

॥ अंतरी पेद्यु ज्ञानज्यात ॥

**NOTH MAHARASHTRA UNIVERSITY,
JALGAON**

**THIRD YEAR B. Sc.
GEOLOGY SYLLABUS**

(Being implemented from June, 2004)

In continuity with the second year B. Sc. Syllabus

Instruction

Two tutorials and two seminars
shall be conducted per paper,
excluding the regular teaching schedule.

॥ अंतरी पेठव् इतनज्योत ॥

NOTH MAHARASHTRA UNIVERSITY, JALGAON
THIRD YEAR B. Sc. GEOLOGY SYLLABUS
(being implemented from June 2004)
In continuity with the second year B. Sc. Syllabus)

Course Structure: There will be twelve theory papers of 50 marks each and three practical courses of 100 mark each. Six theory papers will be taught in term I and the other six theory papers in term II. The examination will be held at the end the year.

PAPER	TERM	COURSE TITLE
I	FIRST	STRUCTURAL GEOLOGY
	SECOND	REMOTE SENSING & GEOMORPHOLOGY
II	FIRST	INDIAN STRATIGRAPHY
	SECOND	ENERGY RESOURCES
III	FIRST	MINERALOGY & OPTICS
	SECOND	PETROLOGY
IV	FIRST	SEDIMENTOLOGY
	SECOND	ECONOMIC GEOLOGY
V	FIRST	GEOTECHNIQUE
	SECOND	LAND AND WATER MANAGEMENT
VI	FIRST	HYDROGEOLOGY
	SECOND	ENVIRONMENTAL GEOLOGY

Practical

Paper.	Course Title	Marks
Practical - I	Mineralogy and Igneous Petrology	100
Practical - II	Sedimentary and Metamorphic Petrology and Paleontology	100
Practical III	Structural & Environmental Geology and Techniques in Geology	100

Paper –I Structural Geology, Remote sensing and Geomorphology

Term-I Structural Geology

Unit	Topic	No. of lectures
Unit 1 :	Introduction :	[2]
a)	Definition of structural geology and its relation with other branches of geology.	
b)	Objectives/uses/value of structural geology and the importance of structural data in geological investigations.	
Unit 2 :	Mechanical principles :	[6]
a)	Force : definition, representation, unit and types (balanced and unbalanced forces)	
b)	Composition and resolution of forces.	
c)	Lithostatic / Hydrostatic pressure, different types of forces.	
d)	Stress and strain : concept and definition.	
e)	Stress-strain diagram : elastic and plastic deformation of brittle and ductile substances, elastic limit and strength of rocks	
f)	Rock deformation.	
g)	Factors controlling rock deformation : pressure, temperature, time, solutions, anisotropy and inhomogeneity of rocks.	
Unit 3 :	Plastic deformation.	[4]
a)	Plastic deformation : definition, examples	
b)	Mechanisms : Intergranular and intragranular movements.	
c)	Recrystallisation with and without change in shape, Reicke's principle.	
Unit 4 :	Fold :	[13]
1.	Definition, part of a fold, characters of : anticline, syncline, symmetrical, asymmetrical, overturned, recumbent, isoclinal, chevron, box, fan, monocline, structural terrace, open, close, parallel, similar, tight, suprataneous, drag, de'collement, and plunging folds.	
2.	Classification of folds : geometrical and genetic	
3.	Recognition of fold in the field :	
1.	Direct observation	
2.	Attitude of beds	
3.	Aerial map pattern	
4.	Topographic characters	
5.	Drilling and mining data	
4.	Mechanics of folding.	
a)	Study of the following genetic types of folding :	
1.	Flexure / flexure slip folding.	
2.	Flow folding.	
3.	Shear folding	
b)	Ultimate causes of folding.	

- Unit 5 : Mechanics of rupturing** [8]
- Force : Definition of tensional, compression, couple and torsional forces.
 - Tension and shear fractures.
 - Complexity of the mechanics of rupturing
 - Rupturing under different forces (tension, compression, couple and torsion)
 - Stress ellipsoid : concept and relation with rupture.
 - Strain ellipsoid : concept and relation with rupture

- Unit 6 : Fault:** [16]
- Movement along fault, slip, shift and separation along fault,
 - Classification of fault Geometrical and genetical.
 - Mechanics of faulting .
 - Faults developed along tension fractures and along shear fractures.
 - Direction of displacement
 - Stress and faulting :
 - geometry and type of faults in relation to stress.
 - Mechanics of gravity, thrust (high and low angle) and strike slip faults.
 - Use of the strain ellipsoid in recognizing movements along faults.
 - Principles of the mechanics of faulting.
 - Application of the principles of the mechanics of faulting to artificially produced gravity and thrust faults.
 - Outlining the principles in mechanics of faulting in terms of the axes of the strain ellipsoid.
 - Application of these principles to specific cases of faulting.

- Unit 7 : Joints :** [4]
Definition, Geometrical and genetic classification.

Weightage :

- Unit I : 0%
- Unit II : 10%
- Unit III : 15%
- Unit IV : 30%
- Unit V : 10%
- Unit VI : 30%
- Unit VII : 5%

Paper -I
Term-II Remote sensing and Geomorphology

Unit	Topic	No. of lectures
1.	Planning of Aerial Photography for achieving stereoscopic coverage of the area. Photographic flight mission.	[3]
2.	Types of aerial photos on the basis of orientation of camera axis of camera axis lens system and special properties of films, printers and photographic equipments.	[2]
3.	types of photography with respect to spectral characteristics and their suitability.	[1]
4.	Scale and geometrical characteristics of photographs.	[1]
5.	Discrepancies occurring in aerial photographs and their effects-tilt, tip, drift, crab and gap	[1]
6.	Comparison between an aerial photograph and a map	[1]
7.	Marginal information on an aerial photograph. Relief, displacement and vertical exaggeration and factors controlling them, of aerial photograph.	[3]
8.	Photo recognition elements used for interpretation of black and white aerial photographs. Mirror and pocket stereoscope	[2]
9.	Photo interpretation of igneous, sedimentary and metamorphic rocks.	[5]
10.	Photo interpretation of geological structures	[2]
11.	Use of satellite imageries in natural resource assessment. Types of lineaments, Mapping of lineaments and their insignificance. Preparation of rosette diagram And its recognition.	[5]
12.	Geomorphology and its relation with physical geology. Some fundamental concepts in geomorphology. Role of climate, lithology, structure and tectonic landscape development. Geomorphic processes, weathering and resultant landforms, topography of folded and faulted structures, slope landforms, drainage patterns and their significance.	[10]
13.	Description and classification of landforms formed by the following geological agents: wind, river, glacier, sea. Karst topography.	[8]
14.	Geomorphometry: altimetry and slope analysis, drainage basin and network characteristics (dendritic, trellis rectangular, radial, annular, parallel, irregular) stream ordering, drainage density, bifurcation ratio and stream frequency. Relationship between basin area & stream length. Drainage network development. Major drainage patterns of India.	[8]

Weightage :

- Unit I to V : 20%
- Unit VI to VIII : 15%
- Unit IX to X : 15%

Paper-II Indian Stratigraphy & Energy Resources

Term-1 Indian stratigraphy

Introduction, Geographical & Geological distribution, Stratigraphic character, classification, lithology, structure, palaeontology & Economic important of following Super Group

Unit	Topic	No. of lectures
1.	a. Archeans & Early proterozoics	[16]
	i) Archeans of Karnataka	
	ii) Archeans of Bihar & Jharkhand	
	iii) Archeans of Rajasthan (BGC, Aravallis & Delhi)	
	iv) Archeans of M.P., Chattisgarh & Maharashtra(Saussar, Sakoli & Chilpighat)	
	b. Proterozoic sedimentary formations & equivalents	[8]
	i) Cuddapah Super Group	
	ii) Vindhyan Super Group	
2.	Gondwana Super Group	[6]
3.	Introduction to Himalayan Geology	[5]
	Lower, Middle & Upper Himalayan formation. Palaeozoic sequence of Spiti	
4.	Mesozoic formation of India	[10]
	i) Jurassic of Cutch	
	ii) Cretaceous of Trichinapoly	
	iii) Deccan Trap	
	iv) Study of Inter, Intra, Lametas, Bagh	
5.	Tertiary of Assam	[2]
6.	Siwalik Group	[2]
7.	The Karewas of Kashmir & Laterites in India	[3]

Weightage :

Unit I	: 60%
Unit II	: 10%
Unit III	: 5%
Unit IV	: 10%
Unit V	: 5%
Unit VI	: 5%
Unit VII	: 5%

Term II- Energy Resources

- 1. Coal Geology-**
Origin, Composition, varieties, scheme of classification. Rank & grade.
Distribution of coal in India. [20]
- 2. Petroleum Geology-**
Origin, Migration, Accumulation, Petroleum basin of India. Exploration for oil
composition of crude oil and gas. [20]
- 3. Geothermal Energy.**
Introduction , distribution of Geothermal resources in India. [5]
- 4. Nuclear minerals-**
Mineralogy, uses and distribution of U & Th [4]
- 5. Polymetallic nodules.** [3]

Weightage :

Unit I	: 60%
Unit II	: 10%
Unit III	: 5%
Unit IV	: 10%
Unit V	: 5%
Unit VI	: 5%
Unit VII	: 5%

Paper -III Mineralogy, Optics and Petrology(Igneous & Metamorphic)

Term I Mineralogy and Optics

Unit	Topic	No. of lectures
1.	Mineral Groups	[5]
I :	Study of following mineral groups with respect to their distinguishing characters, paragenesis, alteration products, and importance :	
i)	Pyroxenes (Enstatite – Ferrosilite, Diopside – Hedenbergite, Augite – Ferro Augite.)	
ii)	Amphibole (Cation distribution in amphibole minerals, Tremolite – Actinolite, Hornblende)	[5]
ii)	Feldspars (alkali feldspar, Perthites – Types and formation, Plagioclase feldspar), Introduction to feldspathoids.	[5]
iv)	Olivine Group	[3]

v) Garnet Group	[3]
vi) Mica Group	[3]
2. Mineral Groups II:	
Study of following mineral groups w.r.t. silicate structure, chemical, physical, optical characters and occurrence	
i) Zeolites	[2]
ii) Aluminosilicate	[2]
3. Optics :	
i) Reflection , Refraction, Double refraction and Birefringence.	[3]
ii) Refractive Index and Relief, Becke line and its uses.	[3]
iii) Twinkling.	[1]
iv) Refractometer – Smith's and Jelly's Refractometer	[4]
v) Colour And Pleochroism Pleochroic Formula of Common minerals.	[2]
vi) Phenomenon and types of extinction.	[2]
vii) Uniaxial and Biaxial minerals.	[2]
viii) Uniaxial and Bi axial Indicatrices	[2]
Interference figure – explanation of central uniaxial interference figure and its sign when the section is perpendicular to optic axis.	
ix) Explanation of Biaxial interference figure perpendicular to Acute bisectrix and its sign.	[3]

Weightage :

- Unit 1 : 45%
- Unit 2 : 10%
- Unit 3 : 45%

**Term II : Petrology
(Igneous and Metamorphic)**

Unit	Topic	No. of lectures
I. Igneous petrology :		
a)	Igneous rocks and the solid Earth Igneous rocks in a broad tectonic frame.	[2]
b)	Crust and Mantle Composition and recycling.	[1]
c)	Melting of magma - Temperature Pressure conditions, generation of magma in their source region, boundary conditions	[2]
d)	Classification of Igneous rocks – CIPW and IUGS	[4]

- e) Reaction series and its interpretation. [2]
- f) Evolution of Magma : Crystal fractionation, F0 -Fa and F0 - Silica systems , Separation mechanism. [13]
- i) Gravity settling.
 - ii) Flow differentiation
 - iii) Flow crystallization
 - iv) Gas streaming
 - v) Liquid immiscibility (Silicate - Silicate)
 - vi) Contamination - Assimilation by melting and without melting . Significance of contamination.
- g) Mixing of magmas (Similar and dissimilar)Role of volatile constituents melting and crystallization of Ternary system (Di - Ab - An) and Basaltic magma. [4]
- h) Petrographic provenances , rock kindreds or associations. [2]

2. Metamorphic rocks :

- a) Fabric of metamorphic rocks - Relict features, crystalloblastic series, foliated fabric, Hornfelsic fabric, cataclastic and granulitic fabric. [3]
- b) Classification and Nomenclature of metamorphic rocks based on fabric composition (ACF and AKF), genesis, grade and facies. [2]
- c) Metamorphic reaction and facies - facies classification of metamorphic rocks, metamorphic mineral facies, interpretation and representation of mineral assemblage. [3]
- d) Stability of minerals - Zeolite, Chlorite, Muscovite, Garnet, Staurolite, Pyroxene, Amphibole, Talc, Biotite, Wollastonite, Carbonates. [3]
- e) Facies classification of metamorphic rocks. [2]
- f) Thermal metamorphism - Metamorphic Aureole, Thermal metamorphism of impure calcareous rocks, Introduction to Hornblende - Hornfels facies and Pyroxene hornfels facies. [3]
- g) Regional metamorphism - Barrovian zones, Introduction to Facies of regional metamorphism - and its mineral assemblage. [2]
- h) Metasomatism - definition , principle types, textural and chemical evidences. [2]

Definition of following terms :

[2]

Uralitisation, Chloritisation, Saussuritisation, Albitisation, Tourmalination, Scapolitisation, Flaser rock, Megmatitisation, Kaolinisation, Schorl rock, Granulite, Leptites, Charnokites, Eclogites, Migmatites, Greisening, Analcitisation, Lit- Par -lit gneiss, Palingenesis, Anatexis.

Weightage :

Unit 1 : 60% (a to e : 20% ; f : 30% ; g and h: 10%)

Unit 2 : 40%

Paper- IV Sedimentology
Term-I

1. **Introduction :** [2]
a) Relation of sedimentology to stratigraphy, geological sciences
b) History of sedimentology [3]
2. **Origin of Sediments :-**
Introduction
Fabric
Composition
General classification [10]
3. **Texture of sediments :**
a) size, size terms, sedimentary aggregates, grade scale,
b) roundness, flatness, sphericity
c) surface texture
d) fabric & frame work
i. concept
ii. elements & analysis
iii. packing
iv. crystalline texture [10]
4. **Granulometric analysis** [10]
a) size frequency and distribution
b) Graphic parameters of size frequency
c) Moment measures
d) size & depositional proves
e) size & environmental analysis
5. **Provenance** [8]
a) Definition & concept
b) Mineral stability
c) Mobility of oxides
d) Mineral & Textural maturity
e) Heavy mineral zones
f) Weathering potential index
7. **Environmental analysis** [10]
1. Concept
2. Parameters
a) physical b) chemical
3. Classification of environment
4. Introduction to facies

- | | |
|--|-----|
| 8. Dispersal of sediments- selective abrasion, selective sorting, progressive dilution | [3] |
| 9. Diagenesis | [3] |
| 10. Classification of Sandstone by Dott | [1] |
| 11. Classification of Limestone by Dulham | [1] |
| 12. Classification of Conglomerates & Shale | [1] |

Weightage :

Unit I & II	5%
Unit III	20%
Unit IV	20%
Unit V	20%
Unit VI	8%
Unit VII	8%
Unit VIII	58%
Unit IX :	5%
Unit X :	5%

Term -II Ore Geology

- | | |
|---|------|
| 1. Definitions : | [1] |
| 2. Classifications : | [1] |
| 3. Metallogenic Epochs and Provinces : | [1] |
| 4. Controls of Ore Localization : | [1] |
| 5. Tectonics and Mineralisation : | [1] |
| 6. Mineral Economics : | [2] |
| 7. Forms, structures & textures of ore deposits : | [5] |
| 8. Ore genetic processes : | [40] |
| 1. Magmatic deposit | |
| 2. Sublimation | |
| 3. Contact-metasomatism | |
| 4. Hydrothermal deposits | |
| 5. Residual concentration | |
| 6. Chemical concentrations | |
| 7. Sedimentation | |
| 8. Evaporation | |
| 9. Submarine, exhalative process | |
| 10. Oxidation & supergene enrichment | |
| 11. Metamorphism | |

Weightage :

Unit I to V 10%

Unit VI & VII 10%

Unit VIII 80%

Paper V
Term-I Geotechniques:
(Mineral exploration + mining + Engineering)

Unit	Topic	No. of lectures
1.	Mineral exploration techniques : Prospecting for minerals, drilling, sampling and assaying methods for exploration; geophysical, agrochemical geobotanical techniques.	[20]
2.	Mining : Principles of ore search and ore appraisal guides: physiographical, mineralogical, feature patterns. Contacts and folds, stratigraphic and lithologic guides. Mining methods: open cast and underground.	[10]
3.	Engineering Techniques : A) Engineering properties of rocks, building stones and road metals and their characteristics B) Geotechnical investigation for selection of dam structure, tunnels, alignment, Bridge, roadways. C) Mass movement, types of slope movements, stability of slopes	[22]

Weightage :

Unit I 25%

Unit II 25%

Unit III 50%

Term II Land and Water Management

1.	Introduction	[10]
	a) Water and land as important resources,	
	b) Degradation of resources,	
	c) Causes and effects,	
	d) Need for management	

- b) Agricultural land use pattern.
- c) Land productivity, capability and capacity.
- e) Degradation of land: causes and effects.
- f) The problems of waste land, wet land, khar land, dry land, desertification with special reference to India. Reclamation of waste lands.
- g) The methods of soil conservation.
 - i) Use of remote sensing in land management.

3. Water related issues and management: [22]

Classification of sources of surface and groundwater.

Exploration and exploitation of water resources

Concepts of water balance and its significance in water use policy.

Irrigation system of irrigation, their merits and demerits.

Consequences of unskilled irrigation practices water logging, soil salinity, causes, consequences and management measures.

Planning, execution and after effects of man made reservoirs.

Utilization of water resources for energy production, drinking, navigation, industries and agriculture.

Water resources management strategy: Concept of watershed, classification of watersheds, watershed characteristics, and multidisciplinary approach to watershed management.

Weightage

Unit I	:	20%
Unit II	:	40%
Unit III	:	40%

**Paper VI : Groundwater Geology & Environmental Geology
Term I : Groundwater**

1. Introduction: [5]

Definition of terms like Hydrology, Geohydrology and Hydrogeology, Scope of groundwater. Distribution of water on earth's surface with percentage. Utilization of groundwater. Groundwater in the Hydrologic cycle.

- Occurrence of Groundwater :** [10]
 Origin of Groundwater, Rocks Properties affecting groundwater. Vertical distribution of groundwater. Geologic formations as Aquifers (Aquiclude, Aquifuge, Aquitard), Types of Aquifers. Geologic & structural factors controlling formation of springs
- Groundwater Movement :** [5]
 Darcy's Law, Tracing groundwater Movement
- Groundwater-level & fluctuations :** [6]
 Secular and seasonal variations, stream flow & groundwater levels, fluctuations due to evapotranspiration. Fluctuations due to Atmospheric pressure, Tides, external loads and earthquakes.
- Groundwater Investigation :** [9]
 (List of methods/ and VES methods in detail), Groundwater explorations)List of programmes, Groundwater development and management
- Artificial Recharge of GW :** [10]
 Surface, Subsurface recharging methods used in Deccan traps (Maharashtra)
- Groundwater Quality :** [7]
 Physio-chemical properties Drinking water standards, irrigation water standards, Industrial water Standards as per WHO

Weightage :

Unit I	: 10%
Unit II	: 20%
Unit III	: 10%
Unit IV	: 10%
Unit V	: 18%
Unit VI	: 25%
Unit VII	: 12%

Term II Environmental Geology

- 1. Introduction:** [8]
 Fundamental concepts, Objectives and scope of environmental geology & global environmental issues (Green-house effect, ozone hole Co₂ increase)

2. **Natural hazards and their environmental impacts:** [12]
- Natural hazards their zoning and risk assessment.
 - Causes , classification, assessment, production and prevention of floods, earthquakes, volcanoes, subsidence and mass movements.
 - Coastal hazards: Cyclones, tsunamis, Shoreline & Sea level changes and their environmental impact and recovery from disasters.
3. **Environmental Pollution:** [12]
- Water and Air Pollution: Sources, types of pollutants, effects, standards and control measures. Case history one each.
 - Solid-Wastes: Sources, disposal methods, effects, recycling techniques, case history.
4. **Mining & Environment:** [8]
Resources & reserves. Impact of mining, recycling and conservation of mineral resources.
5. **Medical Geology:** [12]
Geological environment and human health. Trace elements (fluorides, arsenic, iron, iodine, zinc) and their effects on health.

Weightage :

Unit I	: 15%
Unit II	: 25%
Unit III	: 5%
Unit IV	: 5%
Unit V	: 20%

Practical I Mineralogy and Igneous Petrology
Mineralogy

Study of following minerals for its physical properties, uses, occurrences and locality of

Copper, Silver, Gold, Iron, Sulphur, Graphite, Galena, Sphalerite, Pyrrhotite, Chalcopyrite, Orpiment, Realgar, Pyrite, Fluorite, Halite, Hematite, Magnetite, Pyrolusite, Quartz, Chalcedony, Quartz druse, Massive quartz, Agate (Onyx) varieties , Rock crystal, Smoky quartz (Rauchtopaz), Morion (black variety), Citrine (lemon yellow variety), Milky quartz, Psilomelane, Calcite, Magnetite, Dolomite, Malachite, Barite, Gypsum, Apatite, Olivine, Anadolucite, Sillimanite, Biotite, Muscovite, Staurolite, Garnet, Epidote, Beryl, Tourmaline, Augite, Diopside, Tremolite, Actinolite, Hornblende, Wollastonite,

Hess calculations for Pyroxene

Mineral calculation for Feldspar

Optics : Optical properties of atleast 15 minerals

Uniaxial and biaxial interference figures

Economic Geology

Preparation of an ore-mineral map of India for the following :

Iron, manganese, chromium, copper, lead, zinc and aluminium, petroliferous basins in India,

IGNEOUS PETROLOGY :

- 1 Study of the following megascopic rocks with regard to their texture, mineral composition, colour index, identification and classification :**
Identification of the rocks and their uses using IUGS classification
 - a) Varieties of granites,
 - b) basalts (alkaline and olivine basalt),
 - c) gabbro (anorthosite, troctolite, norite),
 - d) Felsite,
 - e) Peridotite,
 - f) Lamprophyre,
 - g) Carbonatite.
 - h) dacite
 - i) porphyries
- 2 Thin section study of the following rocks with regard to their texture, mineral composition, identification and classification.**
 - a) granite
 - b) olivine basalt
 - c) norite
 - d) troctolite
 - e) anorthosite
 - f) phonolite
 - g) lamprophyre
 - h) peridotite
 - i) trachyte
 - j) andesite
 - k) nepheline syenite
- 3 Description, genesis and significance of the following megascopic textures / structures : granitic, porphyritic, graphic, ropy, glassy, flow, columnar, vesicular and amygdaloidal.**
- 4 Description, genesis and significance of the following textures / structures seen in thin sections :**
 - a) equigranular
 - b) inequigranular
 - c) porphyritic
 - d) intergranular
 - f) intersertal
 - g) poikilitic
 - h) ophitic-subophitic
 - i) graphic
 - j) myrmekitic
 - k) reaction rim
 - l) expansion cracks
 - m) flow structure

5 Based on the given chemical data, calculate the -

- i) Differentiation Index
- ii) CIPW saturated rocks

Practical Paper II : Sedimentary and Metamorphic Petrology, Paleontology and Indian Stratigraphy

SEDIMENTARY PETROLOGY

1. Study of the following megascopic rocks with regard to their texture / structures, mineral composition, identification and classification, giving their sedimentological significance.

conglomerate, breccia, grit, arkose, laterite, bauxite, speckled sandstone, and varieties of sandstone, ferruginous and carbonaceous shale, limestone (chemical and organic) calc tuffa., calcrite

2. Thin section study of the following sedimentary rocks showing authigenic minerals, rock fragments and heavy minerals.

sandstone, arkose, greywacke, nummulitic and oolitic limestones, varieties of limestones

3. Interpretation of the sedimentary structures giving their geological significance.

- | | |
|---------------------------------------|------------------------------------|
| 1) sandstone showing parallel bedding | 2) sandstone showing cross bedding |
| 3) graded bedding | 4) ripple marks |
| 5) mud cracks / sun cracks | 6) lamination |
| 7) tracks and trails | |

4. Plotting and calculation of the sieve analysis data and environmental interpretation.

5. Shape analysis

METAMORPHIC PETROLOGY

6 Study of the following megascopic rocks with regard to their texture / structure, mineral composition, colour, type of metamorphism, grade, facies and the original rock :

Slate, phyllite, chlorite schist, mica (biotite) schist, hornblende schist, staurolite schist, kyanite schist, mica gneiss, hornblende gneiss, sillimanite gneiss, augen gneiss, eclogite, charnokite, fuschite quartzite, banded haematite quartzite, marbles (white, pink, black, serpentine and dolomite varieties) schorl, mica-garnet schist.

7. Study of the thin sections of the following rocks with regard to their texture structure, mineral composition, colour, type of metamorphism, grade, facies and the original rock :

chlorite schist, staurolite schist, kyanite schist, mica schist, mica gneiss, sillimanite gneiss, augen gneiss, eclogite, charnockite, khondalite and banded haematite quartzite mica-garnet schist, marble, quartzite, slate

8. Study of Microscopic structures and their origin
Granulose, Schistose, Gneissose, Porphyroblastic, Idioblastic

Palaeontology

9. Study of 15 animal fossils / shells and 5 plant fossils.

Indian Stratigraphy

10. Preparation of maps showing the geographical distribution of the following stratigraphic units of India.

- Dharwar Supergroup
- Orissa - Singhbhum belt
- Aravalli Supergroup
- Cuddapah Supergroup and its equivalents
- Vindhyan Supergroup and its equivalents
- Palaeozoic of Spiti
- Gondwana Supergroup
- Jurassic of Kutch, Cretaceous of Trichinopoly, Bagh Beds
- Deccan Traps
- Siwaliks
- Tertiaries

11. Assignment on any one topic of interest (may or may not be from the syllabus must use Internet etc for information collection).

Practical III Structural & Environmental Geology and Techniques in Geology

STRUCTURAL MAPS AND PROBLEMS

1. Geological Maps :

i) Description of the topography and geology of the map.

ii) Drawing of a vertical section along a given direction.

(maps with unconformity, vertical - (strike / dip / oblique), vertical dyke, non-plunging fold).

2. **Completion of geological map outcrop :** Given the
 - i) junction of a bed on the base map,
 - ii) three non-collinear points, where the bed outcrops.
(maps may include unconformity, vertical / inclined dyke and fault.

3. **Structural Problems :**
 - I a : Given the hill slope and altitudes of the exposures of the top and bottom of the bed on the hill slopes and the true thickness of the bed, to find the vertical thickness, true dip direction and amount of true dip of the bed.
 - I b : Given the true thickness / vertical thickness / width of outcrop of the bed and the true dip of the bed, to find the apparent dip amount, apparent thickness and apparent width of outcrop of the bed, in the given vertical section, parallel to the apparent dip direction of the bed.

 - II : **Three point problems :** Given the subsurface drill hole data (location, elevation and depth of the bed) for three non-co-linear points. To find :
 - a) Strike, true dip direction and true dip amount of the bed,

 - III : **Problems using stereographic projections :**
 - 1) strike, true dip and apparent dip of a bed :
 - a) Given the strike and true dip of the bed, to find the apparent dip amount for the given apparent dip direction/s.
 - b) Given the strike and true dip of the bed , to find the direction/s for the given amount/s of apparent dip.
 - c) Given the apparent dip amount in two different directions, to find the strike direction, true dip direction and the true dip amount of the bed.

Environmental Geology and Techniques in Geology

- 1 **Determining the following :**
 - a) pH of water and soil,
 - b) electrical conductivity of water and soil,
 - c) Total alkalinity of water.
 - d) Chlorites in water and soil,
 - e) Calcium in water and soil,
 - f) Total hardness of water.
 - g) Phosphates in water and soil,
 - h) Sodium in water and soil,
 - i) Potassium in water and soil,
 - j) Nitrogen in the soil,
 - k) Organic carbon in the soil,
 - l) Presentation of the first two practical reports with variation diagrams,

- m) Land Capability Index.
- n) preparation of solution for the rocks and soil samples.

2. **Vertical Electrical Sounding for Groundwater**

3. **Field Geology :**

Field work for about two weeks in an area of geological interest, anywhere in India. Systematic collection of geological samples, data collection and preparation of a geological field report.

Local monthly tour reports from : 1. Sampling along rivers for sedimentary data. 2. rock collection around the local area for thin section studies. 3. groundwater inventories data from a local village including watershed studies. 4 study of dykes including its thin section and rock analysis. 5. geology specific related to local needs.

4. **Geomorphology :**

Drainage analysis and plotting of basin boundaries. Morphometric analysis (Horton and Strahler methods).

5. **DEMO PRACTICAL : Remote sensing :**

- a) Problems related to 1) scale of the photographs and 2) relief displacement
- b) Tracing of the drainage of an area with the help of aerial photographs.
- c) To identify the geomorphology of an area from aerial photographs.
- d) Lithological and structural interpretation of aerial photographs.

6. **DEMO PRACTICAL on Computer applications in Geology**

Reference Books:

- 1 Singhbhum - Orissa Iron Ore Craton - Sinha Roy
2. Geological Society of India - : Special Publication
3. Geology of Karnataka - : Radhakrishna B. P.
4. Geological Society of India - : Special Publication
5. Geology of Maharashtra - : G. G. Deshpande, G Society Spl Publication
6. Purana Basins of India - G Society Spl Publication
7. Geology of Western and Central India - GSI Spl Publication
8. Stratigraphy of Lesser Himalaya - : K. S. Valdiya
8. A Geological Time Scale - : Brian Harland et. al.,
9. Stratigraphy of India and Burma - M. S. Krishnan
- 10 Fundamentals of Historical geology and Stratigraphy of India : Ravindrakumar
11. Precambrian Stratigraphy - V. J. Gupta
12. Green stone Belt of South India - . Janardhan

Reference Books :

1. Igneous Petrology : Antony Hall
2. Igneous Petrology : McBirney
3. Igneous and Metamorphic Petrology : Myron Best
4. Principles of Petrology : G.W. Tyrrell
5. Igneous, Metamorphic & Sedimentary Petrology : Ehler & Blatt
6. Igneous & Metamorphic Petrology : Turner & Verhoogen
7. Sedimentary Petrology : Pettijohn
8. Sedimentology : Leeder
9. Introduction to Sedimentology : Sengupta
10. Metamorphism : Alfred Harker
11. Petrography of the Igneous and Metamorphic rocks of India : S.C.Chatterjee
12. Metamorphic Petrology, Mineralogy and Field aspects : Turner
13. Metamorphism and Metamorphic belts : Miyashiro
14. Petrology (Igneous, Sedimentary, Metamorphic) : Blatt & Tracy
15. Stratigraphy and Sedimentation : Krumbein and Sloss
16. Principles of Sedimentology : Fridman and Sanders.
17. Applied Sedimentology : R. K. Sukhatankar

Reference Books :

- 1) Structural Geology : M. P. Billings
- 2) Techniques of Modern Structural Geology : Ramsay and Huber
- 3) Structural Geology : De Sitter
- 4) Structural Geology : Ramsay
- 5) Structural Geology for Petroleum Geologists : Russel
- 6) Folding and fracturing of rocks : Ramsay J G
- 7) Structural and Tectonic Principles : Badgley
- 8) Analysis of metamorphic tectonics : Turner and Weiss
- 9) Introduction to Geology : Sander
- 10) Structural Geology : Denis
- 11) Modern Structural Geology (Vol. 1 and 2) : Ramsay and Huber
- 12) Analysis of geological structures : Price N. J. and Cosgrove
- 13) Mechanics in Structural Geology : Bayly B
- 14) Structural Geology : Fundamentals of Modern Developments :Eds : Pergamon Press
- 15) Structural Geology of rocks and region : Davis
- 16) An outline of Structural Geology : Hobbs B E, Means W. D & Williams P. F.
- 17) Structure and Tectonics : Badgley P C

Reference Books for Geotectonics

- 1) General Geology : V. Radhakrishnan
- 2) Plate Tectonics and crustal evolution : Condie
- 3) Aspects of Tectonics : K. S. Valdiya

- 4) Tectonics : E. M. Moores and R.J. Twiss
- 5) Geotectonics : V. V. Belousov
- 6) Geochemistry : Mason
- 7) Physical Geology : A. Homes
- 8) Global Tectonics : Keray P and Vine F. J
- 9) Our evolving planet : Bergen, Alma Mater Fortag
- 10) Dynamic Himalaya : K. S. Valdiya
- 11) Geomorphology and global Tectonics : Summerfield M A

Reference Books :

1. Economic Mineral Deposits : Bateman
2. Mining Geology : Mckenstry
3. Ore deposits of India : Gokhale Rao
4. India's Mineral Resources : Krishnaswami
5. Indian Minerals : D.N.Wadia
6. Industrial Minerals : Deb
7. Geology of the Industrial Rocks and Minerals : Robert L. Bates
8. Mineral Economics : R.K.Sinha., N. L. Sharma
9. National Mineral Policy : G.O.I. Publications
10. Various Legislations : G.O.I Publications
11. I.B.M. Publications : (available at IBM, Nagpur)
12. Environmental Geology : K. S. Valdiya
13. Environmental Geology : Edward A. Keller
14. Mining and Environment : Bharat B Dhar
15. Ground water Hydrology : Todd D K
16. Groundwater assessment, development and management : Karanth K R
17. Groundwater : Raghunath H M
18. Mineral Economics : Sinha R K
19. Environmental Chemistry : A K De

Reference Books :

- 1) Manuel of Field Geology : Compton, R.J.
- 2) Field Geology : Lahee
- 3) Introduction to Geomorphology : Kale, V. S. & Gupta, A.G
- 4) Principles of Geomorphology : Easterbook, Don J.
- 5) Geomorphology : Chorley, R.J, Schumm,S.A, Sugden,D.E.
- 6) Fundamentals of Geomorphology : Rice. R.J.
- 7) Geomorphology and Hydrology : Small,R.J.
- 8) Principles of Geomorphology : Thornbury
- 9) Soils and Landforms : Gerrard,A.J.
- 10) Soil geography and land-use Foth,H.D.and Schafer,J.W.
- 11) Principles of Engineering Geology : Krynine and Judd
- 12) Remote Sensing and Image Interpretation : Kiefer and Lilleesand

- 13) Principles of Remote Sensing : Curran P. J.
- 14 Remote Sensing - Principles and Interpretation : Sabins F.F.
- 15) Text-book on Remote-Sensing Resources and Management : Agarwal, C.S.
- 16) Principles and Applications of Photogeology : Pandey, S. N.
- 17) Geographical Information Systems and Science : Longley, P.A.; Goodchild M.F.; Maguire, D.J; Rhind, D.W.
- 18) Introduction to Integrated Geo - Information Management : Cassettari, Seppi.
- 19) Geographical Information Systems and their Socio-economic applications : Martin David.
- 20) Hydrological measurements for watershed research : Wasi uliah, S.K. Gupta and Dalal S.S.
- 20) Watershed management in India : J.V.S. Murthy
- 21) Groundwater: Hydrology :D.K. Todd
- 22) Groundwater : H. Raghunath
- 23) Groundwater Assessment, development & management : K.R. Karnath
- 24) Groundwater Surveys and investigation : Gautam Mahajan

