles of photographs –relief and tilt displacement, Vertical exaggeration and distortions.

Introduction to Remote Sensing. Types of electromagnetic radiations (EMRT, energy used in remote sensing]. Sensor platforms. Energy interaction with earth surface and atmosphere. Reflectance of minerals, vegetation rocks and water. Scattering. Active and passive sensors imaging.

UNIT -2

Taking measurements from Ariel photographs: Scales, distances area and height. Measuring instruments and their use, Parallax Bar. Preparation of photogeological maps. Mosaic.

Controlling factors of aerial photographs: Scale, flight plan, area, purpose, time and season of photography. Introduction to overlap, side lap, drift, crab. Fiducial marks. Elements of interpretation of Ariel photographs. Background knowledge. Factors affecting aerial photographs.

UNIT -3

Multi spectral scanners (MSS) SLA, SAR. LISS camera. Thermal infrared line scanners (TIRLS Near infrared (NIR, Microwave (Radar) Imagery. Introduction to Image processing. Discrete image processing system. Application of photo geology and remote sensing in the study of geomorphology, lithology, structural features, mineral exploration and hydrogeology. Preparation of base map by radial triangulation. Concept of geographic information system.

References:

- Curan, PJ: principles of remote sensing. ELBS(Longman)
- Drury, SA: Image interpretation in Geology. Allen and Unwin.
- Land, DR: Principles and interpretation of Ariel photographs
- Miller, VC: Photogeology. McGraw.
- Pandey, SN: Principles and applications of Photogeology.
- Parry S Seigal A, and Allen, R: Remote sensing in geology.
- Patel, AN and Surendra Singh: Principles of remote sensing. Scientific Publ.

17	GEOL DSE – 03B	ADVANCED REMOTE SENSING AND GIS	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Introduction and development of remote sensing techniques; ariel remote sensing versus satellite remote sensing. Stereoscopic and pseudoscopic vision, depth perception. Different types of viewing instruments. Vertical exaggeration, factors affecting vertical exaggeration, determination of vertical exaggeration. Geometric elements of ariel photographs, relief displacement. Image parallax. Parallax measurement-measurement of dip, height and thickness of strata. Stereoscopic plotting instruments. Recognition of various photointerpretation elements. Interpretation of ariel photographs for geology, geomorphology and structures.

UNIT -2

Radiation principles. Generation of electromagnetic radiation (EMR, Electromagnetic spectrum. Interaction of EMR with atmosphere and earth material. Spectral signatures. Space platforms. Remote sensing sensors- Multi spectral scanners (MSS), thermal scanners, passive and active microwave scanners, LISS, WIFS. Visual interpretation of MSS, TM, SPOT and IRS images. Digital image processing (DIP). Sources of image degradation. Image rectification and restoration, image enhancement techniques, multi image manipulation- FCC generation, band rationing, pattern recognition and image classification.

UNIT -3

Geographic information system (GIS). Components of GIS system, data structure and data model in GIS, functional elements of GIS. Projections. Application of remote sensing and GIS for mineral exploration, ground water exploration, land use /land cover studies and change detection. Engineering projects and environmental planning.

Reference:

- Curan, PJ: Principles of remote sensing. ELBS (Longman)
- Drury, SA: Image interpretation in Geology.
- Allen and Unwin. Parry S Seigal And Allen, R: Remote sensnig in geology.
- Patel, AN and Surendra Singh: Principles of remote sensing. Scientific Publ.
- Pratt, VK: Digital Image Processing.
- Tripathi and Bajpai ed. Remote sensing in geosciences.

- Jenson: Environmental Remote sensing.

18	GEOL DCC – 12	PRACTICAL	4 Credit
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Duration: 4hrs

Maximum Marks: 100

Practical based on theory papers

SEMESTER – IV

19	GEOL DCC – 13	FUEL GEOLOGY	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are be compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Origin of coal: Physico-chemical characterization. Proximate and ultimate analyses. Rank and varieties of coal. Macroscopic ingredients and microscopic constituents (Maceral, Lithotypes and microlithotypes).

UNIT -2

Indian and international classification of coal. Preparation of coal for industrial purpose (Coal washing , Coal carbonization (Coke manufacturing), Coal gasification and hydrogenation. Briquetting of coal. Geological features of coal seams. Geology of the productive coal fields of India. Methods of coal prospecting. Estimation of the coal reserves. Elementary idea about coal mining methods. Coal bed methane. Underground Coal Gasification.

UNIT -3

Origin, migration and accumulation (Oil traps) of petroleum and natural gas. Kerogene. Geology of productive oil fields of India. Position of oil and natural gas in India. Atomic minerals; mode of occurrence, association and distribution in India. Methods of prospecting of atomic minerals. Productive horizons in India.

References:

- Dahlkamp, FJ: Uranium ore deposits. Springer Verlag.
- Durrane, EM: Radioactivity in geology: Principles and applications. Ellis H.
- Holson, GD and Tiratsoo, EN: Introduction to petroleum geology. Gulf Publ.
- Nttleton, LL: Geophysical prospecting fot oil.
- North, FK: Petroleum Geology. Allen and Unwin.
- Selley, RC: Elements of petroleum geology. Academic press.

20	GEOL DCC – 14	MINING AND MINERAL DRESSING	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are be compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Mining terminology, mine supports, subsidence, shafts and shaft sinking. Breaking of rocks . Percussion and rotary drilling methods. Classification of mining methods. Alluvial mining and opencast mining.

UNIT -2

Underground mining (other than coal mining: Stoping methods, open stopes, timbered stopes, filled stopes, shrinkage stopes, slicing system and caving. Mine atmosphere: mine ventilation, pumping of mine water. Coal mining methods: Board and pillar method, long wall method. Strip mining. Haulage and winding.

UNIT -3

Mineral dressing: Physical properties of minerals used in mineral dressing. Crushers: primary and secondary crushers. Grinding mills. Rod mills, Ball mills. Industrial screening: Types of screens, gravity separation, Heavy-medium separation, Magnetic separation. Froth floatation technique of separation of sulphide ores.

Reference:

- Arogyaswamy, RNP: Courses in mining geology. Oxford-IBH.
- Gaudin: Principles of ore dressing. McGraw Hill.
- Lewis: Elements of mining.
- McKInstry, HE: Mining Geology. Prentice Hall.
- Richards and Looke: Text book of ore dressing. McGraw Hill.
- Roberts: Elements of ore dressing.
- Young: Elements of mining geology

21	GEOL DSE – 04A	HYDROGEOLOGY	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are be compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to

be answered in approximately 250 words each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in 500 words each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Ground water: Origin, importance, occurrences of groundwater. Vertical distribution of ground water. Geological factors governing the occurrence of ground water. Porosity, permeability, transmissivity, specific yield, specific retention, storativity, hydraulic conductivity, storage coefficient, aquifers and their classification. Darcy's law.

UNIT -2

Groundwater flow: confined, unconfined, steady, unsteady and radial flow. Forces causing flow. Water level fluctuations: causative factors and their measurements. Methods of pumping tests and analysis of test data. Ground water Exploration. Water harvesting. Consumptive and conjunctive use of surface and ground water. Concept of watershed management. Natural and artificial recharge of ground water.

UNIT -3

Groundwater quality: Physical characteristics; turbidity, color, test, odor, temperature and specific conductivity. Chemical characteristics: TDS and suspended solids, pH value, hardness, heavy metals and dissolved gases. Biological characteristics; Water contaminants and pollutants. Salt water intrusion in coastal aquifers and their remedial measures. Radio-isotopes in hydrogeological studies. Ground water resources of Rajasthan. National water policy.

References:

- Davis, SN and De Wiest, RJM: Hydrogeology. John Wiley.
- Felter, CW: Applied hydrogeology. Merrill.
- Freeze, RA and Cherry, JA: Ground water. Prentice Hall b.
- Gautam, Mahajan: Ground water survey and investigation.
- Gulman: Hydrogeology and wet land conservation.
- Karanth, KR: Ground water assessments – development and managements.
- Rasghunath, NM: Ground water. Wiley Eastern.
- Subramaniam, V: Water. Kingston Publ.
- Todd, DK: Ground water hydrology. N Wiley.
- Tollman: Ground water.

22	GEOL DSE – 04B	GROUNDWATER EXPLORATION AND MANAGEMENT	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately 20 words each. All questions are be compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately 250 words each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Groundwater and it's interactions with human and society; groundwater in achieving sustainable development goals, sources and processes of groundwater pollution

UNIT -2

Non invasive techniques of groundwater exploration; invasive groundwater exploration; satellite-based groundwater studies, groundwater storage estimations

UNIT -3

Groundwater stress, managing groundwater stress from scarcity and suitability; groundwater sustainability; groundwater remediation methods, problem solving on real life examples. National water policy.

References:

- Fetter, C.W., Boving, T.B. and Kreamer, D.K., 1999. Contaminant hydrogeology. Upper Saddle River, NJ: Prentice hall.
- Mukherjee, A., Scanlon, B.R., Aureli, A., Langan, S., Guo, H. and McKenzie, A.A. eds., 2020. Global groundwater: source, scarcity, sustainability, security, and solutions. Elsevier.
- Domenico, P.A. and Schwartz, F.W., 1998. Physical and chemical hydrogeology (Vol. 506). New York: Wiley

23	GEOL DSE – 05A	ENVIRONMENTAL GEOLOGY	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are be compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Concept of environmental geology. Classification of environment. Ecological perspectives of

environment. Global warming. Impact assessment of degradation and contamination of surface water and ground water quality due to industrialization and urbanization.

UNIT -2

Soil profiles, soil types and soil quality degradation due to irrigation, use of fertilizers and pesticides. Wet lands: Classification, natural and artificial wet lands, problems of reclamation of wet lands. Water logging problems. Desertification and degradation of land. Anti desertification measures.

UNIT -3

Causes floods, flood hazard and management. Impacts of mining activities on environment. Environmental management in mining areas, effects of earthquakes, seismic hazards and management. Environmental pollution due to industries, energy resources, urbanization. Earth's natural hazardous processes and its impact on environment: Volcanic activity, land slides, coastal hazards. Environmental problems related to dams and reservoirs.

References:

- Bel I, FG: Geological hazards. Route Ledge.
- Hsai Yang Fang: Introduction to environmental geotechnology. CRC Press.
- Patwardhan, AM: The dynamic earth system.
- Smith, K: Geological Hazards. Route Ledge.
- Subramaniam, V: Textbook of environmental science. Narosa Graedel, TE and Crutzen, PJ: Atmospheric change Freeman.
- Valdiya, KS: Environmental geology – Indian context. Tata-McGraw.

24	GEOL DSE – 05B	CLIMATOLOGY	4 Credit
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Duration: 3hrs

Maximum Marks: 70

Section A: Section of **20 marks** and consist of 10 questions carrying 2 marks each to be answered in approximately *20 words* each. All questions are be compulsory.

Section B: Section of **30 marks** and consist of 9 questions (3 from each unit) carrying 5 marks each to be answered in approximately *250 words* each. A Candidate has to attempt six questions choosing at least one question from each unit.

Section C: Section of **20 marks**, consist of three questions (1 from each unit) carrying 10 marks each. Candidate has to attempt two questions to be answered in *500 words* each. A Candidate shall attempt any two questions. The examiner shall set one question from each Unit.

UNIT -1

Nature, Scope and Application. The atmosphere: Origin, composition and structure. Distribution of temperature, Insolation and Heat Budget of atmosphere. Atmospheric pressure and winds.

UNIT -2

Atmospheric Moisture and Humidity, Condensation, Clouds and Precipitation, Atmospheric Equilibrium: Stability and Instability. Atmospheric Disturbances: Cyclones (Tropical and Temperate Cyclones).

UNIT -3

Monsoon: Mechanism of monsoon, Global teleconnections in relation to monsoon in India, ENSO, Indian Ocean Dipole Effect. Jet Streams and Monsoon in India. Climatic Classification: Basis of Classification; Koppen's Classification and Thornthwaites.

References:

- Savindra Singh; Climatology.
- D. S. Lal; Climatology: Atmospheric Science.
- John E. Oliver & Hideto Hidore; Climatology: An Atmospheric Science.
- Manik C. Kendrew; Climatology: Principles and Applications.
- John F. Haywood, John Barry & David A. Philander; An Introduction to Climate.
- J. Gribbin & G. A. Stewart; Principles of Climatology.
- P. N. Trewartha; Climatology.
- David H. Hartmann; Climatology: Concepts and Applications.
- T. R. Crichtfield; World Climatology.
- R. N. Tiwari Climatology and Climate Change.

25	GEOL DCC – 15	PRACTICAL	4 Credit
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Duration: 4hrs

Maximum Marks: 100

Practical based on theory papers