

# **MAHATMA GANDHI UNIVERSITY**

## **B. Sc. GEOLOGY PROGRAM**

### **(MODEL I)**

#### **SCHEME AND SYLLABUS**

**(UNDER CHOICE BASED CREDIT AND SEMESTER  
SYSTEM)**

**PREPARED BY BOARD OF STUDIES AND  
FACULTY OF SCIENCE (UG)**

**MAHATMA GANDHI UNIVERSITY**

**PRIYADARSHINI HILLS P. O.**

**KOTTAYAM, KERALA 686 560, INDIA**

**[www.mgu.ac.in](http://www.mgu.ac.in)**

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\* Geology is offered only as Core Course for B.Sc. Geology Program and Vocational Core for B.Sc. Geology and Water Management Program

## **1. Acknowledgement**

The support and guidance from various eminent personalities made this restructuring of B. Sc. Geology syllabus under CBCS 2017 is a success. I place on record my gratitude to the Hon. Vice Chancellor and Pro - Vice Chancellor of Mahatma Gandhi University, Kottayam for the initiative and guidance in restructuring the syllabus. I express profound gratitude to the members of the University Syndicate and Academic council for fruitful steering of the program.

I also thankful to members of Faculty of Science and Board of Studies in Geology for their support and guidance. Administrative support from the Registrar and his office is thankfully acknowledged. Thanks to Academic and the Finance Sections for prompt response to solve technical snags.

I also grateful to all teachers who participated in the workshop organized by the University for restructuring the syllabus. I extend my gratitude to all professionals, academicians and other stakeholders who gave valuable suggestions in this regard.

Dean - Faculty of Science

Mahatma Gandhi University Kottayam

## **2. Introduction**

The Mahatma Gandhi University resolved to introduce Choice Based Credit System (CBCS) from the Academic Year 2017-18 onwards in tune with directives of the University Grants Commission to implement uniform grading system in universities. The primary aim of CBCS is to facilitate mobility of students across institutions within the country and abroad. The draft syllabus was modified by incorporating suggestions from participants in the workshop.

## **3. Aims and Objectives**

The B. Sc. Geology programme is designed to:

1. Provide basic knowledge of different branches of Geology at graduate level.
2. Understand the Earth and its various processes, both external and internal that shape it.
3. Assess the Earth as source of natural resources such as water, minerals, rocks, ores, coal and oil and devise ways and means to extract these for benefit of mankind.
4. Realize the threat of natural disasters and and work out ways to mitigate its effects.
5. Recognize the Earth as an environmental realm and chalk out plans for conserving its resources.

**MAHATMA GANDHI UNIVERSITY**  
**SCHEME OF B.Sc. GEOLOGY PROGRAM (2017 ADMISSION ONWARDS)**  
**FIRST SEMESTER (Duration: 18 weeks)**

Sl. No	Course Category	Title with Course Code		Contact Hours/week	Credits	Mark	
						External	Internal
1	Common Course I: <b>English</b>	Paper I <i>Course Code:</i>		5	4	80	20
2	Common Course I: <b>English</b>	Paper II <i>Course Code:</i>		4	3	80	20
3	Common Course II: <b>Additional Language</b>	Paper I <i>Course Code:</i>		4	4	80	20
4	Complimentary I <b>Mathematics</b>	Mathematics I:  <i>Course Code:</i>		4	3	80	20
5	Complimentary II <b>Physics OR Chemistry</b> <i>(any one to be opted at the time of admission)</i>	Chemistry: Theory	Chemistry I:  <i>Course Code:</i>	2	2	80	20
		Physics: Theory	Physics I:  <i>Course Code:</i>				
		Chemistry: Practical	Chemistry Practical	2	--	--	--
		Physics: Practical	Physics Practical				
6	Core: <b>Geology</b>	Geology: Theory	<b>Methodology and Perspectives in Geology</b> <i>Course Code: GL1CRT01</i>	2	2	80	20
		Geology: Practical	<b>Physical Geology and Geomorphology</b> <i>(Practical sessions in First Semester; Practical examination along with that of Second Semester i.e. GL2CRP01)</i>	2	--	--	--
<b>Total for First Semester</b>				<b>Hours/Week</b> 25	<b>Credits</b> 18	<b>Ext</b> 480	<b>Int</b> 120
						<b>Total: 600</b>	

**MAHATMA GANDHI UNIVERSITY**  
**SCHEME OF B.Sc. GEOLOGY PROGRAM (2017 ADMISSION ONWARDS)**  
**SECOND SEMESTER (Duration: 18 weeks)**

Sl. No	Course Category	Title with Course Code		Contact Hours/ week	Credits	Mark	
						External	Internal
1	Common Course I: <b>English</b>	Paper III: <i>Course Code:</i>		5	4	80	20
2	Common Course II: <b>English</b>	Paper IV: <i>Course Code:</i>		4	3	80	20
3	Common Course II: <b>Additional Language</b>	Paper II <i>Course Code:</i>		4	4	80	20
4	Complimentary I <b>Mathematics</b>	Mathematics II: <i>Course Code:</i>		4	3	80	20
5	Complimentary II <b>Physics OR Chemistry</b> <i>(any one to be opted at the time of admission)</i>	Chemistry: Theory	Chemistry II: <i>Course Code:</i>	2	2	80	20
		Physics: Theory	Physics II: <i>Course Code:</i>				
		Chemistry Practical	Chemistry Practical	2	2	80	20
		Physics: Practical	Physics Practical				
6	Core <b>Geology</b>	Geology: Theory	<b>Geomorphology</b> <i>Course Code: GL2CRT02</i>	2	2	80	20
		Geology: Practical	<b>Physical Geology and Geomorphology</b> <i>(Practical Examination inclusive of First Semester topics)</i> <i>Course Code: GL2CRP01</i>	2	2	80	20
<b>Total for Second Semester</b>				<b>Hours/ Week 25</b>	<b>Credits: 22</b>	<b>Ext 640</b>	<b>Int 160</b>
						<b>Total: 800</b>	

**MAHATMA GANDHI UNIVERSITY**  
**SCHEME OF B.Sc. GEOLOGY PROGRAM (2017 ADMISSION ONWARDS)**  
**THIRD SEMESTER (Duration: 18 weeks)**

Sl. No	Course Category	Title with Course Code		Contact Hours/week	Credits	Mark	
						External	Internal
1	Common Course I: <b>English</b>	English V: <i>Course Code:</i>		5	4	80	20
2	Common Course II: <b>Additional Language</b>	Paper III <i>Course Code:</i>		5	4	80	20
3	Complimentary I <b>Mathematics</b>	Mathematics III: <i>Course Code:</i>		5	4	80	20
4	Complimentary II <b>Physics OR Chemistry</b> <i>(any one to be opted at the time of admission)</i>	Chemistry: Theory	Chemistry – III: <i>Course Code:</i>	3	3	80	20
		Physics: Theory	Physics III: <i>Course Code:</i>				
		Chemistry: Practical	Chemistry Practical	2	--	--	--
		Physics: Practical	Physics Practical				
		<i>Practical sessions in First Semester; Practical examination along with that of Fourth Semester)</i>					
5	Core: <b>Geology</b>	Core: Theory	<b>Crystallography and Physical Mineralogy</b> <i>Course Code: GL3CRT03</i>	3	2	80	20
		Core: Practical	<b>Crystallography and Mineralogy</b> <i>(Practical sessions in Third Semester; Practical examination along with that of Fourth Semester i.e. GL4CRP02)</i>	2	--	--	--
<b>Total for Third Semester</b>				<b>Hours/Week 25</b>	<b>Credits 17</b>	<b>Ext 400</b>	<b>Int 100</b>
						<b>Total: 500</b>	

**MAHATMA GANDHI UNIVERSITY**  
**SCHEME OF B.Sc. GEOLOGY PROGRAM (2017 ADMISSION ONWARDS)**  
**FOURTH SEMESTER (Duration: 18 weeks)**

Sl. No	Course Category	Title with Course Code	Contact Hours/week	Credits	Mark	
					External	Internal
1	Common Course I: <b>English</b>	English VI <i>Course Code:</i>	5	4	80	20
2	Common Course II: <b>Additional Language</b>	Paper IV <i>Course Code:</i>	5	4	80	20
3	Complimentary I <b>Mathematics</b>	Mathematics IV: <i>Course Code:</i>	5	4	80	20
4	Complimentary II <b>Physics OR Chemistry</b>  <i>(any one to be opted at the time of admission)</i>	Chemistry:Theory Chemistry IV: <i>Course Code:</i>	3	3	80	20
		Physics:Theory Physics IV: <i>Course Code:</i>				
		Chemistry:Practical Chemistry Practical II <i>(Examination inclusive of Third Semester topics)</i> <i>Course Code:</i>	2	2	80	20
		Physics:Practical Physics Practical II <i>(Examination inclusive of Third Semester topics)</i> <i>Course Code:</i>				
5	Core: <b>Geology</b>	Geology:Theory <b>Mineralogy</b> <i>Course Code: GL4CRT04</i>	3	2	80	20
		Geology:Practical <b>Crystallography and Mineralogy</b> <i>Course Code: GL4CRP02</i> <i>(Examination inclusive of Third Semester topics)</i>	2	2	80	20
<b>Total for Fourth Semester</b>			<b>Hours/Week</b> 25	<b>Credits</b> 21	<b>Ext</b> 560	<b>Int</b> 140
					<b>Total: 700</b>	



**MAHATMA GANDHI UNIVERSITY**  
**SCHEME OF B.Sc. GEOLOGY PROGRAM (2017 ADMISSION ONWARDS)**  
**FIFTH SEMESTER (Duration: 18 weeks)**

Sl. No.	Course Category	Title with Course Code	Contact Hours/Week	Credits	Marks	
					External	Internal
1	Core: <b>Geology</b> Theory	Stratigraphy and Sedimentary Petrology <i>Course Code: GL5CRT05</i>	4	4	80	20
2		Igneous Petrology <i>Course Code: GL5CRT06</i>	4	4	80	20
3		Metamorphic Petrology and Geochemistry <i>Course Code: GL5CRT07</i>	4	4	80	20
4		Environmental Geology <i>Course Code: GL5CRT08</i>	4	4	80	20
5	Open Course Theory (Other stream)	Understanding the Earth <i>Course Code: GL5OPT01</i>	4	3	80	20
6	Core: <b>Geology</b> Practical	Petrology ( <i>Practical sessions in Fifth Semester; Practical examination in Sixth semester ie., GL6CRP03</i> )	5	-	-	-
<b>Total for Fifth Semester</b>			<b>Hours/Week</b> 25	<b>Credits</b> 19	<b>Ext. 400</b>	<b>Int. 100</b>
					<b>Total: 500</b>	

**MAHATMA GANDHI UNIVERSITY**  
**SCHEME OF B.Sc. GEOLOGY PROGRAM (2017 ADMISSION ONWARDS**  
**SIXTH SEMESTER (Duration: 18 weeks)**

Sl. No.	Course Category	Title with Course Code	Contact Hours/Week	Credits	Marks	
					External	Internal
1	Core: <b>Geology</b> Theory	Structural Geology Course Code: GL6CRT09	4	4	80	20
2		Phanerozoic Stratigraphy of India Course Code: GL6CRT10	4	3	80	20
3		Palaeontology Course Code: GL6CRT11	4	3	80	20
4		Economic Geology Course Code: GL6CRT12	4	4	80	20
5	Core: <b>Choice Based</b> Optional: Theory (any one to be opted in Sixth Semester)	Geotectonics and Precambrian Stratigraphy of India Course Code: GL6CBT01	4	3	80	20
		Marine Geology Course Code: GL6CBT02				
		Remote Sensing and GIS Course Code: GL6CBT03				
6	Core: <b>Geology</b> Practical	Petrology ( <i>Practical sessions in Fifth Semester; Practical examination in Sixth Semester ie. GL6CRP03</i> )	See syllabus of Fifth Semester	2	80	20
7		Structural Geology, Economic Geology & Paleontology Course Code: GL6CRP04	5	2	80	20
8	Study Tour-cum-Geological Field Work (Geological field work and specimen collection) Mark awarded for report of geological field work done during study tour and display of geological specimens collected during field work Course Code: GL6STP01		*See note given below	1	80	20
9	Project Report Course Code: GL6PRP01		--	1	80	20
<b>Total for sixth Semester</b>			<b>Hours/Week</b> 25	<b>Credits</b> 23	<b>Ext. 720</b>	<b>Int. 180</b>
<b>Total: 900</b>						

**\*NOTE:** Three study tours for geological field work, including specimen collection and submission of tour reports, are integral and mandatory component of the program. These study tours are to be scheduled during:

**(1) First or Second semester**, with emphasis on physical Geology and Geomorphology for 5 to 8 days within Kerala and adjacent states.

**(2) Third or Fourth semester**, with emphasis on Mineralogy and mineral deposits for 5 to 8 days within South Indian states.

**(3) Fifth or Sixth semester**, with emphasis on Petrology, Stratigraphy, Structural Geology and Economic Geology, including visit to Quarries, Mines and Academic/Research institutes for 10 to 15 days in different parts of the India

Collective report of these study tours should be submitted in the Sixth Semester, and specimens collected during the field works should be displayed at the time of practical examination in Sixth Semester. Marks and Credits for these will be given in the Sixth Semester mark sheet.

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# MAHATMA GANDHI UNIVERSITY

First Semester B. Sc. Geology (Model I)

First Semester B. Sc. Geology and Water Management (UGC Vocational-Model III)

SYLLABUS OF CORE COURSE – Theory 1 (Common Syllabus to both Programs)

Semester	Hours/Week	Hours /Semester	Exam	Mark			Credit
				Internal	External	Total	
I	2 Hours	36 Hours	3 Hours				2
				20	80	100	

## GL1CRT01: METHODOLOGY AND PERSPECTIVES IN GEOLOGY

**Unit I** Geosciences- introduction to various branches - Physical Geology, Geomorphology, Mineralogy, Structural Geology, Petrology, Global tectonics, Palaeontology, Stratigraphy, Engineering Geology, Marine Geology, Geochemistry, Applied Geophysics, Geochemistry, Hydrogeology, Meteorology, Oceanography, Remote Sensing, Environmental Geology, Disaster Management and Economic Geology. The concept of rock cycle. **(6 Hrs)**

**Unit II** Theories of origin of Earth. Earth - Shape, size, age and rotation. Internal structure of earth; crust, mantle, core; density and chemical composition; major seismic discontinuities. Basic Concepts of Geological Time Scale. **(6 Hrs)**

**Unit III** Endogenic processes: Plate Tectonics. Continental drift hypothesis and Sea floor spreading- evidences. Lithospheric plates, types of plate boundaries, plate movements and associated geological features, mid-ocean ridges, rift valleys, trenches, transform faults, island arcs, volcanic arcs, Benioff zones, mantle plumes, aseismic ridges. Mountains- Types and origin. Isostasy. **(10 Hrs)**

**Unit IV** Volcanoes and their classification. Volcanic eruption- types, products, effects. Global distribution of volcanoes. **(6 Hrs)**

**Unit V** Earthquakes - types and causes, propagation of seismic waves, focus and epicenter, elastic rebound theory, seismograph and seismogram. Intensity and magnitude of earthquakes, effect of earthquakes, seismic belts of the world, Earthquake hazard zonation of India. **(8 Hrs)**

### References

1. Arthur Holmes, Principles of Physical Geology (Edinburgh: Thomas Nelson and Sons, 1944 and New York: Ronald Press, 1945).
2. Strahler, Arthur Newell, The Earth Sciences, New York, Harper & Row
3. Carlson, Plummer and Mc Geary: Physical Geology– Earth revealed, Published by Mc Graw - Hill, 2006
4. Carlson, Plummer and Mc Geary: Introductory Geology – Earth Revealed, Published by McGraw -Hill.
5. Press and Siever, Understanding Earth, W. H. Freeman; 4 edition, 2003
6. Ernst W. G., Earth Systems: Processes and Issues, Cambridge University Press, 2000.
7. Frederick K. Lutgens, Essentials of Geology (11th Edition) Pearson Prentice Hall, Pearson Education, Inc. New Jersey 2012

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**MAHATMA GANDHI UNIVERSITY**  
 First Semester B. Sc. Geology (Model I)  
 First Semester B. Sc. Geology and Water Management (UGC Vocational- Model III)  
**SYLLABUS OF CORE COURSE – Practical 1 (Common Syllabus to both Programs)**

Semester	Hours/Week	Hours /Semester	Exam	Mark			Credit
				Interna	External	Total	
I	2 Hours	36 Hours	Exam in II Sem	--	--	--	Nil

**(Note: Practical sessions in First semester; Practical examination in Second semester)**

**GL2CRP01: PHYSICAL GEOLOGY**

Clinometer and Brunton Compass- Map orientation, Elements of map reading, fore bearing and back bearing.

Topographic sheets: scale, legends- types and categories, interpretation of contours and identification of natural landscape elements, scale measurements, slope calculation. Determination of latitude and longitude from toposheets, measurement of distance between two points.

Construct sketches, cutaway section of earth and earth spheres, Plate boundaries.

Determination of epicentre of an earthquake.

Stereoscope and stereo-pairs – identification of landforms.

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# MAHATMA GANDHI UNIVERSITY

Second Semester B. Sc. Geology (Model I)

Second Semester B. Sc. Geology and Water Management (UGC Vocational- Model III)

## SYLLABUS OF CORE COURSE – Theory 2 (Common Syllabus to both Programs)

Semester	Hours/Week	Hours /Semester	Exam	Mark			Credits
				Internal	External	Total	
II	2 Hours	36Hours	3 hours	20	80	100	2

### GL2CRT02: GEOMORPHOLOGY

**Unit I** Exogenic Processes: Weathering - factors, types and products of weathering. Physical and chemical processes. Soil, factors affecting soil formation and soil profile. Laterite. Mass wasting - types, causes and control. **(6 Hrs)**

**Unit II** Geological agents. Cycle of erosion. Streams – Stream as a geological agent. Drainage basin and drainage pattern. Stream erosion, transportation and deposition. Development and evolution of fluvial landforms- different stages of fluvial evolution- youth, mature and old age stages. **(8 Hrs)**

**Unit III** Hydrologic cycle. Origin and occurrence of groundwater. Water table, types of aquifers. Groundwater as a geological agent- erosional and depositional features. Karst topography, stalagmite, stalactite, caves. **(6 Hrs)**

**Unit IV** Oceans- salinity of ocean water. Waves, currents and tides. Coastal erosion, transportation and deposition. Classification of coastlines and coastal morphology. Eustatic sea level changes. Physiographic features of ocean floor: continental shelf, continental slope, continental rise, submarine canyons, abyssal plains, MORs, deep sea trenches, guyots, seamounts. Coral reefs- types, their formation and distribution. **(8 Hrs)**

**Unit V** Glaciers– Formation, movement and morphology. Types of glaciers. Erosion, transportation and deposition by glaciers. Glacial landforms. Global warming and its effects on glaciers. Geological action of winds. Landforms of Aeolian origin. **(8 Hrs)**

### References

1. Ahamed E. (1972) Coastal Geomorphology of India. Orient Longman, New Delhi.
2. Thornbury W. D. (1968). Principles of Geomorphology, Wiley.
3. Plummer Carlson, Mc Geary (2003).Physical Geology. McGraw–Hill.
4. Weisberg J, and Parish, H. (1974). Introductory Oceanography. McGraw Hill.
5. Arthur Holmes, Principles of Physical Geology (Edinburgh: Thomas Nelson and Sons, 1944 and New York: Ronald Press, 1945.
6. Bloom A, Geomorphology– A Systematic analysis of Late Cenozoic Landforms (Third edition) Wavel and Press Inc.
7. Kale Vishwas S, Gupta. Introduction to Geomorphology, Orient Black Swan (2000)
8. Sparks B. W. Geomorphology, Longmans (1969)

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# MAHATMA GANDHI UNIVERSITY

Second Semester B. Sc. Geology (Model I)

Second Semester B. Sc. Geology and Water Management (UGC Vocational- Model III)

SYLLABUS OF CORE COURSE– Practical 1 (Common Syllabus to both Programs)

## Core Practical 1: GL2CRP01 PHYSICAL GEOLOGY AND GEOMORPHOLOGY

Semester	Hours/Week	Hours /Semester	Exam	Mark			Credit
				Internal	External	Total	
I	2 Hours	36 Hours	3 Hours				2
I				20	80	100	

### Part A: PHYSICAL GEOLOGY

Note: See syllabus of First semester Core Practical ‘Physical Geology’. Practical sessions conducted in First Semester. Practical examination conducted as combined single examination as **Physical Geology and Geomorphology** in Second Semester.

### Part B: GEOMORPHOLOGY

Study of toposheets to identify different drainage pattern and its illustration.

Delineation of drainage basins and identification of stream order in toposheets and their illustration.

Identification and representation of different landforms in toposheets.

Schematic representation of evolution of fluvial landform through youth, mature and old stages

Diagrammatic representation of evolution of meandering stream, hydrologic cycle, drainage network and sand dunes.

Preparation of thematic maps (drainage, contour, landuse, landforms, slope) from toposheets.

Morphometric analysis of drainage basins- stream ordering, drainage frequency, drainage density, bifurcation ration and relief ratio.

Preparation of profile from contour maps and topo sheets

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# MAHATMA GANDHI UNIVERSITY

## Third Semester B. Sc. Geology (Model I)

### Third Semester B.Sc. Geology and Water Management (UGC Vocational- Model III)

#### SYLLABUS OF CORE COURSE– Theory 3 (Common Syllabus to both Programs)

Semester	Hours/Week	Hours /Semester	Exam	Mark			Credits
				Internal	External	Total	
III	3 Hours	54 Hours	3 hours	20	80	100	2

### GL3CRT03: CRYSTALLOGRAPHY AND PHYSICAL MINERALOGY

**Unit I** Significance of crystallography in mineralogy. Elements of crystallography: crystalline state and crystals. Morphology of crystals, faces, edges, vertex, forms and zones. Crystal angles– plane angles, interfacial angles and solid angles; Contact Goniometer, Law of Constancy of Interfacial Angles. External symmetry elements in crystals. Crystallographic axes: choice of axes, labeling and orientation. Classification of crystals into systems and classes. Nomenclature of crystal faces: intercepts, parameters, unit face, Weiss notation, Miller indices. Law of crystal indices, axial ratio. Brief study of holohedral, hemihedral, hemimorphic and enantiomorphic forms. **(14 hrs)**

**Unit II** Systematic crystallography: The study of symmetry, simple forms and combinations of the following crystal classes.  
Isometric system- Normal, tetrahedral, pyritohedral and plagioclinic classes.  
Tetragonal system- Normal, tripyramidal and sphenoidal classes. **(10 hrs)**

**Unit III** Hexagonal system- Hexagonal Division: Normal, tripyramidal, trapezohedral classes. Rhombohedral Division: Rhombohedral, trirhombohedral and trapezohedral classes. Orthorhombic system- Normal, hemimorphic and sphenoidal classes. **(10 hrs)**

**Unit IV** Monoclinic system- Normal class. Triclinic system- Normal class.  
Twinning in crystals- Twin laws, elements of twinning, twinaxis, twin plane, composition plane and important examples of twinning. Brief study of morphological imperfections in crystals.  
Basic concepts of spherical and stereographic projections in crystallography, Wulff net, projection of symmetry elements of Isometric system Normal Class. **(10 hrs)**

**Unit V** Mineral- definition of Mineral and Mineraloid, scope and aim of Mineralogy. Physical mineralogy: physical properties of minerals- form, habit, cleavage, fracture, color, diaphaneity, luminescence, fluorescence, phosphorescence, play of colours, luster, streak, hardness, specific gravity. Electrical, magnetic and radioactive properties of minerals. **(10 hrs)**

#### References

1. Dana: A text book of Mineralogy- Asia Publishing House.
2. Phillips: An Introduction to Crystallography– Longmans Green
3. Read: Rutley's elements of mineralogy- Thomas Murby
4. Mason and Berry: Elements of Mineralogy - Freeman
5. Klein and Hurlbut– Manual of Mineralogy – John Wiley

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# MAHATMA GANDHI UNIVERSITY

Third Semester B. Sc. Geology (Model I)

Third Semester B. Sc. Geology and Water Management (UGC Vocational- Model III)

SYLLABUS OF CORE COURSE – Practical 2 (Common Syllabus to both Programs)

Semester	Hours/Week	Hours /Semester	Exam	Mark			Credit
				Internal	External	Total	
III	2 Hours	36 Hours	Exam in IV Sem	--	--	--	Nil

**(Note: Practical sessions in Third semester; Practical examination in Fourth semester)**

## GL4CRP02: CRYSTALLOGRAPHY AND MINERALOGY

Drawing of symmetry elements of normal classes of all systems. Identification and description of the following crystal models.

Isometric system: Galena, Garnet, Spinel, Magnetite, Fluorite, Sphalerite, Tetrahedrite, Pyrite and Cuprite.

Tetragonal system: Zircon, Cassiterite, Rutile, Apophyllite, Wulfenite, Chalcocopyrite.

Hexagonal system: Beryl, beta quartz, Calcite, Tourmaline, Alpha quartz.

Orthorhombic system: Barite, Olivine, Topaz, Sulphur, Staurolite.

Monoclinic system: Gypsum, Orthoclase, Augite, Hornblende.

Triclinic: Axinite, Albite, Kyanite.

Twin crystals: Spinel, Fluorite, Rutile, Calcite, Quartz, Staurolite, Aragonite, Gypsum, Augite, Orthoclase, Albite.

Determination of physical properties of minerals- form, habit, cleavage, fracture, color, luster, streak, hardness and specific gravity.

### GUIDE LINES FOR PRACTICAL EXAMINATION- QUESTION PAPER

#### CRYSTALLOGRAPHY AND MINERALOGY

1. Identification of crystal models and write the symmetry elements
2. Identification of crystal models and write the forms present
3. Write the face symbols and Miller indices of crystal models
4. Identification of type of twinning in crystal models
5. Identification of form/habit present
6. Identification of crystal system of minerals
7. Identification of type of cleavage and/or fracture
8. Identification of luster
9. Identification of color and streak
10. Identification of most important distinguishing physical properties

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# MAHATMA GANDHI UNIVERSITY

Fourth Semester B. Sc. Geology (Model I)

Fourth Semester B. Sc. Geology and Water Management (UGC Vocational- Model III)

## SYLLABUS OF CORE COURSE – Theory 4 (Common syllabus to both Programs)

Semester	Hours/Week	Hours /Semester	Exam	Mark			Credits
				Internal	External	Total	
IV	3 Hours	54 Hours	3 hours	20	80	100	2

### GL4CRT04: MINERALOGY

**Unit I Optical Mineralogy:** Ordinary and polarized light, polarization of light, refractive index, critical angle and total internal reflection. Polarization by reflection, absorption, refraction. Double refraction, construction of Nicol prism. Isotropic and anisotropic substances. Petrological microscope-parts and functions. Optical accessories- mica plate, gypsum plate and quartz wedge. Birefringence, uniaxial and biaxial minerals, optic sign, relief, pleochroism, interference colour and its order, extinction. Basic description of indicatrix. **(15 hrs)**

**Unit II Chemical Mineralogy:** Polymorphism, isomorphism, pseudomorphism, solid solution and exsolution in minerals. **(3 hrs)**

**Unit III Descriptive Mineralogy:** Classification of minerals. Rock forming and ore forming minerals. Silicates- Structure and classification of silicate minerals. Physical, chemical and optical properties of the following: olivines, garnets, pyroxenes amphiboles, micas, feldspars, feldspathoids, quartz. **(14 hrs)**

**Unit IV** Systematic study of andalusite, sillimanite, kyanite, epidote family, beryl, cordierite, tourmaline, clay minerals, zeolite group, calcite and dolomite. **(8 hrs)**

**Unit V** Systematic study of the important non-silicate minerals- diamond, graphite, sulphur, gold, silver, copper, realgar, orpiment, stibnite, molybdenite, cinnabar, sphalerite, galena, chalcopyrite, pyrite, magnetite, hematite, marcasite, barite, gypsum, halite, fluorite, corundum, cuprite, chromite, rutile, cassiterite, ilmenite, monazite, psilomelane, pyrolusite, goethite, limonite, bauxite, aragonite, magnesite, malachite and azurite. **(14 hrs)**

### References

1. Dana- A textbook of mineralogy– Asia Publishing House, Wiley.
2. Read- Rutley's elements of mineralogy–Thomas Murby & Co.
3. Mason and Berry- Elements of Mineralogy–W. H. Freeman & Co.
4. Deer, Howie and Zussman- An introduction to rock forming minerals. Longmans.
5. Berry, Mason, Dietrich - Mineralogy, CBS Publication
6. Klein and Hurlbut–Manual of Mineralogy, John Wiley & Sons
7. Winchel and Winchel- Optical Mineralogy
8. William D. Nesse- Introduction to Mineralogy, Oxford University Press.

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# MAHATMA GANDHI UNIVERSITY

Fourth Semester B. Sc. Geology (Model I)

Fourth Semester B. Sc. Geology and Water Management (UGC Vocational-Model III)

## SYLLABUS OF CORE COURSE– Practical 2 (Common Syllabus to two Programs)

Semester	Hours/Week	Hours /Semester	Exam	Mark			Credit
				Internal	External	Total	
IV	2 Hours	36 Hours	3 hours	20	80	100	2

### GL4CRP02: CRYSTALLOGRAPHY AND MINERALOGY

#### PART A: CRYSTALLOGRAPHY

Note: See syllabus of Third semester Core Practical ‘Crystallography and Physical Mineralogy. Practical sessions conducted in Third Semester. Practical examination conducted as combined single examination as **Crystallography and Mineralogy** in Fourth Semester.

#### PART B: MINERALOGY

##### Megascopic study and identification of following minerals:

Quartz, smoky quartz, milky quartz, amethyst, chalcedony, agate, jasper, chert, opal, orthoclase, microcline, plagioclase, perthite, nephelene, leucite, enstatite, bronzite, hyperthene, diopside, augite, wollastonite, anthophyllite, tremolite, actinolite, hornblende, olivine, serpentine, muscovite, biotite, vermiculite, phlogopite, chlorite, epidote, garnet, natrolite, stilbite, apophyllite, talc, gypsum, apatite, steatite, andalusite, kyanite, sillimanite, stauroilite, cordierite, apatite, beryl, topaz, calcite, dolomite, tourmaline, zircon, fluorite, magnetite, hematite, chromite, sphalerite, psilomelane, pyrolusite, graphite, corundum.

(14 hrs)

##### Microscopic study of following minerals:

Quartz, microcline, orthoclase, albite, oligoclase, labradorite, nephelene, leucite, enstatite, hypersthene, augite, diopside, hornblende, tremolite, actinolite, anthophyllite, biotite, muscovite, olivine, epidote, diopside, garnet, chlorite, cordierite, andalusite, sillimanite, kyanite, stauroilite, calcite, apatite, zircon, tourmaline.

(22 hrs)

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# MAHATMA GANDHI UNIVERSITY

Fifth Semester B. Sc. Geology (Model I)

Fifth Semester B. Sc. Geology and Water Management (UGC Vocational - Model III)

## SYLLABUS OF CORE COURSE – Theory 5 (Common Syllabus to both Programs)

Semester	Hours/Week	Hours /Semester	Exam	Mark			Credits
				Internal	External	Total	
V	4 Hours	72 Hours	3 hours	20	80	100	4

### GL5CRT05: STRATIGRAPHY AND SEDIMENTARY PETROLOGY

**Unit I** Definition and scope. Brief study of the guiding principles/laws of Stratigraphy (Principles of uniformitarianism; superposition; cross-cutting relationships; original horizontality; truncation; included fragments; and faunal succession). Concept of stratum, its delineation and general nomenclature.

Concept of facies: lithofacies and biofacies. Concept of breaks in stratigraphic records: Unconformities, diastems, hiatus - overlap and offlap. **(15 hrs)**

**Unit II** Concept of geological column and geological time scale. Principles of lithostratigraphy, biostratigraphy and chronostratigraphy and hierarchy of their units. Principles and methods of local and regional correlation. **(15 hrs)**

**Unit III** Origin of sediments. Diagenesis- Compaction, cementation, authigenesis, recrystallization and replacement. Classification of sedimentary rocks– Clastic and non-clastic rocks. Clastic texture-concept of size, Udden-Wentworth and Phi scale scheme. Grain shape, morphology and fabric. Non-clastic texture – different types of crystalline texture. Brief study of the following: Primary, secondary and organic structures. **(15 hrs)**

**Unit IV** Categorization of mechanical rocks: Argillaceous, arenaceous and rudaceous rocks. Introduction to the following: sandstone, shale, conglomerate and breccia. **(12 hrs)**

**Unit V** Introduction to limestone, Classification of limestone– Folk and Dunham scheme. Brief study of the following chemical and biochemical sedimentary rocks: Calcareous, ferruginous, siliceous, phosphatic and evaporates. **(15 hrs)**

### References

1. Dunbar & Rogers - Principles of Stratigraphy. Willey.
2. Krumbein & Sloss - Stratigraphy and Sedimentation. Freeman.
3. Tyrrel - Principles of Petrology, Asia Publishing House.
4. Huang - Petrology, MC Graw Hill.
5. Pettijhon - Sedimentary Rocks, Harper & Bros.
6. Harker - Petrology for Students, Cambridge.
7. Folk – Sedimentology, Hemphils
8. Greensmith - Sedimentary Petrology

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# MAHATMA GANDHI UNIVERSITY

Fifth Semester B. Sc. Geology (Model I)

Fifth Semester B. Sc. Geology and Water Management (UGC Vocational- Model III)  
SYLLABUS OF CORE COURSE – Theory 6 (Common Syllabus to both Programs)

Semester	Hours/Week	Hours /Semester	Exam	Mark			Credits
				Internal	External	Total	
V	4 Hours	72 Hours	3 hours	20	80	100	4

## GL5CRT06: IGNEOUS PETROLOGY

**Unit I** Rock- definition, types, rock cycle, plutonic, hypabyssal and volcanic igneous rocks. Origin of magma; primary and parental magmas. Cooling history of igneous rocks, melting and crystallization. Bowen's reaction series. Study of following binary systems: Diopside-Anorthite (Eutectic), Albite-anorthite (solid solution), Forsterite-silica (Incongruent), Albite-orthoclase (solvus).

(12 hrs)

**Unit II** Petrotectonic settings, partial melting and magma generation (mid oceanic ridges and subduction zones only), Diversity of igneous rocks- magmatic differentiation process, fractional crystallization, liquid immiscibility and assimilation/contamination.

(16 hrs)

**Unit III** Forms of Intrusive igneous rocks: Concordant forms- sill, laccolith, lopolith and phaccolith. Discordant forms - dykes, cone sheets, volcanic neck, ring dyke, batholiths, stocks, bosses and bysmaliths. Forms of extrusive igneous rocks: lava flows, pyroclastic deposits - agglomerate, lapilli, volcanic ash and pumice.

(14 hrs)

**Unit IV** Igneous structures: Vesicular and amygdaloidal structures, blocky lava, ropy lava, pillow structure, flow structure, sheet joints, mural jointing, and columnar jointing. Textures: definition and description; Crystallinity- crystallites, microlites, devitrification; Granularity- absolute and relative grain size; Shapes of crystals; Mutual relations- Equigranular textures: allotriomorphic, hypidimorphic, Panidiomorphic, Inequigranular textures: porphyritic and poikilitic textures, Intergrowth texture- perthite, antiperthite, graphic, vermicular textures, Overgrowth textures- orbicular structure, Reaction textures- coronas, Directive textures – trachytic texture, spherulitic structure and perlitic fracture.

(16 hrs)

**Unit V** Classification: bases of classification – texture, mineralogy and chemistry. Classification based on mineralogy – felsic and mafic minerals, mode, colour index and IUGS classification - QAP classification of plutonic & volcanic rocks and ultramafic rock classification.

Chemical classification – Based on silica saturation and based on alkali & silica (brief introduction of alkalic, subalkalic, calc-alkalic and tholeiitic groups only) – Total alkali vs silica classification for volcanic rocks. A short account of CIPW norm and normative minerals.

Texture, mineralogy, classification, occurrence and origin of granites and basalts. Brief petrographic character of common igneous rocks- syenite, diorite, gabbro, andesite, rhyolite, pegmatites, lamprophyres, carbonatite, dunite, peridotite, anorthosite and kimberlite.

(14 hrs)

## References

1. Tyrrell: Principles of Petrology. Chapman and Hall Ltd., London.
2. Bowen: The Evolution of the Igneous Rocks. Dover publication, Inc, New York.
3. Barth: Theoretical Petrology. Wiley.
4. Walstrom: Theoretical Igneous Petrology, Wiley.
5. Turner and Verhoogen: Igneous and Metamorphic Petrology. Mc Graw Hill.
6. Hatch and Wells: Petrology of Igneous Rocks. Thomas Murby & Wells, M.K. (Publ.)
7. Johannesen: Descriptive Petrography of Igneous Rocks, Vols. I to IV. Allied Pacific.
8. Wilson: Igneous Petrogenesis. Unwin Hyman Inc., USA.
9. John D. Winter (2012) Introduction to Igneous and metamorphic Petrology

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# MAHATMA GANDHI UNIVERSITY

Fifth Semester B. Sc. Geology (Model I)

Fifth Semester B. Sc. Geology and Water Management (UGC Vocational- Model III)

## SYLLABUS OF CORE COURSE – Theory 7 (Common Syllabus to two Programs)

Semester	Hours/Week	Hours/ Semester	Exam	Mark			Credits
				Internal	External	Total	
V	4 Hours	72 Hours	3 Hours	20	80	100	4

### GL5CRT07: METAMORPHIC PETROLOGY AND GEOCHEMISTRY

**Unit I** Definition of metamorphism. Factors of metamorphism - pressure, temperature, chemically active fluids, time and parent rock chemistry. Pressure temperature limits of metamorphism. Anatexis, palingenesis and migmatites. Metasomatism. (12 hrs)

**Unit II** Types of metamorphism– Contact metamorphism, Regional metamorphism – orogenic & ocean floor, Burial metamorphism, Cataclastic metamorphism, hydrothermal metamorphism Impact/shock metamorphism and plutonic metamorphism. Metamorphism associated with convergent and divergent plate margins. (12 hrs)

**Unit III** Metamorphic grade concept. Progressive and retrogressive metamorphism. Stability of minerals in P-T field. Metamorphic mineral zone concept- index minerals & Isograd, Barrovian metamorphic zone, metamorphic paragenesis, Goldschmidt's mineralogical phase rule. Metamorphic facies concept. Metamorphic differentiation, Concept of geothermobarometry. (15 hrs)

**Unit IV** Metamorphic textures – Crystalloblastic and Relict textures. Metamorphic structures– foliations, lineations, cataclastic and miscellaneous. Metamorphism of pelitic, carbonate and mafic rocks. Petrography of the following metamorphic rocks: slate, phyllite, quartzite, marble, schists, amphibolite, gneisses, eclogite, blueschist, mylonite, hornfels and granulites - charnockite (massive, incipient), khondalite & leptynite. (15 hrs)

**Unit V** Geochemistry: Metallic, Co-valent, Ionic and Van der Waals Bonding in Minerals. Geochemical classification of elements: lithophile, chalcophile, siderophile, atmophile. Eh-pH in geological environment. Major elements in rocks and use of variation diagrams. (18 hrs)

#### References

1. Winter - Textbook of Igneous and Metamorphic Petrology. Prentice Hall.
2. Winkler - Petrogenesis of Metamorphic Rocks, 5th, 6th and 7th eds. Springer Verlag.
3. Yardley - Textbook of Metamorphic Petrology. ELBS, London.
4. Turner & Verhoogen - Igneous and Metamorphic Petrology, McGraw Hill.
5. Williams, Turner & Gilbert – Petrography. Freeman.
6. Mason – Geochemistry, John Wiley.
7. Tyrrel - Principles of Petrology. Asia Publishing House.
8. Krauskopf – Geochemistry

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**MAHATMA GANDHI UNIVERSITY**  
 Fifth Semester B.Sc. Geology (Model I)  
 Fifth Semester B.Sc. Geology and Water Management (UGC Vocational-Model III)  
**SYLLABUS OF CORE COURSE- Theory 8 (Common Syllabus to both Programs)**

Semester	Hours/Week	Hours/ Semester	Exam	Mark			Credits
				Internal	External	Total	
V	4 Hours	72 Hours	3 Hours	20	80	100	4

**GL5CRT08: ENVIRONMENTAL GEOLOGY**

**Module I**

**Unit 1 Multidisciplinary nature of environmental studies**

Definition, scope and importance. Need for public awareness. **(4 hrs)**

**Unit 2 Natural Resources**

Renewable and non-renewable resources: Natural resources and associated problems.

- a) **Forest resources:** Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.
  - b) **Water resources:** Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams- benefits and problems.
  - c) **Mineral resources:** Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
  - d) **Food resources:** World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
  - e) **Energy resources:** Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies.
  - f) **Land resources:** Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of individual in conservation of natural resources.
- Equitable use of resources for sustainable life styles. **(10 hrs)**

**Unit 3 Ecosystems**

Concept of an ecosystem, Structure and function of an ecosystem, producers, consumers and decomposers. Energy flow in the ecosystem, Ecological succession Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the given ecosystem- Forest ecosystem. **(6 hrs)**

**Module II**

**Unit 1 Biodiversity and its conservation**

Introduction, Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. India as a mega-diversity nation. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. **(8 hrs)**

**Unit 2 Environmental Pollution**

Definition. Causes, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides. **(8 hrs)**



### **Unit 3 Social Issues and the Environment**

Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people: its problems and concerns, case studies. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. **(10 hrs)**

### **Module III**

- Unit 1 Environmental geosciences-** Concept, definition, scope and importance.  
**Unit 2** Role of Geology in environmental studies. Concept of sustainable development  
**Unit 3 The physical environment-** Atmosphere, hydrosphere, lithosphere and biosphere. **(10 hrs)**

### **Module IV**

- Unit 1** Environmental planning and management. Geology and urban planning.  
**Unit 2** Brief description of Environmental Impact Assessment – EIA  
**Unit 3** Environmental Impact of urbanization. Impact of mining on environment. **(10 hrs)**

### **Module V**

- Unit 1 Human Rights** – An Introduction to Human Rights, meaning, concept and development. Three Generations of Human Rights (Civil and Political Rights; Economic, Social and Cultural Rights).  
**Unit 2 Human Rights and United Nations** – contributions, main human rights related organs - UNESCO, UNICEF, WHO, ILO, Declarations for women and children, Universal Declaration of Human Rights.  
**Human Rights in India** – Fundamental rights and Indian Constitution, Rights for children and women, Scheduled Castes, Scheduled Tribes, Other Backward Castes and Minorities  
**Unit 3 Environment and Human Rights** - Right to Clean Environment and Public Safety: Issues of Industrial Pollution, Prevention, Rehabilitation and Safety Aspect of New Technologies such as Chemical and Nuclear Technologies, Issues of Waste Disposal, Protection of Environment.  
**Conservation of natural resources and human rights-** Reports, Case studies and policy formulation. Conservation issues of Western Ghats- mention Gadgil committee report, Kasthuriengan report. Over exploitation of ground water resources, marine fisheries, sand mining etc. **(8 hrs)**

### **Internal: Field Study** (Field work equal to 5 lecture hours)

Visit to a local area to document environmental grassland/hill/mountain  
Visit a local polluted site - Urban/Rural/Industrial/Agricultural study of common plants, insects, birds etc.  
Study of simple ecosystem- pond, river, hill slopes, etc.

## References

1. Bharucha Erach, Text Book of Environmental Studies for undergraduate Courses. University Press, IInd Edition 2013 (TB)
2. Clark R. S., Marine Pollution, Clarendon Press Oxford (Ref)
3. Cunningham, W. P. Cooper, T. H. Gorhani, E & Hepworth, M.T.2001 Environmental Encyclopedia, Jaico Publ. House. Mumbai. 1196p .(Ref)
4. Dc A. K. Environmental Chemistry, Wiley Eastern Ltd.(Ref)
5. Down to Earth, Centre for Science and Environment (Ref)
6. Heywood, V. H. & Watson, R. T. 1995. Global Biodiversity Assessment, Cambridge University Press 1140pb (Ref)
7. Jadhav H. & Bhosale V. M. 1995. Environmental Protection and Laws. Himalaya Pub. House, Delhi 284p (Ref)
8. Mekinney, M. L. & Schock R. M. 1996 Environmental Science Systems & Solutions. Web enhanced edition 639p (Ref)
9. Miller T. G. Jr., Environmental Science, Wadsworth Publishing Co. (TB)
10. Odum E. P 1971. Fundamentals of Ecology. W.B. Saunders Co. USA 574p (Ref)
11. Rao. M. N & Datta. A. K. 1987 Waste Water treatment Oxford & IBII Publication Co.Pvt.Ltd.345p (Ref)
12. Rajagopalan R., Environmental Studies from crisis and cure, Oxford University Press, Published: 2016 (TB)
13. Sharma B.K., 2001. Environmental Chemistry. Geol Publ. House, Meerut (Ref)
14. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (Ref)
15. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Stadards, Vol I and II, Enviro Media (Ref)
16. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication (Ref)
17. Wanger K. D., 1998 Environmental Management. W. B. Saunders Co. Philadelphia, USA 499p (Ref)
18. (M) Magazine (R) Reference (TB) Textbook
19. Valdia K.S (1987) Environmental Geology – Indian Context –Tata Mc Graw Hill
20. Geomorphology and Environmental Geo science. Willey international
21. Donald R Coates, 1981, Environmental Geology, John Wiley and sons
22. Peter T Elawan, 1970. Environmental Geology, Harper & Raw
23. Keller E.A (1978) environmental Geology –Bell &Howell USA.
24. Amartya Sen, The Idea Justice, New Delhi: Penguin Books, 2009.
25. Chatrath, K. J.S., (ed.), Education for Human Rights and Democracy (Shimla: Indian Institute of Advanced Studies, 1998)
26. Law Relating to Human Rights, Asia Law House, 2001.
27. Shireesh Pal Singh, Human Rights Education in 21<sup>st</sup> Century, Discovery Publishing House Pvt.Ltd, New Delhi,
28. S. K. Khanna, Children And The Human Rights, Common Wealth Publishers, 1998. 2011.
29. Sudhir Kapoor, Human Rights in 21<sup>st</sup> Century, Mangal Deep Publications, Jaipur,2001.
30. United Nations Development Programme, Human Development Report 2004: Cultural Liberty in Today's Diverse World, New Delhi: Oxford University Press, 2004.

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**MAHATMA GANDHI UNIVERSITY**  
 Fifth Semester B. Sc. Geology (Model I)  
 Fifth Semester B. Sc. Geology and Water Management (UGC Vocational-Model III)  
 (Common Syllabus to both Programs)

**OPEN COURSE - THEORY (FOR STUDENTS OF OTHER STREAMS)**

Semester	Hours/Week	Hours/ Semester	Exam	Mark			Credits
				Internal	External	Total	
V (Open Course)	4 Hours	72 Hours	3 Hours				3
				20	80	100	

**GL5OPT01: UNDERSTANDING THE EARTH**

**Unit I** Introduction to Geology – branches of Geology. The earth: size, shape, density, volume and internal structure. Hydrologic Cycle, Groundwater – infiltration, zones of groundwater, ground and perched water tables, open and bore wells, natural and artificial recharge.

**(14 hrs)**

**Unit II** Exogenic processes: Weathering - agents, types and products of weathering. Mass wasting– types, Landslides.

**(14 hrs)**

**Unit III** Endogenic processes: Volcanoes - types and distribution of major volcanoes. Products of volcanism – volcanic gas, dusts, lava and pyroclastics. Earthquakes - seismic waves and propagation, epicenter and focus, intensity and magnitude scales, seismographs and seismogram, Tsunami.

**(16 hrs)**

**Unit IV** Minerals– definition, salient physical properties – habit, color, streak, luster, cleavage and hardness. General classification of minerals - rock forming and economic minerals with common examples.

**(14 hrs)**

**Unit V** General classification of rocks– Igneous, Metamorphic and Sedimentary with common examples. Fossils – uses, fossilization processes.

**(14 hrs)**

**References**

1. Holmes: Principles of Physical Geology
2. Strahler: Earth Sciences
3. Thornbury: Principles of Geomorphology
4. Carlson and Plummer: Physical Geology: Earth Revealed
5. Monroe and Wicander: Physical Geology
6. Klein and Hurlburt: Manual of Mineralogy
7. Anantharaman: Palaeontology
8. Gribble: Rutley's Elements of Mineralogy
9. Perkins: Mineralogy
10. Tyrrell: Principles of petrology
11. Ehlers and Blatt: Petrology

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# MAHATMA GANDHI UNIVERSITY

Fifth Semester B. Sc. Geology (Model I)

Fifth Semester B. Sc. Geology and Water Management (UGC Vocational- Model III)

## SYLLABUS OF CORE COURSE – Practical 3 (Common syllabus to both Programs)

Semester	Hours/Week	Hours/ Semester	Exam	Mark			Credits
				Internal	External	Total	
V	5 Hours	90 Hours	Exam in VI Sem	20	80	100	2

(Note: Practical sessions in Fifth Semester; Practical examination in Sixth semester)

### GL6CRP03: PETROLOGY

#### Megascopic identification of the following rocks:

Mica Granite, Hornblende Granite, Graphic granite, Granite Porphyry, Pegmatite, Aplite, Syenite, Nepheline Syenite, Syenite porphyry, Diorite, Gabbro, Anorthosite, Dunite, Pyroxenite, Dolerite, Basalt, Rhyolite, Felsites, Obsidian, Pumice, Scoria.

Slate, Phyllite, Schist (different types), Gneiss (different types), Quartzite, Marble, Amphibolite, Eclogite, Leptynite, Charnockite, Khondalite, Mafic Granulite, Schorl rock, Banded Magnetite Quartzite.

Conglomerate, breccia, sandstone (coarse, medium, fine), limestone (micritic, dolomitic, marl, oolitic, fossiliferous), mudstone, shale, fossiliferous shale, black shale.

#### Microscopic identification and description of the following rocks:

Mica Granite, Hornblende Granite, Graphic Granite, Granite–porphyry, Syenite, Nepheline Syenite, Diorite, Gabbro, Dunite, Pyroxenite, Dolerite, Anorthosite, Basalt,

Slate, Chlorite schist, Mica schist, Kyanite schist, Garnetiferous schist, Charnockite, Eclogite, Amphibolite, Leptynite, Khondalite, Cordierite gneiss, Garnet–sillimanite gneiss, Garnetiferous Biotite Gneiss

Sandstone (different types), limestone (different types), shale

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# MAHATMA GANDHI UNIVERSITY

Sixth Semester B. Sc. Geology (Model I)

Sixth Semester B. Sc. Geology and Water Management (UGC Vocational-Model III)

SYLLABUS OF CORE COURSE – Theory 9 (Common Syllabus to both Programs)

Semester	Hours/Week	Hours /Semester	Exam	Mark			Credits
				Internal	External	Total	
VI	4 Hours	90 Hours	3 Hours	20	80	100	4

## GL6CRT09: STRUCTURAL GEOLOGY

**Unit I** Introduction: Attitude of planar linear structures Strike, Dip, Plunge and Pitch. Width of outcrops. Outlier and Inlier. Overlap and offlap. Rule of V's. Primary and secondary structures. Use of primary structures in determining top of beds. Unconformities. **(14 hrs)**

**Unit II** Rock deformation – Stress and strain. Stages of rock deformation. Basic concept of spherical and stereographic projections in structural geology. Wulf net and Schmidt net. **(10 hrs)**

**Unit III** Fold- Terminology. Classification of folds- Geometric and genetic. Recognition of folds in field and map. **(22 hrs)**

**Unit IV** Faults– Terminology and classification. Mechanics of faulting. Criteria for recognition of faults in field and map. **(22 hrs)**

**Unit V** Foliation– Tectonites, Compositional, Disjunctive, Continuous, Slaty cleavage, Schistosity, Flow cleavage, Fracture cleavage, Shear cleavage. Relationship of foliation with fold and shear zones.

Lineation - Discrete, constructional and mineral lineations.

Joints – Nature, origin, classification and geologic significance.

Geological mappings, Procedures and equipments in mapping. Use of Clinometer and Brunton compasses in field. **(22 hrs)**

### References

1. Billings (1974) Structural Geology. 11<sup>th</sup> edition, Prentice Hall.
2. Park R G (1997) Foundations of Structural Geology 3<sup>rd</sup>, Chapman & Hall
3. Hills Elements of Structural Geology
4. Hobbs, Means and Williams (1976). An Outline of Structural Geology. John Wiley.
5. John Robberts - Introduction to Geological Maps and Structures, Pergamon Press.
6. Ken McClay - The mapping of Geological Structures. Geological Society of London. John Wiley and Sons.
7. R J Twiss & E M Moore (2007) Structural Geology 2<sup>nd</sup> edition. Freeman & Company

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# MAHATMA GANDHI UNIVERSITY

Sixth Semester B. Sc. Geology (Model I)

Sixth Semester B. Sc. Geology and Water Management (UGC Vocational- Model III)

## SYLLABUS OF CORE COURSE – Theory 10 (Common syllabus for both Programs)

Semester	Hours/Week	Hours /Semester	Exam	Mark			Credits
				Internal	External	Total	
VI	4 Hours	90 Hours	3 hours	20	80	100	3

### GL6CRT10: PHANEROZOIC STRATIGRAPHY OF INDIA

**Unit I** Concept of geological time scale in relation to Indian Phanerozoic stratigraphy. Sedimentary basins of India. Geological and physiographic divisions of India. **(16 hrs)**

**Unit II** Detailed study of following Paleozoic succession of India. Cambrian of Salt range. Paleozoic of Spiti region. Gondwana supergroup – its distribution, lithology, classification, structural features and coal resources. Gondwana of east coastal region. **(22 hrs)**

**Unit III** Detailed study of following Mesozoic succession of India. Mesozoic Spiti region. Jurassic of Kutch. Cretaceous Formations in Tamil Nadu and Narmada Valley. **(18 hrs)**

**Unit IV** Detailed study of following Cenozoic succession of India. Tertiaries of Kerala and Tamilnadu. Siwalik Supergroup. Karewa Formation. Indo – Gangetic alluvium. **(16 hrs)**

**Unit V** Deccan Traps– its lithology, distribution, classification, Supra-, Infra- and intertrappeans. Hydrocarbon bearing formations of India with special reference to Cambay, Rajasthan, Bombay offshore, Cauvery, Krishna Godavari, Assam – Arakan and Tripura basins. **(18 hrs)**

### References

1. Krishnan: Geology of India and Burma, 6<sup>th</sup> Edition, CBS.
2. Wadia: Geology of India, TATA McGraw – Hill.
3. Ravindrakumar Fundamentals of Historical Geology and Stratigraphy of India
4. Pascoe: Manual of the Geology India and Burma, Govt. of India Publications.
5. Vaidyanathan and Ramakrishnan (2008) Geology of India (Vol. I & II). Geological Society of India, Bangalore.

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# MAHATMA GANDHI UNIVERSITY

Sixth Semester B. Sc. Geology (Model I)

Sixth Semester B. Sc. Geology and Water Management (UGC Vocational- Model III)

## SYLLABUS OF CORE COURSE – THEORY (Common Syllabus to both Programs)

Semester	Hours/Week	Hours/ Semester	Exam	Mark			Credits
				Internal	External	Total	
VI	4 Hours	72 Hours	3 Hours	20	80	100	3

### GL6CRT11: PALAEOLOGY

**Unit I** Life through geologic history. Scope and subdivisions of paleontology. Fossilization – methods. Concept of body fossils, trace fossils, transported fossils, leaked fossils, synthetic fossils and pseudo fossils. Taxonomy and synthetics, Binomial nomenclature. Uses of fossils. **(10 hrs)**

**Unit II** Phylum Arthropoda, Class– Trilobita - General morphology: Cephalon: glabella, facial suture, free cheek, fixed cheek, genal angle, genal spine, cranidium; thorax– pygidium, classification, geological history. **(8 hrs)**

**Unit III** Phylum Brachiopoda- General morphology, umbo, hinge line, pedicle opening, delthyrium, deltidium pseudo deltidium – Brachial skeleton – morphometric details, ornamentation, classification, geological history.

Phylum Echinodermata: Class Echinoidea- General morphology, periproct, apical system (Anus, ocular plates, Genital plates, madriporic plates), corona (Ambulacra, inter ambulacra) – peristome – Regular and irregular echinoids – classification – geological history. **(15 hrs)**

**Unit IV** Phylum Mollusca: Class Pelecypoda- General characters– umbo, Hinge line– ligament – lunule and escutcheon– adductor impressions, pallial line, pallial sinus, dental patterns, ornamentation, classification, geological history. Class Gastropoda- General morphology, shell forms, whorl, spire, spiral angle, suture, aperture, columella, umbilicus, peristome, aperture, (holostomatus and siphonostomatus), types of coiling– dextral and sinistral, ornamentation, classification and geological history. **(15 hrs)**

**Unit V** Micropalaeontology and Palynology - an introduction. Brief account of the following plant fossils- Glossopteris, Gangamopteris, Ptilophyllum, Calamites, Lepididendron and Sigillaria. **(6 hrs)**

### References

1. Woods - Invertebrate Palaeontology. Cambridge.
2. Romer - Vertebrate Palaeontology. Chicago Press.
3. Arnold - An Introduction to Palaeobotany. McGraw Hill.
4. Haq and Boersma - Introduction to marine Micropalaeontology. Elsevier, Netherlands.
5. Raup and Stanely - Principles of Palaeontology. CBS Publishers.
6. Moore, Lalicker & Fishcher - Invertebrate Fossils, Harper Brothers.
7. Shrock and Twenhofel - Principles of Invertebrate Palaeontology. Arnold Publication
8. Brasier, M.D. Microfossils, George Allen & Unwin, 1980.
9. Bignot, G. Elements of Micropaleontology, IHRDC-Boston, 1985.
10. Nield & Tucker Palaeontology –An Introduction, Pergamon Press, Oxford, England, 1985
11. Anis Kumar Ray, Fossils in Earth Sciences, Prentice-Hall of India Pvt Ltd, New Delhi, 2008

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# MAHATMA GANDHI UNIVERSITY

Sixth Semester B. Sc. Geology (Model I)

Sixth Semester B. Sc. Geology and Water Management (UGC Vocational- Model III)

## SYLLABUS OF CORE COURSE – Theory 12 (Common Syllabus to both Programs)

Semester	Hours/Week	Hours/ Semester	Exam	Mark			Credits
				Internal	External	Total	
VI	4 Hours	90 Hours	3 Hours	20	80	100	4

### GL6CRT12: ECONOMIC GEOLOGY

**Unit I** Scope of Economic Geology. Ore and Gangue Minerals. Mineral Resources and reserves. Tenor of ores. Syngenetic and Epigenetic deposits. Strategic and Critical Minerals. **(8 hrs)**

**Unit II** Processes of formation of mineral deposits: Origin due to internal processes of  
(1) Magmatic deposits, Hydrothermal deposits and Contact metasomatic deposits  
(2) Metamorphic deposits. **(20 hrs)**

**Unit III** Processes of formation of mineral deposits: Origin due to External / Surface processes of following types of deposits -  
1. Evaporate deposits.  
2. Sedimentary deposits- mechanical concentration, residual concentration  
3. Oxidation and Supergene Sulphide enrichment.  
4. Volcanic exhalative deposits. **(22 hrs)**

**Unit IV** Metallogenic Epochs and Provinces with particular reference to India. A brief study on mode of occurrence, distribution in India and important economic uses of ore minerals of the following - Aluminium, Chromium, Gold, Iron, Copper, Lead, Manganese, Silver, Thorium, Titanium, Uranium and Zinc. Mineral resources of Kerala. **(25 hrs)**

**Unit V** Materials for Abrasives, Refractories, Ceramics and Cement. Gemstones. Fuel minerals: Coal - origin and resources in India, Petroleum – origin and brief study on petroliferous basins of India **(15 hrs)**

### References

1. Anthony M. Evans, An introduction to Ore Geology, second edition, ELBS 1980.
2. Gokhale and Rao, Ore Deposits of India.
3. Krishnaswamy, Indian Mineral Resources.
4. Mead L.Jensen and Alan M. Bateman - Economic Mineral Deposits, John Wiley & Sons Third edition, revised printing, 1981.
5. Park and Macdiarmid, Ore Deposits, Freeman, 1964.
6. Roy Chacko (ed.), Mineral Resources of Kerala. Dept of Mining and Geology 2005.
7. Soman, Geology of Kerala, Geological Society of India, second revised edition 2002.
8. Umeshwer Prasad- Economic Mineral Deposits, CBS Publishers, 1996.
9. Wadia, Minerals of India, National Book Trust, India, 5th edition, 1994.
10. Levenson, Geology of Petroleum, Mc Graw Hill, 1967.

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# MAHATMA GANDHI UNIVERSITY

Sixth Semester B. Sc. Geology (Model I)

Sixth Semester B. Sc. Geology and Water Management (UGC Vocational- Model III)

## SYLLABUS OF CHOICE BASED OPTIONAL – Theory 1 (Common Syllabus to both Programs)

Semester	Hours/Week	Hours/ Semester	Exam	Mark			Credits
				Internal	External	Total	
VI	4 Hours	54 Hours	3 Hours	20	80	100	3

### GL6CBT01: GEOTECTONICS AND PRECAMBRIAN STRATIGRAPHY OF INDIA

**Unit I** Gross tectonic features of continents– orogenic belts, continental margin types, Shield areas and cratons, Rift valleys. **(12 hrs)**

**Unit II** Plate tectonics- basic concepts. Tectonic features of the ocean floor. Significance of mid-ocean ridges and Island arcs in continental growth. Plate tectonics in relation to igneous activity and metallogenesis. **(12 hrs)**

**Unit III** General study of the distribution and nomenclature of Early Precambrians of India. Major cratons and fold belts of the Indian shield. Detailed study of the lithology, classification, age, structure, syn- and post- tectonic intrusives, organic remains, radiometric age and economic resources of Dharwar Craton- Sargur Schist Complex, Peninsular Gneiss. **(18 hrs)**

**Unit IV** Gross structural features of mobile belts and high grade terrains. Charnockite– Khondalite bearing High Grade terrains of Peninsular India. Eastern Ghat belts and Southern Granulite terrain. Precambrian rocks of Kerala. **(16 hrs)**

**Unit V** General study of the distribution and nomenclature of Proterozoic successions of India and detailed study of the lithology, age, classification (lithostratigraphic), structure, associated intrusives, organic remains and economic resources of Cuddapah Supergroup and Vindhyan Supergroup. **(14 hrs)**

#### References

1. Billings: Structural Geology. 11th edition, Prentice Hall.
2. Hobbs Means and Williams (1976) An Outline of Structural Geology. John Wiley.
3. John L. Robbers - Introduction to Geological maps and Structures, Pergamon Press.
4. Ken Mc Clay-The mapping of Geological Structures, Geol Soc London, John Wiley & Sons.
5. Krishnan: Geology of India and Burma, 6th Edition, CBS.
6. Wadia: Geology of India, TATA McGraw – Hill.
7. Ravindrakumar: Fundamentals of Historical Geology and Stratigraphy of India.
8. Pascoe: A manual of the Geology India and Burma, Govt. of India Publications.
9. Vaidyanathan & Ramakrishnan: Geology of India (Vol.I&II) Geol. Soc. of India, Bangalore.
10. Soman: Geology of Kerala, Geological Society of India, Bangalore.
11. Radhakrishna: Geology of Karnataka, Geological Society of India, Bangalore
12. Sanjib Chandra, Sarkar, Anupendra Gupta, Crustal evolution and Metallogeny in India, Cambridge University Press, Delhi, India 2012.
13. Amal Das Gupta, An introduction to Earth Science, World Press Private Limited, Kolkata - 2006

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# MAHATMA GANDHI UNIVERSITY

Sixth Semester B. Sc. Geology (Model I)

Sixth Semester B. Sc. Geology and Water Management (UGC Vocational- Model III)

## SYLLABUS OF CHOICE BASED OPTIONAL – Theory 2 (Common Syllabus to both Programs)

Semester	Hours/Week	Hours /Semester	Exam	Mark			Credits
				Internal	External	Total	
VI	4 Hours	72 Hours	3 hours	20	80	100	3

### GL6CBT02: MARINE GEOLOGY

**Unit I** Morphology of ocean floor- Mid oceanic ridge system, Subduction zones, island arcs, trenches, conjugate oceanic basins, seamounts, Guyots and ridges. Morphology of Indian Ocean. **(16 hrs)**

**Unit II** Distribution of temperature, salinity and density in sea water. Nutrients in sea water, Eustatic changes of sea level and their effects. **(12 hrs)**

**Unit III** Oceanographic expeditions. Ocean floor drilling programmes– ODP, DSDP & JOIDES. Ocean floor mapping- Echo sounding, multi beam survey and ROVs. Marine pollution-oil spill, algal blooms, industrial effluents. **(12 hrs)**

**Unit IV** Types of coasts and coastal geomorphology, coastal upwelling and downwelling, Turbidity currents and turbidites, Mud banks, Tides and their origin. Law of the Sea – EEZ & CRZ. **(14 hrs)**

**Unit V** Marine sediments: Classification (Lithogenous, Biogenous, Hydrogenous, Cosmogenous) and distribution. Mineral resources of the oceans - polymetallic nodules, phosphatic deposits, volcanogenic massive sulphide (VMS) deposits. **(18 hrs)**

### References

1. Pinet Paul, R. Oceanography– An Introduction to the Planet Oceanus, West Publishing Co, 1992.
2. Pond, S. and Pickard, G.L. Introductory Dynamical Oceanography, 2nd Ed., Pergamon Press, 1983.
3. King, C. A. M. Beaches and Coasts, Arnold, London, 1972.
4. Trask P. D. Recent Marine Sediments, Dever Publications, 1939.
5. Krumbein, W.C. and Pettijohn, F.J. Manual of Sedimentary Petrology, Appleton Century Co., 1938.
6. Pickering, K. T. Hiscott, R.N. and F.J. Hedn. Deep Marine Environments– clastic sedimentation and Tectonics, Unwin and Hyman, 1989.
7. Roy Chester. Marine Geochemistry, Unwin Hyman, 1990.
8. Selley, R.C Ancient Sedimentary Environments, Corwell University Press, 1972.
9. Pettijohn, F. J., Potter, P. E. and Siever, R., Sand and Sandstone, Springer Verlag, 1972
10. Shepard F.P., Submarine Geology, Harper & Row, New York, 1963

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# MAHATMA GANDHI UNIVERSITY

Sixth Semester B. Sc. Geology (Model I)

Sixth Semester B. Sc. Geology and Water Management (UGC Vocational - Model III)

## SYLLABUS OF CHOICE BASED OPTIONAL – Theory 3

(Common Syllabus to both Programs)

Semester	Hours/Week	Hours /Semester	Exam	Mark			Credits
				Internal	External	Total	
VI	4 Hours	72 Hours	3 hours	20	80	100	3

### GL6CBT03: REMOTE SENSING AND GIS

**Unit I** Basic principles of remote sensing - Electromagnetic spectrum. Remote Sensing data products. Aerial photography: Types of aerial photographs-vertical/oblique/high oblique. Scale of aerial photographs. Flight plan and flight lines. Overlap and side lap. Stereoscopic vision. Stereo pair. **(8 hrs)**

**Unit II** Geotechnical and photographic elements of air photo interpretation – tone, texture, color, association, site, drainage patterns etc. Interpretation of drainage pattern and fluvial landforms. Recognition of different landforms from aerial photographs. Remote sensing sensors – passive and active sensors. Multispectral scanning-RADAR system. **(20 hrs)**

**Unit III** Indian Remote Sensing Satellites. Application of remote sensing in geologic mapping, structural mapping, mineral, groundwater exploration, geomorphologic mapping. Application of remote sensing in water pollution, marine pollution. **(20 hrs)**

**Unit IV** Geoinformatics– Definition and various disciplines constituting it. Geographic Information System (GIS) – The purpose of GIS; components of GIS; GIS software. Types of Data – Raster and Vector. **(18 hrs)**

**Unit V** Spatial data input – Digitizing paper maps. Georeferencing. Transformation and Projection. Spatial data analysis – analytical capabilities of a GIS; Overlay functions, Mapping qualitative and quantitative data. GIS Applications in Geosciences – Geology; Groundwater; Mineral Exploration; Urban planning. **(14 hrs)**

### References

1. Burrough & Mc Donnel - Introduction to Geographic Information System.
2. Anji Reddy - Remote Sensing and Geographic Information system.
3. C.P. Lo and A.K.W Yeung (2005). Concepts and Techniques of Geographic Information Systems. Prentice Hall of India.
4. Stephen Wise (2002). GIS Basics. CRC Press.
5. Paul V. Bolstad (2005) GIS Fundamentals: A First Text on Geographic Information Systems. Eider Press.
6. Tasha Wade and Shelly Sommer (2006) A to Z GIS: An Illustrated Dictionary of Geographic Information Systems ESRI Press.
7. Keith C. Clarke (2007) Getting Started With GIS. Prentice Hall.
8. Gupta, R. P. - Remote Sensing Geology.
9. Lillesand T. M. & Kiefer R.W. - Remote Sensing and Image Interpretation.
10. Ramasamy, S. M. - Remote Sensing in Geomorphology.

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# MAHATMA GANDHI UNIVERSITY

Sixth Semester B. Sc. Geology (Model I)

Sixth Semester B. Sc. Geology and Water Management (UGC Vocational-Model III)

SYLLABUS OF CORE COURSE – Practical 4 (Common Syllabus to both Programs)

Semester	Hours/Week	Hours/ Semester	Exam	Mark			Credits
				Internal	External	Total	
VI	5 Hours	90 Hours	3 Hours	20	80	100	2

## GL6CRP04: STRUCTURAL GEOLOGY, ECONOMIC GEOLOGY AND PALAEOLOGY

### Part A: STRUCTURAL GEOLOGY

#### I. Diagrammatic illustration of -

Structural features - Attitude of beds, true and apparent dip, strike and dip symbols, rules of 'V', types of Folds, Faults, Joints and Unconformities.

#### II. Maps with suitable sections and geological descriptions

Simple horizontal beds.

Illustrating Rule of V's.

Simple dipping beds.

Simple dipping beds with intrusions

Problems involving bore-hole data, thickness, dip and apparent dip.

Dipping beds with unconformity.

Folded beds.

Maps with different types of faults.

Combination maps (Unconformity, intrusion, folds and faults) – at least 5-6 maps

#### III. Problems involving true and apparent dip, true vertical thickness and width of outcrops.

Three point problems. Stereographic projection of planar and linear features.

### Part B: ECONOMIC GEOLOGY

#### Megascopic identification and description of Indian occurrences & uses of the following ore and industrial minerals: -

**Sulphides:** Realgar, Orpiment, Stibnite, Molybdenite, Galena, Sphalerite, Chalcophyrite, Pyrite.

**Sulphates:** Barite, Celestite, Gypsum.

**Oxides:** Corundum, Hematite, Ilmenite, Magnetite, Chromite, Cassiterite, Pyrolusite, Psilomelane, Goethite, Limonite, Bauxite.

**Carbonates:** Calcite, Dolomite, Magnesite, Siderite, Aragonite, Cerussite, Azurite, Malachite.

**Industrial Minerals:** Halite, Fluorite, Phosphatic Nodule, Monazite, Graphite, Coal and its varieties, Asbestos.

### Part C: PALAEOLOGY

Identification and description of general morphological features of the following fossils:

Phylum Mollusca: Pelecepods, Gastropods, Cephalopods.

Phylum Brachiopod.

Phylum Echinodermata: Echinoidea.

Phylum Arthropoda: Trilobites.

Plant fossils: Glossopteris, Ptilophyllum.

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