

The new B.Sc (Honours) Course in Geology is for six semesters and the Final Examinations will be conducted by the university at the end of each semester. The total mark for the course is 800 and the semester wise distribution of marks is as follows:

Semester	Paper Code	Theory	Marks	Paper No.	Practical	Marks
First	GELH101	General Geology and Crystallography & Mineralogy	75	GELH102	Crystallography & Mineralogy	25
Second	GELH201	Petrology	75	GELH202	Petrology	25
Third	GELH301	Structural Geology and Geotectonics	75	GELH302	Structural Geology	25
Fourth	GELH401	Stratigraphy and Palaeontology	75	GELH402	Stratigraphy and Palaeontology	25
Fifth	{ GELH501	Igneous and Sedimentary & Metamorphic Petrology	75	GELH502	Igneous and Sedimentary & Metamorphic Petrology	25
		GELH503	Economic Geology	75	GELH504	Economic Geology
Sixth	{ GELH601	Remote sensing and Hydrogeology	75	GELH602	Remote sensing and Hydrogeology	25
		GELH 603	Applied Geology (Exploration, Mining and Engineering Geology)	75	GELH604	Field work and Field Report

Semester	THEORY				PRACTICAL				TOTAL (Theory + Practical)
	Paper Code	Internal Assessment	End Semester	Total Marks	Paper Code	Internal Assessment	End Semester	Total Marks	
First	GELH101	19	56	75	GELH102	6	19	25	100
Second	GELH201	19	56	75	GELH202	6	19	25	100
Third	GELH301	19	56	75	GELH302	6	19	25	100
Fourth	GELH401	19	56	75	GELH402	6	19	25	100
Fifth	GELH501	19	56	75	GELH502	6	19	25	100
	GELH503	19	56	75	GELH504	6	19	25	100
Sixth	GELH601	19	56	75	GELH602	6	19	25	100
	GELH 603	19	56	75	GELH604	6	19	25	100

Question Paper pattern: (Theory)

- (a) There will be a total of eight questions in all.
- (b) Two questions are to be set from each unit. Each question will carry 14 marks. Four questions are to be answered, selecting at least one from each unit ($14 \times 4 = 56$).
- (c) Internal Assessment for 19 marks is to be conducted by the respective Colleges.

Duration of Examination: Theory paper: 3 hours
 Practical paper: 4 hours

Paper: GELH 101 (Theory): General Geology and Crystallography & Mineralogy

(Contact hours: 72)

Max Marks: 75

Time: 3 hours

Unit I: General Geology

Geology: Scope and different branches. Recent thought on the origin of the earth. Composition of the crust. Interior of the earth and evidences from seismic records. Rock cycle, Age of the earth. Geological Time Scale.

Surfacial processes: Weathering, erosion, and mass wasting. Erosion, transportation and deposition by wind, river, glacier and associated landforms produced.

✓ Earthquakes: Basic terms, causes, seismic waves and earthquake zones of India.

✓ Preliminary idea of Volcanoes: Basic elements, types and products.

Basic Concepts of Isostasy (Pratt's and Airy's hypotheses) and Plate tectonics

Unit II: Crystallography

Minerals as crystals. Crystallographic axes, parameters and Miller indices. Crystal forms and symmetry elements. Axial elements and classification of crystals into six systems. Symmetry and forms of normal classes of the six systems. Crystal aggregates, parallel growth and twins, twin plane and composition plane. Space lattice, unit cell. Crystal chemistry: elementary idea of bonding, substitution of elements, preliminary ideas of crystal defects.

Unit III: Mineral optics

Minerals: Definition. Minerals as constituents of rocks. Physical properties of minerals.

Isomorphism and polymorphism, pseudomorphism. Structural framework of silicates and their broad classification.

Polarization of light, Nicol prism, parts of polarizing microscope.

Isotropic and anisotropic minerals, double refraction, birefringence, pleochroism, interference colour, extinction, uniaxial and biaxial minerals.

Unit IV: Descriptive Mineralogy: Physical and optical properties of the following group of minerals: Feldspar, feldspathoid, olivine, amphibole, pyroxene, mica, aluminium silicate, silica.

Reading list:

1. Berry, L.G. and Mason, B.(1979) *Minerology*, CBS
2. Dana, E.S. and Ford, W. (1986)*Textbook of Minerology*, John Wiley .
3. Davis, G.H(1984) *Structure of Rocks and Regions*, John Wiley
4. Deer, W.A., Howie R.A. and Zussman, J. (1976) *An Introduction to Rock Forming Minerals*, John Wiley
5. Ehlers, E.G. (1987) *Optical Minerology*, Blackwell.
6. Flint, R.F. and Skinner, (1974)B.J. *Physical Geology*, John Wiley
7. Ghosh, S.K.(1993) *Structural Geology*, Pergamon Press
8. Holmes. A.(1975) *Principles of Physical Geology*, Nelson and Sons .
9. Klein, C. and Hurlbut, C.S.(1985) *Manual of Minerology*, John Wiley
10. Larson, E. and Birkeland, P.(1982) *Putnam's Geology*, OUP
11. Leet, D. and Judson, S.(1974) *Physical Geology*, Prentice Hall
12. Mason, B. and Moore, C.B. (1985) *Principles of Geo-Chemistry*, Wiley Eastern
13. Mukherjee, P.K. (1992)*A Text Book of Geology*, World Press
14. Park, R.G.(1985) *Foundations of Structural Geology*, Chapman and Hall
15. Phillips, W.R. and Griffin, (1986)D.T. *Optical Minerology*, CBS
16. Pluigm, B. and Marshak, S.(1991) *Earth Structure: An Introduction to Structural Geology and Tectonics*, McGraw Hill
17. Putnam, W.C.(1971) *Geology*, OUP
18. Read, H.H.(1984) *Rutley's Elements of Minerology*, CBS
19. Read, H.H. and Watson, J.(1988) *Introduction to Geology*, ELBS
20. Rogers, A.F. and Kerr, P. (1992) *Optical Minerology*. Blackwell
21. Winchell, A.N.(1979) *Elements of Optical Minerology* John Wiley
22. Dexter Perkins, *Mineralogy*
23. Twiss and Moores, (1989) *Structural Geology*

Paper: GELH102 (Practical): Crystallography and Mineralogy

(Contact hours: 48)

Max. Marks: 25

19

Time: 4 hours

1. Crystallography

Marks: $2 + 2 = 4$

Study of symmetry elements and forms of the crystals belonging to the normal classes of isometric, tetragonal hexagonal, orthorhombic, monoclinic and triclinic systems. (Clinographic sketch and Identification of Forms)

2. Mineralogy

Recognition of the following minerals in hand specimens based on their physical characters:

Marks: $1\frac{1}{2} \times 6 = 9$

Quartz, orthoclase, microcline, plagioclase, augite, hornblende, tremolite, actinolite, olivine, kyanite, sillimanite, muscovite, biotite, staurolite, garnet, apatite, tourmaline, calcite, talc, gypsum, fluorite, topaz and corundum.

Identification of the following minerals under microscope:

Marks: $3\frac{1}{2} \times 2 = 7$

Quartz, nepheline, orthoclase, microcline, kyanite, sillimanite, plagioclase, muscovite, biotite, augite, hypersthene, hornblende, olivine, garnet, tourmaline, and calcite.

3. Laboratory records and viva – voce

Marks: $2 + 3 = 5$

Reading List:

1. Butler, B. and Bell, J.D. (1988) *Interpretation of Geological Maps*, John Wiley
2. Ehlers, E.G. (1987) *Optical Mineralogy*, Blackwell.
3. Gokahle, N. (1987) *Manual of Geological Maps*, CBS
4. Moorehouse, W.W. (1985) *The Study of Rocks in Thin section*, CBS
5. Read, H.H. (1984) *Rutley's Elements of Mineralogy*, CBS
6. Sen, A.K. (1995) *Laboratory Manual of Geology*, Modern Book Agency, Calcutta

Paper: GELH201 (THEORY): Petrology

(Contact Hours: 72)

Max.Marks: 75

Time: 3 hours

Group A: (Igneous Petrology)

Unit I: Introduction:

Igneous rocks and magma. Mode of occurrence of igneous rocks-volcanic, hypabyssal and plutonic rocks; forms of igneous rocks – extrusive (vesicular structure, pillow structure, flow banding, ropy lava, blocky lava, columnar jointing) and intrusive rocks. Bowen's Reaction Series. Magmatic differentiation and Assimilation. IUGS classification for plutonic volcanic rocks.

Unit II: Texture and Petrography:

Textures and micro- structures of igneous rocks.

Petrography of the following rocks - granite, granodiorite, pegmatite, rhyolite, diorite, trachyte, gabbro, dolerite, basalt, norite, syenite, peridotite, dunite.

Group B: (Sedimentary and Metamorphic Petrology)

Unit III: Sedimentary Petrology:

Introduction to sedimentology and process of sedimentation- breakdown of rocks. Diagenesis. Genetic classification of sedimentary rocks.

Texture of sedimentary rocks; clastic and non - clastic textures.

Structures of sedimentary rocks: Mechanical, penecontemporaneous, chemical and organic structures.

Siliciclastic rocks: Conglomerate and breccia, composition, classification;

Sandstone: Composition, maturity and Dott's classification;

Shale: Types and composition.

Carbonates: Limestone- components, classification as proposed by Folk and Dunham.

Unit IV: Metamorphic petrology:

Concept of metamorphism; factors and types of metamorphism. Concepts of grades of metamorphism with the help of Barrovian index minerals and basic divisions of metamorphic grade (metamorphic facies).

Textures, structures and naming of metamorphic rocks- granoblastic, porphyroblastic, poikiloblastic, cataclastic, maculose, schistose, granulose and gneissose.

Petrography of common metamorphic rocks: Slate, phyllite, schist, quartzite, marble, amphibolite and gneiss.

Distribution, association and brief petrography of charnockite, khondalite, gondite and granulite.

Reading List

1. Best, M.G.(1986) *Igneous and Metamorphic Petrology*, CBS
2. Carmichael, I., Turner, F. and Verhoogen, J.(1977) *Igneous Petrology*, McGraw Hill
3. Collinson, J.D. and Thompson, D.B(1989). *Sedimentary Structures*, Unwin Hyman
4. Ehlers, E.G. and Blatt, H.(1987) *Petrology*, CBS Publication New Delhi
5. Hall, A(1987) *Igneous Petrology*, ELBS
6. Hatch, F. Wells, A.K. and Wells, M.K.(1984) *Petrology of Igneous Rocks*, CBS
7. Mason, R.(1978) *Petrology of Metamorphic Rocks*, CBS
8. Pettijohn, F.J.(1984) *Sedimentary Rocks*, CBS
9. Sengupta, S.(1994) *Introduction to Sedimentology*, Oxford and IBH
10. Tucker, M.(1981) *Sedimentary Petrology*, ELBS
11. Turner, F. and Verhoogen, J.(1977) *Igneous and Metamorphic Petrology*, CBS
12. Tyrell, G.H.(1976) *Principles of Petrology*, Asia Publishing House
13. Winkler, H.G.F.(1976) *Petrogenesis of Metamorphic Rocks*, Springer Verlag
14. Yardley, B.(1989) *An Introduction to Metamorphic Petrology*, ELBS
15. Raymond L.A.(2002) *The study of Igneous, Sedimentary and Metamorphic Rocks* McGraw Hill
16. Winter J.D. *An Introduction to Igneous and Metamorphic Petrology*, Prentice Hall

Paper: *GELH 301 (THEORY): Structural Geology and Geotectonics*

(Contact hours -72)

Max. Marks: 75

Time: 3 hours

Group A: (Structural Geology)

Unit I: Introduction to Structural Geology and Fold

Scope of structural geology: Introduction to basic structural elements, linear and planar structures and their measurement. Outcrops of rocks/folds on horizontal and uneven surfaces. Some common primary structures and their significance—bed, graded-bed, cross-bed, flute-cast, mud-crack, ripple-mark, load-cast, pillow structure. Unconformity: Definition, types and recognition. Folds: Definition, elements of folded surfaces, classification of folds on the basis of genesis, sense of curvature, fold shape, fold facing, Fleuty's and Ramsay's classification and fold shape in profile plane. Pumpelly's rule, fold symmetry. Mechanism of folding. Recognition of folds in field and map.

Unit II: Fault, foliation and lineation

Joints: Definition, surface morphology, types, joint arrays and origin of joints.

Faults: Definition, fault and shear zones, elements of faults, classification of faults on the basis of slip and separation. Changes in fault attitude. Fault length and termination. Recognition of faults in field and map. Mechanism of faulting.

Foliation: Definition, foliation in igneous, sedimentary and metamorphic rocks and fault zones. Rock cleavage: Powell's classification of foliation; Relation of foliation with other structures.

Lineation: Definition, primary and secondary lineation; Use of lineation in structural analysis.

Unit III: Rock deformation:

Concept of force, stress, resolution of stress; stress on a plane and at a point; stress ellipse and ellipsoid; components of stress and stress tensor; stress states.

Deformation and strain, homogeneous and heterogeneous strain; strain and strain parameters; angular strain and shear strain; strain ellipse and ellipsoid; strain path, co-axial and non-co-axial strain, pure shear simple shear and general shear; strain states.

Variations of strain with confining pressure, temperature, time and solution.

Group B (Geotectonics)

Unit IV: Continental Drift and Plate tectonics:

Concept of continental drift as a forerunner to plate tectonics; geological, paleontological and paleo-climatological evidences. Gondwanaland and its break-up.

Concept, constitution of plates and plate margin, plate motion and causes of plate motion. Divergent boundaries- triple points, ridge and rift valley, sea floor spreading. Strike-slip boundaries- transform faults. Convergent boundaries- trench, Benioff zone, island arcs, mountain chain. Plate tectonics model for the evolution of ocean basins and mountain belts. Wilson cycle.

Reading Lists:

1. Condie, K.C.(1989)*Plate Tectonics and Crustal Evolution*, Oxford Pergamon Press
2. Davis, G.H.(1984) *Structure of Rocks and Regions*, John Wiley
3. Hobbs, B. Means, W.D. & Williams, P.(1976) *An Outline of Structural Geology*, John Wiley
4. Keary, P. and Vine, F.J.(1990) *Global Tectonics*, Blackwell
5. Moores, E.M. and Twiss, F.(1995) *Tectonics*, W.H. Freeman
6. Pluigm, B. and Marshak, S.(1991) *Earth Structure: An Introduction to Structural Geology and Tectonics*, McGraw Hill
7. Wyllie, P.J.(1971) *Dynamic Earth*, John Wiley

Paper: GELH202 (PRACTICAL) Petrology

(Contact hours: 48)

Max. Marks: 25

Time: 4 hours

1. Petrology: (Hand specimens)

Marks: $1\frac{1}{2} \times 6 = 9$

Recognition of the following rocks in hand specimens-

Granite, pegmatite, gabbro, syenite, rhyolite, trachyte, diorite, dolerite, basalt, dunite, shale, limestone, sandstone, conglomerate, phyllite, slate, gneiss, quartzite, schist, gneiss, marble.

2. Petrology: (Thin sections)

Marks: $4 \times 2 = 8$

Study of mineral constituents, texture and structure of the following rocks and their identification:

Granite, rhyolite, syenite, diorite, gabbro, dolerite, basalt, limestone, sandstone, gneiss and schist.

3. Geological Field Work (Local)

Marks: 4 (Field work 2+Field report 2)

4. Laboratory notebook and viva-voce

Marks: $2+3=5$

Reading List:

1. Collinson, J.D. and Thompson, D.B.(1989) *Sedimentary Structures*, Unwin Hyman
2. Heinrich, E.(1976) *Microscopic Petrology*, McGraw Hill
3. Moorehouse, W.W.(1985) *A Study of Rocks in Thin Section*, CBS
4. Read, H.H.(1984) *Rutley's Elements of Mineralogy*, CBS
5. Sen, A.K(1995) *Laboratory Manual of Geology*, Modern Book agency, Calcutta
6. Williams H., Turner, F and Gilbert, C.(1985) *Petrography*, CBS

Paper: GELH 302 (PRACTICAL): Structural Geology

Max. Marks: 25

(Contact hours: 48)

Time: 4 hours

Marks: 3

1. Reading of contour maps and geological maps.
2. Drawing of profiles and cross sections, and descriptions of simple and complex geological maps with folds, faults, unconformities and intrusions. *Marks: 5*
3. Outcrop completion of beds. Solution to bore-hole problems. *Marks: 3*
4. Stereographic projection for determining trend, plunge, rake, strike, true and apparent dip, fold axis. *Marks: 5*
5. Plotting of pole to planes, Determination of paleo- current from cross-beds. *Marks: 4*
6. *Laboratory records and viva-voce* *Marks : 2+3=5*

Reading List:

1. Davis, G.H.(1984) *Structure of Rocks and Regions*, John Wiley
2. Ghosh, S.K.(1993) *Structural Geology*, Pergamon Press
3. Gokhale, N.(1987) *Manual of Geological Maps*, CBS Publication New Delhi

Paper: **GELH 401(THEORY): Stratigraphy and Palaeontology**

(Contact hours -72)

Max. Marks: 75

Time: 3 hours

Group A: (Stratigraphy)

Unit I: General stratigraphy and Precambrian stratigraphy of India

Principles of stratigraphy. Stratigraphic units: Time - units, chrono - stratigraphic units, litho - stratigraphic units and bio-stratigraphic units

Correlation, litho-, bio- and chrono-stratigraphic correlation. Principles of radiometric dating of rocks.
Precambrian rocks of Singhbhum- Orissa, Karnataka, Rajasthan, Meghalaya-Assam, Cuddapah and Vindhyan Super-groups

Unit II: Indian stratigraphy (Phanerozoic eon)

Palaeozoic rocks of Kashmir. Triassic rocks of Spiti valley, Jurassic rocks of Cutch, , Gondwana Super-group of Peninsular India, Deccan traps, Cretaceous rocks of Tiruchirapalli and Narmada valley , Lithostratigraphy of Meghalaya, Siwalik Group, Tertiary rocks of North-East India

Group B: (Palaeontology)

Unit III: General palaeontology:

Scope and subdivisions of palaeontology. Fossils, fossilization and uses of fossils. Micro – palaeontology, types of micro fossils and utility.
A study of the evolutionary trends in trilobites and Equidae. Siwalik mammals of India

Unit IV: Invertebrate fossils and plant fossils:

A general study of the morphological characters and geological distribution of the following- brachiopods, mollusks (bivalves, gastropods and cephalopods), trilobites; graptoloidea, foraminifera and echinoidea.

Idea of Pre-Gondwana flora, Gondwana flora, Post-Gondwana flora of India. A study of the morphological characters and geological distribution of *Glossopteris*, *Gangamopteris*, *Vertebraria*, *Ptilophyllum*.

Reading List

1. Faure, E.(1986) *Isotope Geology*, John Wiley
2. Krishnan, M.S.(1996) *Geology of India and Burma*, CBS
3. Kumar, R.(1996) *Fundamentals of Historical Geology and Stratigraphy of India*, Wiley Eastern
4. Shrock, R.R. and Twenhofel,(1987) *Invertebrate Paleontology*, CBS
5. Wadia, D.N. *Geology of India*,(1983)McMillan
6. Weller, J.M. (1989)*Stratigraphic Principles and Practice*, Universal, New Delhi
7. Woods, H.(1985)*Invertebrate Paleontology*, CBS

Paper: GELH 402(PRACTICAL): Palaeontology and Stratigraphy

(Contact hours: 48)

Max. Marks: 25

Time: 4 hours

1. Stratigraphy

Marks: 4

Study of the rocks from important stratigraphic horizons of the India (Precambrian rocks of Indian Peninsular, Vindhyan Supergroup, North-East India)

2. Palaeontology

Marks: 2 x 5 = 10

Identification and study of the following fossils:

Micraster, Clypeaster, Hemiaster, Terebratula, Rhynchonella, Productus, Spirifer, Nucula, Lima, Pecten, Spondylus, Trigonina, Cardita, Ostrea, Conus, Cypraea, Natica, Cerithium, Murex, Physa, Turritella, Fusus, Voluta, Nautilus, Baculites, Belemnites, Perisphinctes, Ceratites, Zaphrentis, Phacops, Nummulites, Alveolina, Discocyclus, Glossoscolecus, Gangamopteris, Vertebraria and Ptillophyllum.

3. Drawing and labeling of the important fossils as mentioned above.

Marks: 3

Arrangement of different fossils as mentioned above in stratigraphic order.

Marks: 3

4. Laboratory notebook and viva-voce

Marks: 2+3=5

Reading List:

1. Krishnan, M.S(1996) *Geology of India and Burma*, CBS
2. Sen, A.K.(1995) *Laboratory Manual of Geology*, Modern Book agency, Calcutta
3. Woods, H(1985) *Invertebrate Paleontology*, CBS

Group A: (Igneous Petrology)

Unit I: Introduction:

Pressure and temperature domains of igneous processes. Physical properties of magma- temperature, volatile content, viscosity and density. Role of volatile in magmatic crystallization. Processes of magma formation and sources of magma. Salient features controlling ascent of magma. Preliminary ideas on distribution of igneous rocks in continental crust and oceanic crust. Concept of equilibrium and phase rule, Bi-variant field, univariant curve and invariant point. Studies on crystallization of melts in the following systems with particular reference to phase rule: Diopside-Anorthite, Albite-Anorthite, Nepheline-Quartz, Diopside-Albite-Anorthite, and petrogenetic application of these systems.

Unit II: Mineralogy and petrogenesis: :

Origin of some common textures: Porphyritic, ophitic, perthite, spinifex. Mineralogical and textural features of the following rocks: Lamprophyre, kimberlite, nepheline-syenite, tonalite, basalt, pyroxenite and peridotite. Petrogenesis of the following rocks with their distribution in India: Granite, basalt, anorthosite, peridotite, alkaline rocks.

Group B : (Sedimentary and Metamorphic Petrology)

Unit III: Sedimentary Petrology

Elementary ideas on hydraulics of open channel flows. Scalar and vector properties of sediments. Sedimentary facies: Definition, litho- and bio- facies, Walther's law. Salient features of environments of deposition. Statistical analysis of grain size data: Mean, median, mode, standard deviation, skewness and kurtosis.. Heavy minerals and provenance. General petrography of evaporites and volcanoclastics.

Unit IV: Metamorphic Petrology:

Types of metamorphic changes: Mineralogical, textural and chemical. Pressure – temperature limits of metamorphism. Elementary ideas on processes of solid-state transformation: Recrystallization and neo-crystallization. Mineralogical assemblage and textures of the following rocks: Mylonite, migmatite, calc-silicate rocks, eclogite. Metamorphic grade and zones, isograde and iso-reaction grad. Metamorphic facies: Facies classification, P-T fields of different metamorphic facies. Criteria for equilibrium and disequilibrium, phase rule and its application. Regional metamorphism of pelitic rocks, mafic rocks and contact metamorphism of impure limestone. Brief idea of retrograde metamorphism and metamorphic differentiation.

Reading Lists:

1. Best, M.G.(1986) *Igneous and Metamorphic Petrology*, CBS
2. Carmichael, I.; Turner, F. and Verhoogen, J.(1977) *Igneous Petrology*, McGraw Hill
3. Collinson, J.D. and Thompson, D. B. (1989). *Sedimentary Structures*, Unwin Hyman
4. Ehlers, E.G. and Blatt, H.(1987) *Petrology*, CBS Publication New Delhi
5. Hall, A(1987) *Igneous Petrology*, ELBS
6. Hatch, F. Wells, A.K. and Wells, M.K.(1984) *Petrology of Igneous Rocks*, CBS
7. Mason, R.(1978) *Petrology of Metamorphic Rocks*, CBS
8. Pettijohn, F.J.(1984) *Sedimentary Rocks*, CBS
9. Sengupta, S.(1994) *Introduction to Sedimentology*, Oxford and IBH
10. Tucker, M.(1981) *Sedimentary Petrology*, ELBS
11. Turner, F. and Verhoogen, J.(1977) *Igneous and Metamorphic Petrology*, CBS
12. Tyrell, G.H. (1976) *Principles of Petrology*, Asia Publishing House
13. Winkler, H.G.F. (1976) *Petrogenesis of Metamorphic Rocks*, Springer Verlag
14. Yardley, B. (1989) *An Introduction to Metamorphic Petrology*, ELBS
15. Raymond L.A.(2002) *The study of Igneous, Sedimentary and Metamorphic Rocks* McGraw Hill
16. Winter J.D.(1998) *An introduction to Igneous and Metamorphic Petrology*, Prentice Hall

Paper: GELH 502(PRACTICAL): Igneous, Sedimentary and Metamorphic petrology
Max. Marks: 25

(Contact hours: 48)
Time: 4 hours

1. **Igneous petrology:**

Identification of the following rocks in *hand specimens*:

Nepheline syenite, norite, granodiorite, andesite, peridotite, pyroxenite, dunite, anorthosite, aplite.

Marks: $1\frac{1}{2} \times 2 + 5 = 8$

Petrography and petrogenesis of the following rocks in thin sections:

Nepheline syenite, norite, granodiorite, trachyte, peridotite, pyroxenite, dunite, anorthosite.

2. **Sedimentary petrology:**

Identification of the following rocks in *hand specimens*: breccia, conglomerate, greywacke, limestone, shale, sandstone.

Marks: $1\frac{1}{2} \times 1 + 4 + 1 = 6\frac{1}{2}$

Petrography and petrogenesis of the following rocks in thin sections:

Conglomerate, micrite, sparrite, fossiliferous limestone, greywacke, arkose, arenite.

Identification of important heavy minerals in thin sections.

Marks: $1\frac{1}{2} \times 1 + 4 = 5\frac{1}{2}$

3. **Metamorphic petrology:**

Identification of the following rocks in *hand specimens*: granulite, amphibolite, khondolite, charnockite.

Petrography and petrogenesis of the following rocks in thin sections:

Granulite, amphibolite, charnockite, augen-gneiss, chlorite schist.

4. **Laboratory records and viva- voce**

Marks: $2+3=5$

Reading List:

1. Collinson, J.D. and Thompson, D.B.(1989) *Sedimentary Structures*, Unwin Hyman
2. Heinrich, E.(1976) *Microscopic Petrology*, McGraw Hill
3. Moorehouse, W.W.(1985) *A Study of Rocks in Thin Section*, CBS
4. Read, H.H.(1984) *Rutley's Elements of Mineralogy*, CBS
5. Sen, A.K(1995) *Laboratory Manual of Geology*, Modern Book agency, Calcutta
6. Williams H., Turner, F. and Gilbert, C.(1985) *Petrography*, CBS

Group A: (Economic Geology)

Unit I: General

Definition of ore, gangue and tenor.

Processes of formation of economic mineral deposits: Endogenetic processes (Igneous processes: Magmatic concentration, sublimation pegmatitic, pyrometasomatic, hydrothermal, submarine exhalation; Metamorphic processes: Contact metamorphism, dynamo thermal metamorphism, metasomatism); Exogenetic processes (Sedimentary process: Processes associated with weathering and erosion- mechanical concentration, residual concentration, oxidation and supergene enrichment).

Classification of mineral deposits- Lindgren's classification, Bateman's classification, Simple genetic classification.

Metallogenetic provinces and epochs.

Unit-II: Indian economic minerals deposits:

Mineralogy, mode of occurrence, origin, uses and distribution in India of the following: Gold, copper, lead, zinc, aluminum, iron, chromium, manganese, sillimanite, mica, gypsum, limestone, diamond and barite.

Unit III: Petroleum and radioactive minerals:

Definition, mode of occurrence, composition, origin, migration, accumulation, uses of petroleum and its distribution in India with special reference to North- East India.

Mineralogy, mode of occurrence, origin, uses and distribution of Thorium and Uranium deposits of India.

Unit IV: Coal:

Definition, physical and chemical properties, macroscopic and microscopic constitution, fixed carbon, fuel ratio, coke, carbonization, mode of occurrence, origin, types, and uses of coal. Distribution of coal in India.

Reading list:

1. Bateman, A.M. and Jensen, M.L.(1981) *Economic Mineral Deposits*, John Wiley
2. Beavis, F.C.(1985) *Engineering Geology*, Blackwell
3. Bhimasankaram, V.L.S(1990) *Exploration Geophysics*, Association of Exploration Geophysicists, Hyderabad
4. Evans, A.M.(1987) *An Introduction to Ore Geology*, ELBS
5. GSI Misc. Publication no.30, *Geology and Mineral Resources of North-Eastern States*
6. Kaul, I., Bhattacharya, A.K. and Sengupta, S.(1990) *General and Applied Geophysics*, Association of Exploration Geophysicists, Hyderabad
7. Keary, P. and Brooks, M. (1988) *An Introduction to Geophysical Exploration*, ELBS
8. Kesavelu, N.C.(1993) *Engineering Geology*, Momilam India
9. Krishnasamy and Sinha(1988) *Indian Mineral Resources* Oxford and IBH

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Paper: GELH 504 (PRACTICAL) Economic Geology

(Contact hours: 48)

Max. Marks: 25

Time: 4 hours

1. *Economic minerals:*

Marks: $1\frac{1}{2} \times 12 = 18$

Recognition of the following economic minerals in hand specimens:

Chalcopyrite, malachite, azurite, cuprite, pyrite, hematite, magnetite, siderite, limonite, illmenite, stibnite, psilomelane, pyrolusite, braunite, chromite, galena, sphalerite, bauxite, laterite, corundum, sillimanite, kyanite, magnesite, barite, sulphur, calcite, asbestos, muscovite, biotite, fluorite, apatite.

2. *Industrial Minerals:*

Marks: 2

Recognition of the economic minerals used in following industries: cement, refractory, ceramic & glass, iron & steel.

3. *Laboratory records and viva-voce.*

Marks: $2+3=5$

Reading List:

1. Sen, A.K. (2005) *A Handbook of Economic Geology*, Modern Book Agency, Calcutta
2. Sen, A.K. (1995) *Laboratory Manual of Geology*, Modern Book agency, Calcut

Paper: GELH 601(THEORY): Remote Sensing and Hydrogeology

(Contact hours: 72)

Max. Marks: 75

Time: 3 hours

Group A: (Remote Sensing)

Unit I: Physical basis of Remote Sensing and Photogeology

Introduction to remote sensing: Indian efforts, elements and processes of remote sensing.

Electro Magnetic Spectrum; Sensors and its types, Platform and its types.

Elements of aerial photo and satellite imageries: interpretation for geologic purposes: Photo elements and geotechnical elements.

Application of remote sensing in geological sciences.

Unit II: Basic Photogrammetry

Flight lines and geometry of vertical aerial photography; fiducial marks, principal point and conjugate principal point; scale and height measurement on single vertical aerial photographs. Vertical exaggeration. Stereovision and stereoscopes. Mosaics-controlled, semi-controlled and uncontrolled. Annotations.

Aerial photographs and maps; types of aerial photographs; advantages and limitations of aerial photographs,

Geographical Information System (GIS) and Global Positioning System (GPS): Definition, component and uses.

Group B: Hydrogeology

Unit III: Hydrogeology:

Concept of hydrologic cycle.

Definition and origin of ground water, its occurrence and distribution. Water table and piezometric surface. Ground water movement-Darcy's law. Hydrologic properties of rocks - porosity, permeability, specific yield, specific retention, transmissivity and storativity. Aquifers- confined and unconfined aquifers. Springs.

Unit IV: Groundwater exploration and Management:

Basic concepts of ground water survey. Selection of sites for dug and bore wells. Artificial recharge methods of ground water. Groundwater quality and its pollution. Ground water provinces of India.

Reading List:

1. Miller, V.C.(1981) *Photogeology*, McGraw Hill
2. Pandey, S.N (1987) *Principles and Applications of Photo Geology*, New Age, Delhi
3. Price, M. (1985)*Introducing Ground water*, George Allen and Unwin
4. Raghunath, H.M.(1996) *Ground Water*, New Age
5. Ramasamy, S.M (2003)*Remote Sensing in Geology*, Rawat, Jaipur
6. Singh, P.(1999) *Engineering and General Geology*, Kataria and Sons, Delhi
7. Todd, D.K(1986) *Groundwater hydrology*, John Wiley
8. Keller, E.A.(2008)*Environmental Geology*, Oxford
9. Ravi P. Gupta (2002) *Remote Sensing Geology*, Springer
10. Thomas M. Lillesand Ralph W. Kiefer , *Remote Sensing and Image Interpretation*
11. George B. Korte, P.E. *The GIS Book- How to Implement, Manage and Assess the Value of Geographic Information System*
12. M.A. Siddiqui (2005) *Introduction to Geographical Information Systems*
13. Aroygaswamy, R.N.P.(1980) *Mining Geology*, Oxford

Paper: GELH 602(PRACTICAL): Remote Sensing and Hydrogeology

(Contact hours: 48)

Max. Marks: 25

Time: 4 hours

1. Remote Sensing

Study of the aerial photographs with the help of tone, texture, shape & size. Drainage pattern and their interpretation. GPS handling.

Marks: 5 + 5 + 2 = 12

2. Hydrogeology

Drawing of ground water contours and determination of flow direction
Interpretation of groundwater quality maps

Marks: 4 + 4 = 8

3. Laboratory note book and viva-voce

Marks: 2+3=5

Reading List:

1. Pandey, S.N.(1987) *Principles and Applications of Photo Geology*, New Age, Delhi
2. Sen, A.K.(1987) *Laboratory Manual of Geology*, Modern Book agency, Calcutta
3. Todd, D.K.(1986) *Groundwater hydrology*, John Wiley

Paper: GELH 603 (THEORY): Applied Geology (Exploration, Mining and Engineering Geology)

(Contact hours: 72)

Max. Marks: 75

Time: 3 hours

Unit I: Exploration techniques:

Principles of geological exploration. Sampling and its types. Drilling and its types.

Unit II: Geochemical exploration and geophysical methods:

Geochemical exploration and geophysical exploration (gravity, magnetic, electrical, seismic and radiometric methods).

Unit III: Mining geology:

Common mining terms: Exploitation, Development, Shaft and its types, Hanging and foot walls, Adit, Drive and level, Cross cut, Tunnel, Raise and winze, Ore bin, Chute, Stope and its types.

Elementary idea about open cast and underground mining along with advantages and disadvantages. Types of mining methods (glory hole and hydraulic mining for open cast mining and room & pillar and long wall for underground mining)

Unit IV: Engineering geology

Engineering geological properties of rocks and soils. Geological and geotechnical investigation for dams, tunnels and highways. Landslides: causes and mitigation.

Reading list:

1. Beavis, F.C.(1985) *Engineering Geology*, Blackwell
2. Bhimasankaram, V.L.S(1990) *Exploration Geophysics*, Association of Exploration Geophysicists, Hyderabad
3. Evans, A.M.(1987) *An Introduction to Ore Geology*, ELBS
4. GSI Misc. Publication no.30, *Geology and Mineral Resources of North-Eastern States*
5. Kaul, I; Bhattacharya, A.K. and Sengupta, S.(1990) *General and Applied Geophysics*, Association of Exploration Geophysicists, Hyderabad
6. Keary, P. and Brooks, M. (1988) *An Introduction to Geophysical Exploration*, ELBS
7. Kesavelu, N.C.(1993) *Engineering Geology*, Momilam India
8. Krishnasamy and Sinha(1988) *Indian Mineral Resources* Oxford and IBH, New Delhi
9. Arogyaswamy R.N.P.(1997) *Courses in Mining Geology*, Oxford & IBH Publishing Co. New Delhi

Paper: GELH 604 Geological Field work and Field report

Max. Marks: 25

Two field works and field reports are required with reference to petrology, palaeontology, stratigraphy, economic geology and applied geology

1. Field work and field report with reference to petrology and stratigraphy

(Marks: Field work 6+ Field report 4=10)

2. Field work and field report with reference to economic geology and applied geology

(Marks: Field work 6+ field report 4 = 10)

3. Viva-voce:

(Marks: 5)