

FYUGP

GEOLOGY HONOURS/ RESEARCH

FOR UNDER GRADUATE COURSES UNDER
BINOD BIHARI MAHTO KOYALANCHAL UNIVERSITY, DHANBAD



Implemented from
Academic Session 2022-2026


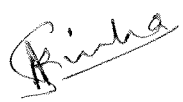



UNIVERSITY DEPARTMENT OF GEOLOGY

BINOD BIHARI MAHTO KOYALANCHAL UNIVERSITY,
DHANBAD- 828130 (JHARKHAND)

Memo No: BBMKU/R/1292/2022, dated on 20.09.22

As per Guidelines of the Binod Bihari Mahto Koyalanchal University, Dhanbad, Syllabus for undergraduate courses of Geology honours/research under NEP-2020 was prepared by Members of Board of Studies of FYUGP. List of members are following below

Name of Members		Signature
1. Dr. Shailendra Kr. Sinha, Dean, Faculty of Science, BBMK Univ, Dhanbad	-Chairman	
2. Dr. Atul Kumar Sinha, HoD, University Dept. of Geology, BBMK Univ, Dhanbad	-Convenor	
3. Dr. Sagar Kumar Swain, HoD, Dept. of Geology, PKRM College, BBMK Univ, Dhanbad	-Member	
4. Dr. Krishna Gopal, University Dept. of Geology, BBMK Univ, Dhanbad	-Member	
5. Shri Pradeep Kumar Adhikari Head, Department of Geology, K.C.B College, Bero, Ranchi University, Ranchi	-External expert	

COURSE STRUCTURE FOR FYUGP 'HONOURS/ RESEARCH'

Table 1: Credit Framework for Four Year Undergraduate Programme (FYUGP) under State Universities of Jharkhand [Total Credits =176]

Undergraduate Programme (T I U Gr) under State Universities of Jharkhand [Total Credits =176]																					
Semester	Common Courses (29)										Introductory Courses (15)		Internship/ Project (4)	Major (PHYSICS) (54) + Adv. Major (PHYSICS) (24)	Minor* (32)		Research Courses (18)				Total Credit
	Language and Communication Skills (Modern Indian Language including TRL) (6)	Language and Communication Skills (English) (6)	Environmental Studies (3)	Understanding India (2)	Health & Wellness, Yoga Education, Sports & Fitness (2)	Digital Education (3)	Mathematical & Computational Thinking and Analysis (2)	Value-Based Course/ Global Citizenship Education (2)	Community Engagement/ NCC/ NSS/ (3)	Introductory Courses [Natural Sc./ Humanities/ Social Sc./Commerce] (9)	Introductory Course [Vocational Studies] (6)	Natural Sc./ Humanities/ Social Sc./ Commerce (18)			Vocational Studies (14)	Research Methodology Courses (6)	Research Proposal, Review of Literature (4)	Research Internship/ Field Work (4)	Preparation of the Research Project Report (4)		
I	2	3	4	5	6	7	8			9	10	11	14	15	16	17	18	19	20	21	
II	6			2	2					3	3		6							22	
III		6				2	2			3	3		6							22	
IV													6+6	6	4					22	
Exit Point: Undergraduate Certificate																					
V						3				3		4	6							22	
VI													6+6	6	4					22	
Exit Point: Undergraduate Diploma																					
VII													6+6	6	4					22	
VIII													6+6	6	4					22	
Exit Point: Bachelor's Degree																					
IX													6+6 (Adv. Topics)			6	4			22	
X													6+6 (Adv. Topics)		2			4	4	22	
Exit Point: Bachelor's Degree with Hons. /Research																					

*A student has to select three subjects for 'Introductory Regular Courses' from a pool of subjects associated with the Major (GEOLOGY) offered by the institution. One of the three subjects will continue as 'Minor' from semester IV onwards, based on the academic interest and performance of the student.

COURSES OF STUDY FOR FOUR YEAR UNDERGRADUATE PROGRAMME

Table 2: Course structure for Undergraduate Certificate Programme [May Exit after Sem.-II]

Semester	Common Courses			Introductory Courses		Major	Total Credits
Sem.-I	LCS (MIL/TRL) (6 Credits)	Understanding India (2 Credits)	Health & Wellness, Yoga Education, Sports & Fitness (2 Credits)	IRC-1 (3 Credits)	IVS-1A (3 Credits)	MJ-1 (6 Credits)	(22)
Sem.-II	LCS (English) (6 Credits)	Global Citizenship Education (2 Credits)	Mathematical & Computational Thinking (2 Credits)	IRC-2 (3 Credits)	IVS-1B (3 Credits)	MJ-2 (6 Credits)	(22)

Total = 44 Credits

(LCS: Language and Communication Skills; MIL: Modern Indian Languages; TRL: Tribal Regional Languages; IRC: Introductory Regular Courses; IVS: Introductory Vocational Studies, MJ: Major)

Table 3: Course structure for Undergraduate Diploma Programme [May Exit after Sem.-IV]

Semester	Common Courses			Introductory	Major Courses Credits	Minor	Internship/ Vocational Project	Total
Sem.-III	Environmental Studies (3 Credits)	Community Engagement/ NCC/ NSS (3 Credits)	Digital Education (3 Credits)	IRC-3 (3 Credits)	MJ-3 (6 Credits)		Internship/ Project (4 Credits)	(22)
Sem.-IV					MJ-4, MJ-5 (6+6=12 Credits)	MN-1 (6 Credits)	VS-1 (4 Credits)	(22)

Total = 88 Credits

(MN: Minor; VS: Vocational Studies)

Table 4: Course structure for Bachelor's Degree Programme*[May Exit after Sem.-VI]*

Semester	Major Courses	Minor Courses	Vocational	Total Credits
Sem.-V	MJ-6, MJ-7 (6+6 = 12 Credits)	MN-2 (6 Credits)	VS-2 (4 Credits)	(22)
Sem.-VI	MJ-8, MJ-9 (6+6 = 12 Credits)	MN-3 (6 Credits)	VS-3 (4 Credits)	(22)

Total = 132 Credits**Table 5: Course structure for Bachelor's Degree with Hons./Research Programme**

Semester	Advance Courses	Research Courses	Vocational	Total Credit
Sem.-VII	AMJ-1, AMJ-2 (6+6=12 Credits)	Research Methodology (6 Credits)	Research Proposal (4 Credits)	(22)
Sem.-VIII	AMJ-3, AMJ-4 (6+6=12 Credits)	Research Int./Field Work (4 Credits)	Research Report (4 Credits)	(22)

Total = 176 Credits

(AMJ: Advance Major; VSR: Vocational Studies associated with Research)

Session 2022-26 onwards

SEMESTER WISE COURSES OF STUDY FOR FOUR YEAR UNDERGRADUATE
PROGRAMME **2022 onwards**

Table 6: Semester wise Course Code and Credit Points:

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		Credits
	Code	Papers	
I	CC-1	Language and Communication Skills (Modern Indian language including TRL)	6
	CC-2	Understanding India	2
	CC-3	Health & Wellness, Yoga Education, Sports & Fitness	2
	IRC-1	Introductory Regular Course-1	3
	IVS-1A	Introductory Vocational Studies-1	3
	MJ-1	Major paper 1 (Disciplinary/Interdisciplinary Major)	6
II	CC-4	Language and Communication Skills (English)	6
	CC-5	Mathematical & Computation Thinking Analysis	2
	CC-6	Global Citizenship Education & Education for Sustainable Development	2
	IRC-2	Introductory Regular Course-2	3
	IVS-1B	Introductory Vocational Studies-2	3
	MJ-2	Major paper 2 (Disciplinary/Interdisciplinary Major)	6
III	CC-7	Environmental Studies	3
	CC-8	Digital Education (Elementary Computer Applications)	3
	CC-9	Community Engagement & Service (NSS/ NCC/ Adult Education)	3
	IRC-3	Introductory Regular Course-3	3
	IAP	Internship/Apprenticeship/ Project	4
	MJ-3	Major paper 3 (Disciplinary/Interdisciplinary Major)	6
IV	MJ-4	Major paper 4 (Disciplinary/Interdisciplinary Major)	6
	MJ-5	Major paper 5 (Disciplinary/Interdisciplinary Major)	6
	MN-1	Minor Paper 1 (Disciplinary/Interdisciplinary Minor)	6
	VS-1	Vocational Studies-1 (Minor)	4

V	MJ-6	Major paper 6 (Disciplinary/Interdisciplinary Major)	6
	MJ-7	Major paper 7 (Disciplinary/Interdisciplinary Major)	6
	MN-2	Minor Paper 2 (Disciplinary/Interdisciplinary Minor)	6
	VS-2	Vocational Studies 2 (Minor)	4
VI	MJ-8	Major paper 8 (Disciplinary/Interdisciplinary Major)	6
	MJ-9	Major paper 9 (Disciplinary/Interdisciplinary Major)	6
	MN-3	Minor Paper 3 (Disciplinary/Interdisciplinary Minor)	6
	VS-3	Vocational Studies 3 (Minor)	4
VII	AMJ-1	Advance Major paper 1 (Disciplinary/Interdisciplinary Major)	6
	AMJ-2	Advance Major paper 2 (Disciplinary/Interdisciplinary Major)	6
	RC-1	Research Methodology	6
	RC-2	Research Proposal	4
VIII	AMJ-3	Advance Major paper 3 (Disciplinary/Interdisciplinary Major)	6
	AMJ-4	Advance Major paper 4 (Disciplinary/Interdisciplinary Major)	6
	RC-3	Research Internship/Field Work	4
	RC-4	Research Report	4
	VSR	Vocational Studies (Associated with Research)	2
		Total Credit	176

Abbreviations:

CC	Common Courses
IRC	Introductory Regular Courses
IVS	Introductory Vocational Studies
IAP	Internship/Apprenticeship/ Project
VS	Vocational Studies
MJ	Major Disciplinary/Interdisciplinary Courses
MN	Minor Disciplinary/Interdisciplinary Courses
AMJ	Advance Major Disciplinary/Interdisciplinary Courses
RC	Research Courses
VSR	Vocational Studies associated with Research

SEMESTER WISE COURSES IN PHYSICS FOR FYUGP

2022 onwards**Table 7: Semester wise Examination Structure for Physics Major:**

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		Examination Structure			
	Code	Papers	Credits (T+P)	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I	MJ-1	Earth System Science, Crystallography & Mineralogy	6 (4+2)	15	60	25
II	MJ-2	Structural Geology	6 (4+2)	15	60	25
III	MJ-3	Igneous Petrology	6 (4+2)	15	60	25
IV	MJ-4	Sedimentary & Metamorphic Petrology	6 (4+2)	15	60	25
	MJ-5	Economic Geology	6 (4+2)	15	60	25
V	MJ-6	Stratigraphy & Paleontology	6 (4+2)	15	60	25
	MJ-7	Elements Of Geochemistry	6 (4+2)	15	60	25
VI	MJ-8	Hydro Geology & Geomorphology	6 (4+2)	15	60	25
	MJ-9	Engineering Geology, Remote Sensing & GIS	6 (4+2)	15	60	25
VII	AMJ-1	To be selected from the pool of Advance papers	6			
	AMJ-2	To be selected from the pool of Advance papers	6			
	RC-1	Research Methodology	6			
	RC-2	Research Proposal	4			
VIII	AMJ-3	To be selected from the pool of Advance papers	6			
	AMJ-4	To be selected from the pool of Advance papers	6			
	RC-3	Research Internship/Field Work	4			
	RC-4	Research Report	4			
	VSR	Vocational Studies (Associated with Research)	2			
		Total Credit	98			

Note:

- Total 6 credits of AMJ papers will be distributed either as 4(T) +2(P) OR 6(T); depending upon the paper. Distribution of marks in Mid-Semester and End-Semester will be accordingly.

LIST OF ADVANCE MAJOR (AMJ) PAPERS TO BE SELECTED BY THE STUDENTS FOR SEMESTER VII & VIII:

1. FUEL GEOLOGY
2. ORE GEOLOGY
3. EXPLORATION GEOLOGY
4. ENVIRONMENTAL GEOLOGY
5. EARTH & CLIMATE
6. SOIL GEOSCIENCE
7. SEDIMENTOLOGY
8. RIVER SCIENCE
9. INTRODUCTION OF GEOPHYSICS
10. EVOLUTION OF LIFE THROUGH TIME
11. URBAN GEOLOGY
12. FOSSILS & THEIR APPLICATIONS

Table 8: Semester wise Examination Structure for Geology Minor:

Semester	Code	Papers	Credits (T+P)	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
IV	MN-1	Petrology, Geochemistry & Structural Geology	6 (4+2)	15	60	25
V	MN-2	Earth Resources & Essentials of Geology	6 (4+2)	15	60	25
VI	MN-3	Stratigraphy & Palaentology	6 (4+2)	15	60	25
		Total Credit	18			

**NEP UG Syllabus
Semester I**

Major – 1 (MJ - 1) EARTH SYSTEM SCIENCE, CRYSTALLOGRAPHY & MINERALOGY

Credit – 4

FM= 100 [75 +25]

Lectures – 60 Hours

T= 75 {60Ext. +15 Int.} (10+05)}

Instructions:

- There will be two groups of questions. **Group A** is compulsory which will contain **three questions**.
- **Question no. 1** will be **very short answer type** consisting of **five questions of 1 mark each**.
- **Question no. 2 & 3** will be of **short answer type** of **5 marks each**.
- **Group B** will contain **descriptive type five questions of 15 marks each**, out of which **any three are to answer**.

Learning Outcomes:

After successfully completing this course, the students will be able to understand:

1. The aim of this course is to study the major mineral groups, their occurrences, physical, chemical and crystallographic properties and their possible uses in industry.
2. The course aims also to study the external symmetry of the crystals through external elements of symmetry, crystal classes and systems, and the relations of symmetry to the internal structure using the chemical and physical properties of the minerals.
3. Focus is given on the physical and chemical properties of minerals, from macroscopic to microscopic.
4. The course will investigate how geologic materials and processes influence mineral occurrence, stability, and composition.
5. The course is divided into different modules as given in the course content and covers the structure of minerals, characters of minerals and mineral chemistry.

Unit	Topic	Total no. of Lectures
Unit 1: Earth as a planet, Interior of Earth, Plate Tectonics		
1.1	Earth as a planet: 1.1.1: General characteristics and origin of the Universe, Solar System and its planets. The terrestrial and jovian planets. Meteorites and Asteroids,	04
	1.1.2: Earth in the solar system - origin, size, shape, mass, density, rotational and revolution parameters and its age.	04

1.2	Interior of Earth	02
	1.2.1: Internal Structure of the earth & Composition	
	1.2.2: Primary & Secondary discontinuity with depth	02
	1.2.3: Earth's magnetic field: Convection in Earth's core and production of its magnetic field	02
1.3	Plate Tectonics	04
	1.3.1: Concept of plate tectonics, sea-floor spreading, Isostasy and continental drift	
	1.3.2: Geodynamic elements of Earth- Mid Oceanic Ridges, trenches, transform faults and island arcs Origin of oceans, continents, mountains and rift valleys	04
	1.3.3: Earthquake, earthquake belts, distribution, Scale Volcanoes- types, products and their distribution	04
Unit 2: Hydrosphere and Atmosphere, Soil, Understanding the past from stratigraphic records		Total no. of Lectures
2.1	Hydrosphere and Atmosphere	04
	2.1.1: Introduction to hydrosphere and atmosphere; Oceanic current system and effect of Coriolis force; Wave erosion and beach processes; Atmospheric circulation; Earth's heat budget.	
	2.1.2: Soils- processes of formation, soil profile and soil types.	02
2.2	2.2.1: Understanding the past from stratigraphic records: Stratigraphy: introduction and scope; Standard stratigraphic time scale, Introduction to geochronological methods and their application in geological studies; Laws of superposition and faunal succession; Concepts of uniformitarianism.	04
Unit 3: Crystallography, Crystal symmetry and projections		Total no. of Lectures
3.1	Crystallography: 3.1.1: Elementary ideas about crystal morphology in relation to internal structures Crystal parameters and indices Crystal symmetry and classification of crystals into six systems and 32 point groups	06
3.2	Crystal symmetry and projections 3.2.1: Elements of crystal chemistry and aspects of crystal structures Stereographic projections of symmetry elements and forms	04
Unit 4: Rock forming minerals		Total no. of Lectures

4.1	Rock forming minerals 4.1.1: Minerals - definition and classification, physical and chemical properties Composition of common rock-forming minerals, Silicate and non-silicate structures; CCP and HCP structures	06
Unit 5: Properties of light and optical microscopy		Total no. of Lectures
	Properties of light and optical microscopy Nature of light and principles of optical mineralogy, Isotropic & Anisotropic, Birefringence, Interference color, Extinction, Uniaxial & Biaxial Indicatrix, Introduction to the petrological microscope and identification of common rock-forming minerals	08

Books Recommended

- Duff, P. M. D., & Duff, D. (Eds.). (1993). *Holmes' principles of physical geology*. Taylor & Francis.
- Emiliani, C. (1992). *Planet earth: cosmology, geology, and the evolution of life and environment*. Cambridge University Press.
- Gross, M. G. (1977). *Oceanography: A view of the earth*.
- Klein, C., Dutrow, B., Dwight, J., & Klein, C. (2007). *The 23rd Edition of the Manual of Mineral Science (after James D. Dana)*. J. Wiley & Sons.
- Kerr, P. F. (1959). *Optical Mineralogy*. McGraw-Hill.
- Verma, P. K. (2010). *Optical Mineralogy (Four Colour)*. Ane Books Pvt Ltd.
- Deer, W. A., Howie, R. A., & Zussman, J. (1992). *An introduction to the rock-forming minerals (Vol. 696)*. London: Longman.





**Practical
Semester I**

**Major – 1 (MJ - 1) P (Practical) EARTH SYSTEM SCIENCE,
CRYSTALLOGRAPHY & MINERALOGY**

Credit – 2
FM= 100 [75 +25]

Lectures – 30 Hours
P = 25 (20Ext. +05Int.)

Practical Marks

- 1. Experiments from 1-8**
- 2. Experiments from 9-10**
- 3. Experiments from 11**
- 4. Class record & Viva Voce**

Distribution

05
05
05
05

Total=20

Suggested Practical:

MJ 1 EARTH SYSTEM SCIENCE, CRYSTALLOGRAPHY & MINERALOGY

1. Study of major geomorphic features and their relationships with outcrops through physiographic models.
2. Detailed study of topographic sheets and preparation of physiographic description of an area
3. Study of soil profile of any specific area
4. Study of distribution of major lithostratigraphic units on the map of India
5. Study of distribution of major dams on map of India and their impact on river systems
6. Study of major ocean currents of the World
7. Study of seismic profile of a specific area and its interpretation
8. Observation and documentation on symmetry of crystals
9. Study of physical properties of minerals in hand specimen: Silicates: Olivine, Garnet, Andalusite, Sillimanite, Kyanite, Staurolite, Beryl, Tourmaline, Augite, Actinolite, Tremolite, Hornblende, Serpentine, Talc, Muscovite, Biotite, Phlogopite, Quartz, Orthoclase, Plagioclase, Microcline, Nepheline, Sodalite, Zeolite, Quartz varieties: Chert, Flint, Chalcedony, Agate, Jasper, Amethyst, Rose quartz, Smoky quartz, Rock crystal.
10. Native Metals/non-metals, Sulfides, Oxides- Copper, Sulfur, Graphite, Pyrite, Corundum, Magnetite Hydroxides, Halides, Carbonates, Sulfates, Phosphates: Psilomelane, Fluorite, Calcite, Malachite, Gypsum, Apatite.
11. Study of some key silicate minerals under optical microscope and their characteristic properties.

Semester II

Major – 2 (MJ - 2) STRUCTURAL GEOLOGY**Credit – 4****FM= 100 [75 +25]****Lectures – 60 Hours****T= 75 {60Ext. +15 Int.} (10+05)}****Instructions:**

- There will be two groups of questions. **Group A** is compulsory which will contain **three** questions.
- **Question no. 1** will be **very short answer type** consisting of **five** questions of **1** mark each.
- **Question no. 2 & 3** will be of **short answer type** of **5** marks each.
- **Group B** will contain **descriptive type** five questions of **15** marks each, out of which **any three** are to answer.

Learning outcomes

After successfully completing this course, the students will be able to understand:

1. This course helps the students to understand how to use structures and appreciate the dynamic nature of the Earth's lithosphere.
2. The students will learn the skills of identifying different structure and will be acquainted with field measurements required for geological mapping, learn how to read geologic maps and solve simple map problems and preparations of cross sections.

Unit	Topic	Total no. of Lectures
Unit 1: Structure and Topography		
1.1	Effects of topography on structural features, Topographic and structural maps; Importance representative factors of the map, compass-Clinometer & Brunton, V's Rule	02
Unit 2: Stress and strain in rocks		
2.1	Concept of rock deformation: Stress and Strain in rocks & their types, Strain ellipses of different types and their geological significance. ductile and brittle deformation, Young's modulus of Elasticity Planar and linear structures; Concept of dip and strike; pitch and plunge, Outcrop patterns of	04

	different structures.	
Unit 3: Folds		
3.1	Fold morphology; Geometric and genetic classification of folds & recognition of fold in the Field. Introduction to the mechanism of folding: Buckling, Bending, Flexural slip and flow folding, shear zones and their types	10
Unit 4: Foliation and lineation		
4.1	Description, origin & types of foliations: axial plane cleavage and its tectonic significance, Description, origin & types of lineation and relationship with the major structures	06
Unit 5: Fractures, faults and Joints		
5.1	Geometric and genetic classification of fractures and faults, Effects of faulting on the outcrops Geologic/geomorphic criteria for recognition of faults and fault plane solutions, Joints types & significance, Unconformities: their types & significance	04

Books Recommended

- Davis, G. R. (1984) *Structural Geology of Rocks and Region*. John Wiley Billings, M. P. (1987) *Structural Geology*, 4th edition, Prentice-Hall.
- Park, R. G. (2004) *Foundations of Structural Geology*. Chapman & Hall.
- Pollard, D. D. (2005) *Fundamental of Structural Geology*. Cambridge University Press.
- Ragan, D. M. (2009) *Structural Geology: an introduction to geometrical techniques (4th Ed)*. Cambridge University Press (For Practical)
- Lahee F. H. (1962) *Field Geology*. McGraw Hill

**Practical
Semester II****Major – 2 (MJ - 2) STRUCTURAL GEOLOGY****Credit – 2****FM= 100 [75 +25]****Lectures – 30 Hours****P = 25 (20Ext. +05Int.)****Practical Marks****1. Experiments from 1-5****2. Experiments from 6-10****3. Field Visit Report****4. Class record & Viva Voce****Distribution****05****05****05****05**

Total=20**Suggested Practical****STRUCTURAL GEOLOGY**

1. Basic idea of topographic contours, Topographic sheets of various scales.
2. Introduction to Geological maps: Lithological and Structural maps
3. Structural contouring and 3-point problems of dip and strike
4. Drawing profile sections and interpretation of geological maps of different complexities, Exercises of stereographic projections of mesoscopic structural data (planar, linear, folded etc.)
5. Completion of outcrop of maps from partial data.
6. Outcrop pattern of horizontal and dipping beds, fold, fault, unconformity, dyke and sill.
7. Graphical solutions of simple structural problems: dip-strike, true dip-apparent dip
8. Three point problems and determination of dip and strike from borehole data.
9. Determination of vertical and true thickness of inclined beds.
10. Drawing of vertical geological sections to illustrate different geological structures.
11. Geological Mapping of two weeks duration in a geologically complex area and Field Work Report based on it

Semester III

Major – 3 (MJ - 3) IGNEOUS PETROLOGY**Credit – 4****FM= 100 [75 +25]****Lectures – 60 Hours****T= 75 {60Ext. +15 Int.} (10+05)}****Instructions:**

- There will be two groups of questions. **Group A** is compulsory which will contain **three** questions.
- **Question no. 1** will be **very short answer type** consisting of **five** questions of **1** mark each.
- **Question no. 2 & 3** will be of **short answer type** of **5** marks each.
- **Group B** will contain **descriptive type** **five** questions of **15** marks each, out of which **any three** are to answer.

Learning outcomes

After successfully completing this course, the students will be able to:

1. On completion of the course the students will have gained an understanding of the processes involved in the formation of igneous rocks, their textures, structures, classifications.
2. The students will also be able to identify, describe and classify rocks using hand specimens and in thin sections.

Unit	Topic	Total no. of Lectures
Unit 1: Forms	Magma - nature and composition; forms, Mode of occurrence of igneous rocks, Textures and structures of igneous rocks, Nature and type of partial melting in the mantle. Magmatic differentiation, Assimilation.	12
Unit 2: Phase diagrams	Unary, Binary Phase diagrams in understanding crystal-melt equilibrium–An-Ab, Or-Ab, Di-An, Eutectic & solid solution series, Ternary phase diagrams: Di-Ab-An, An-Di-Fo, An-Ab-Or. Magma generation in crust and mantle, their emplacement and evolution,	12
Unit 3: Magmatism in different tectonic settings	Magmatism in the oceanic domains (MORB, OIB), Magmatism along the plate margins (Island arcs/continental arcs), Alkaline magmatism, Mafic Intrusion, Continental Flood Basalt	12

Unit 4: Thermodynamics & classification of igneous rocks Introduction to thermodynamics & different Laws; Phase Rule: Phase, Component, Degree of Freedom, classification of igneous rocks based on physical, mineralogical and chemical attributes; IUGS and CIPW classification schemes; TAS diagram; magma generation and differentiation; Bowen's reaction principle.	12
Unit 5: Petrogenesis of Igneous rocks Petrogenesis, Origin & tectonic settings of I-, S-, A- type granites, Felsic and Mafic igneous rocks, Komatites, Granitoids, Basalt, Gabbros, Anorthosite, Alkaline rocks, Kimberlites, Lamprophyres, Peridotite, Andesite & Carbonatites.	12

Books Recommended:

- Philpotts, A., & Ague, J. (2009). *Principles of igneous and metamorphic petrology*. Cambridge University Press.
- Winter, J. D. (2014). *Principles of igneous and metamorphic petrology*. Pearson.
- Rollinson, H. R. (2014). *Using geochemical data: evaluation, presentation, interpretation*. Routledge.
- Raymond, L. A. (2002). *Petrology: the study of igneous, sedimentary, and metamorphic rocks*. McGraw- Hill Science Engineering.
- McBirney, A. R. (1984). *Igneous Petrology*. San Francisco (Freeman, Cooper & Company) and Oxford (Oxford Univ. Press),
- Myron G. Best (2001). *Igneous and Metamorphic Petrology*, K. G. Cox, J. D. Bell. (1979). *The Interpretation of Igneous Rocks*. Springer/Chapman & Hall.
- Bose M.K. (1997). *Igneous Petrology*. G W Tyrrell. (1926). *Principles of Petrology*. Springer.

**Practical
Semester III****Major – 3 (MJ - 3) IGNEOUS PETROLOGY****Credit – 2****FM= 100 [75 +25]****Lectures – 30 Hours****P = 25 (20Ext. +05Int.)****Practical****Marks Distribution**

- 1. Experiments from 1**
- 2. Experiments from 2**
- 3. Experiments from 3**
- 4. Class record & Viva Voce**

05**05****05****05**

Total=20**Suggested Practical:****IGNEOUS PETROLOGY**

1. Megascopic identification of igneous rocks.
2. Thin Section study of acid, basic and ultramafic rocks.
3. Plotting of rock compositions in classification diagrams (IUGS and CIPW classification schemes; TAS diagram)

Semester IV

Major – 4 (MJ - 4) SEDIMENTARY & METAMORPHIC PETROLOGY**Credit – 4****FM= 100 [75 +25]****Lectures – 60 Hours****T= 75 {60Ext. +15 Int.} (10+05)}****Instructions:**

- There will be two groups of questions. **Group A** is compulsory which will contain **three questions**.
- **Question no. 1** will be **very short answer type** consisting of **five questions of 1 mark each**.
- **Question no. 2 & 3** will be of **short answer type of 5 marks each**.
- **Group B** will contain **descriptive type five questions of 15 marks each**, out of which **any three are to answer**.

Learning outcomes

After successfully completing this course, the students will be able to:

1. On completion of the course the students will have gained an understanding of the processes involved in the formation of sedimentary & metamorphic rocks, their textures, structures, classifications.
2. The students will also be able to identify, describe and classify rocks using hand specimens and in thin sections.

Unit	Topic	Total no. of Lectures
Unit 1: Origin of sediments Weathering and sedimentary flux: Physical and chemical weathering, soils and paleosols. Process of formation of sedimentary rocks: sediment generation, transportation, deposition, lithification, and diagenesis Sediment Granulometry Grain size scales Udden-Wentworth and Krumbein (phi) scale, particle size distribution, Environmental connotation; particle shape and fabric, Carbonate rocks, controls of carbonate deposition, components and classification of limestone & sandstones		12
Unit 2: Sedimentary textures, structures and environment Fluid flow, sediment transport and sedimentary structures: Basic concept of sedimentary environment and facies; interpretation and reconstruction of sedimentary facies and depositional		12

environment, Paleocurrent analysis- Paleocurrents for different sedimentary environments, Sedimentary texture, Structure- Primary and syn-sedimentary structures	
Unit 3: Metamorphism: controls and types. Definition of metamorphism. Factors controlling metamorphism Types of metamorphism - contact, regional, fault zone metamorphism, impact metamorphism, Texture & Structure of metamorphism, Metasomatism	12
Unit 4: Metamorphic facies and grades Index minerals, Metamorphic zones and isogrades. Concept of metamorphic facies and grade Mineralogical phase rule of closed and open system, Classification of metamorphic rocks; introduction to P-T-t paths; ACF, AKF and AFM diagrams.	12
Unit 5: Metamorphic mineral reactions (prograde and retrograde), Paired metamorphic belts, Concepts of geothermometry and geobarometry Metamorphic rock associations- Schists, Gneisses, Khondalites, Charnockites, Blueschists and Eclogites	12

Books Recommended:

- Prothero, D. R., & Schwab, F. (2004). *Sedimentary geology*. Macmillan.
- Tucker, M. E. (2006) *Sedimentary Petrology*, Blackwell Publishing.
- Collinson, J. D. & Thompson, D. B. (1988) *Sedimentary structures*, Unwin- Hyman, London.
- Nichols, G. (2009) *Sedimentology and Stratigraphy Second Edition*. Wiley Blackwell.
- Philpotts, A., & Ague, J. (2009). *Principles of igneous and metamorphic petrology*. Cambridge University Press.
- Winter, J. D. (2014). *Principles of igneous and metamorphic petrology*. Pearson.
- Rollinson, H. R. (2014). *Using geochemical data: evaluation, presentation, interpretation*. Routledge.
- Raymond, L. A. (2002). *Petrology: the study of igneous, sedimentary, and metamorphic rocks*. McGraw- Hill Science Engineering.
- Yardley, B. W., & Yardley, B. W. D. (1989). *An introduction to metamorphic petrology*. Longman Earth Science Series

Semester IV

Major – 5 (MJ - 5) ECONOMIC GEOLOGY

Credit – 4

FM= 100 [75 +25]

Lectures – 60 Hours

T= 75 {60Ext. +15 Int.} (10+05)}

Instructions:

- There will be two groups of questions. **Group A** is compulsory which will contain **three** questions.
- **Question no. 1** will be **very short answer type** consisting of **five questions of 1 mark each**.
- **Question no. 2 & 3** will be of **short answer type** of **5 marks each**.
- **Group B** will contain **descriptive type five questions** of **15 marks each**, out of which **any three are to answer**.

Learning outcomes

After successfully completing this course, the students will be able to:

1. On completion of the course the students are expected to gain knowledge about various economic minerals, their processes of formation, mode of occurrence and uses.

Unit	Topic	Total no. of Lectures
Unit 1: Ores and gangues: Ores, gangue minerals, tenor, grade and lodes classification of economic deposits. Magmatic processes - early magmatic, late magmatic and residual liquid processes; hydrothermal processes; contact metamorphic processes; metamorphic ore forming processes.		12
Unit 2: Skarns, greisens, and Exogenous processes: weathering products and oxidation and supergene enrichment, placer deposits, petroleum and natural gas - constituents, properties, origin, and uses; coal - physical and chemical constituents, classification, mode of occurrence, origin, and uses; introduction to radioactive minerals		12
Unit 3: Mineral exploration Geological Prospecting and Exploration: Definitions and Principles; Methods of Prospecting; Different stages of Exploration. Radiometric survey.		12

Sampling, Cut-off grade, Resources and Reserves. Estimation of reserves Geochemical Exploration: Introduction, geochemical mobility and association of elements. Methods of Geophysical Investigation: Gravity method, Magnetic method, Seismic Method, Resistivity Method, IP Method & SP Method	
Unit 4: Metallic and Nonmetallic ores Mode of Occurrence, chemical composition, uses and distribution in India of following: Metallic deposits: Ores of Iron, Aluminum, Copper, Manganese, Lead and Zinc, Gold Non-metallic deposits: Mica, Asbestos and Limestone, Kyanite, Barite, Magnesite	12
Unit 5: Metallogenic provinces and epochs, types & Nature of ore forming fluids. Fluid inclusions and their application in the genesis of ores. Isotopes and their bearing on ore genesis and application.	12

Books Recommended:

- Guilbert, J.M. and Park Jr., C.F. (1986) *The Geology of Ore deposits*. Freeman & Co.
- Bateman, A.M. and Jensen, M.L. (1990) *Economic Mineral Deposits*. John Wiley.
- Evans, A.M. (1993) *Ore Geology and Industrial minerals*.
- Wiley Laurence Robb. (2005) *Introduction to ore forming processes*. Wiley.
- Gokhale, K.V.G.K. and Rao, T.C. (1978) *Ore deposits of India their distribution and processing*, Tata- McGraw Hill, New Delhi.
- Deb, S. (1980) *Industrial minerals and rocks of India*. Allied Publishers.
- Sarkar, S.C. and Gupta, A. (2014) *Crustal Evolution and Metallogeny in India*. Cambridge Publications.

**Practical
Semester V**

**Major – 4 & 5 (MJ – 4 & 5 P) (Practical) SEDIMENTARY, METAMORPHIC PETROLOGY
& ECONOMIC GEOLOGY**

Credit – 4

Lectures – 30 Hours

P = 50 (40Ext. +10Int.)

Practical

Marks Distribution

1. Sedimentary Petrology Experiment:	10
2. Metamorphic Petrology Experiment	10
3. Economic Geology Experiment	10
4. Field Report	05
5. Class record & Viva Voce	05

Total=40

Suggested Practical

MJ 4: SEDIMENTARY & METAMORPHIC PETROLOGY

1. Study of important Sedimentary rocks in hand specimens and thin sections
2. Megascopic and microscopic study (textural and mineralogical) of different metamorphic rocks,
3. Graphic plots for petrochemistry and interpretation of assemblages: ACF, AKF & AFM diagrams.

MJ 5: ECONOMIC GEOLOGY

1. Megascopic identification ore forming minerals (Oxides and sulphides).
2. Study of microscopic properties of ore forming minerals (Oxides and sulphides).
3. Preparation of maps: Distribution of important ores and other economic minerals in India.
4. Geological Mapping of two weeks duration of Economic Geology and Field Work Report based on it.



Semester V

Major – 6 (MJ - 6) STRATIGRAPHY & PALEONTOLOGY

Credit – 4

FM= 100 [75 +25]

Lectures – 60 Hours

T= 75 {60Ext. +15 Int.} (10+05)}

Instructions:

- There will be two groups of questions. **Group A** is compulsory which will contain **three** questions.
- **Question no. 1** will be **very short answer type** consisting of **five questions of 1 mark each**.
- **Question no. 2 & 3** will be of **short answer type** of **5 marks each**.
- **Group B** will contain **descriptive type** **five questions of 15 marks each**, out of which **any three are to answer**.

Learning outcomes

Upon successful completion of this course, students should be able to:

1. Stratigraphers study the composition and arrangement of layered or stratified rocks.
2. Paleontologists study the remains of plants and animals which have been preserved in the earth's crust by natural processes.
3. With these objectives in mind it becomes pertinent to understand the basic concepts of

Unit	Topic	Total no. of Lectures
Unit 1:		12
Principles of stratigraphy: Introduction to the concepts of lithostratigraphy, biostratigraphy, chronostratigraphy, seismic stratigraphy, chemostratigraphy, Magnetostratigraphy; Principles of stratigraphic analysis and Physiographic and tectonic subdivisions of India: Concept of paleogeographic reconstruction; Sequence stratigraphy and their subdivisions with Indian examples. Introduction to the physiographic and tectonic subdivisions of India. Introduction to Indian Shield		
Unit 2:		12
Pre-Cambrian Stratigraphy of India: Pre-Cambrian geology of Singhbhum and Dharwar, Karnataka; Introduction to Proterozoic basins of India; Geology of Vindhyan and Cudappah basins of India. Phanerozoic Stratigraphy of India:		

Geology, Structure and hydrocarbon potential of Gondwana basins. Cenozoic stratigraphy of India: a. Siwalik successions, b. Assam basins. Stratigraphy and structure of Krishna-Godavari basin, Cauvery basin, Bombay offshore basin and their potential for hydrocarbon exploration	
Unit 3: Volcanic provinces of India and Stratigraphic boundaries: Deccan Traps, Important Stratigraphic boundaries in India - a. Precambrian-Cambrian boundary, b. Permian-Triassic boundary, and c. Cretaceous-Tertiary boundary, d. Neogene-Quaternary boundary	12
Unit 4: Fossilization and fossil record: Nature and importance of fossil record; Fossilization processes and modes of preservation Taxonomy and Species concept: Species concept with special reference to paleontology, Theory of organic evolution.	12
Unit 5: Invertebrates: Brief introduction of important fossils groups: morphology and geological history of Trilobita, Brachiopoda, Gastropoda, Cephalopoda and Lamellibranch. Vertebrates and other fossils: Evolution of horse and intercontinental migrations. Human evolution. Gondwana Flora Application of fossils in Stratigraphy: Index fossils, correlation Fossils and Paleo-environmental analysis, Fossils and paleobiogeography	12

Books Recommended:

- Krishnan, M. S. (1982) *Geology of India and Burma*, CBS Publishers,
- Delhi Doyle, P. & Bennett, M. R. (1996) *Unlocking the Stratigraphic Record*. John Wiley
- Ramakrishnan, M. & Vaidyanadhan, R. (2008) *Geology of India Volumes 1 & 2*, Geological Society of India, Bangalore.
- Valdiya, K. S. (2010) *The making of India*, Macmillan India Pvt. Ltd.
- Raup, D. M., Stanley, S. M., Freeman, W. H. (1971) *Principles of Paleontology*
- Clarkson, E. N. K. (2012) *Invertebrate paleontology and evolution 4th Edition* by Blackwell Publishing.
- Benton, M. (2009). *Vertebrate paleontology*. John Wiley & Sons.
- Shukla, A. C., & Misra, S. P. (1975). *Essentials of paleobotany*. Vikas Publisher

➤ *Armstrong, H. A., & Brasier, M.D. (2005) Microfossils. Blackwell Publishing.*

Semester V

Major – 7 (MJ - 7) ELEMENTS OF GEOCHEMISTRY

Credit – 4

FM= 100 [75 +25]

Lectures – 60 Hours

T= 75 {60Ext. +15 Int.} (10+05)}

Instructions:

- There will be two groups of questions. **Group A** is compulsory which will contain **three** questions.
- **Question no. 1** will be very short answer type consisting of **five** questions of **1** mark each.
- **Question no. 2 & 3** will be of short answer type of **5** marks each.
- **Group B** will contain descriptive type five questions of **15** marks each, out of which any three are to answer.

Learning outcomes

After successfully completing this course, the students will be able to:

1. Understand the distribution of various elements and their abundances in the earth's crust.
2. To understand how chemical weathering of minerals and rocks control the composition of sediments/soil and natural water.

Unit	Topic	Total no. of Lectures
Unit 1: Concepts of geochemistry & stable isotope Introduction to properties of elements: The periodic table. Chemical bonding, Geochemical classification of elements Stable isotope systematics: Carbon, Oxygen, Hydrogen and Sulphur and their implication.		12
Unit 2: Layered structure of Earth and isotope geochemistry Composition of different Earth reservoirs and the nuclides and radioactivity. Discovery of Radioactivity and isotopes as well and its influence on Earth Sciences. Nuclide types, their abundances, and atomic weights. Decay mechanisms of radioactive atoms. Radioactive decay and growth. Basic principles of radiometric dating methods of Rocks: K – Ar and Ar – Ar methods, Rb – Sr and Sm – Nd methods, U – (Th–)Pb methods.		12

Unit 3: Advection and diffusion. Chromatography. Aqueous geochemistry- basic concepts and speciation in solutions, Eh, pH relations Whole rock analysis (major, trace REE), Concept of compatible and incompatible elements, Use of geochemistry in deducing tectonics.	12
Unit 4: Geochemistry of solid Earth The solid Earth – geochemical variability of magma and its products. The Earth in the solar system, the formation of solar system Composition of the bulk silicate Earth. Meteorites	12
Unit 5: Cosmic abundance of elements Distribution of elements in solar system and in Earth Chemical differentiation and composition of the Earth, General concepts about geochemical cycles and mass balance. Properties of elements, Geochemical behavior of major elements.	12

Books Recommended:

- Mason, B. (1986) *Principles of Geochemistry*. 3rd Edition, Wiley New York.
- Rollinson, H. (2007) *Using geochemical data – evaluation, presentation and interpretation*. 2nd Edition. Publisher Longman Scientific & Technical.
- Walther, J. V. (2009). *Essentials of geochemistry*. Jones & Bartlett Publishers.
- Albarède, F. (2003). *Geochemistry: an introduction*. Cambridge University Press.
- Faure, Gunter and Teresa M. Mensing (2004). *Isotopes: Principles and Applications*, Wiley India Pvt. Ltd





**Practical
Semester V**

Major – 6& 7 (MJ – 6 & 7) (Practical) Stratigraphy, Paleontology & Elements of Geochemistry
Credit – 4**Lectures – 30 Hours****P = 50 (40Ext. +10Int.)**

Practical**Marks Distribution**

1. Stratigraphy Experiment	10
2. Paleontology Experiment	10
3. Elements of Geochemistry Experiment	10
4. Record & Viva voce	10

Total=40**Suggested Practical****MJ 6 Stratigraphy & Paleontology**

1. Study of geological map of India and identification of major stratigraphic units; Study of rocks in hand specimens from known Indian stratigraphic horizons;
2. Drawing various Paleo-geographic maps of Precambrian time; Study of different Proterozoic supercontinent reconstructions.
3. Study of fossils showing various modes of preservation; Study of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate, vertebrate and plant fossils

MJ 7 Elements of Geochemistry

1. Types of geochemical data analysis and interpretation; of common geochemical plots.
2. Geochemical analysis of geological materials.
3. Geochemical variation diagrams and its interpretations



Semester VI

Major – 8 (MJ - 8) HYDRO GEOLOGY & GEOMORPHOLOGY**Credit – 4****Lectures – 60 Hours****FM= 100 [75 +25]****T= 75 {60Ext. +15 Int.} (10+05)}****Instructions:**

- There will be two groups of questions. **Group A** is compulsory which will contain **three** questions.
- **Question no. 1** will be **very short answer type** consisting of **five** questions of **1** mark each.
- **Question no. 2 & 3** will be of **short answer type** of **5** marks each.
- **Group B** will contain **descriptive type** **five** questions of **15** marks each, out of which **any three** are to answer.

Learning outcomes

After successfully completing this course, the students will be able to:

Understand the fundamental concepts of hydrogeology.

They will learn about occurrence and movement of groundwater, aquifers and their parameters, groundwater exploration methods, aspects of groundwater chemistry and groundwater management. The advantages to study geomorphology, fundamentals of working of earth surface processes, and various geomorphic techniques, geomorphology of India, and extra-terrestrial landforms.

Unit	Topic	Total no. of Lectures
Unit 1: Hydrologic Cycle, Distribution of water in Earth crust, Groundwater in hydrologic cycle; Ground water, origin, types, importance; Aquifer, their types and characteristics; Hydrologic properties of aquifer materials: porosity; permeability; specific yield; specific retention, hydraulic conductivity,		12
Unit 2: Forces and laws of groundwater movement; Darcy law and its application in hydrogeology; Confined, unconfined; Methods of pumping test and evaluation of aquifer parameters. Springs: types, origin and movement of water, Hydrographic analyses, Water budget studies; Water resource inventory of the basin; Consumptive and conjunctive use of surface and groundwater; Causative factors for Water Table fluctuation.		12

Unit 3: Wells: types, drilling methods, construction, design and development of wells; Physical and Chemical characteristics of groundwater. Interpretation of chemical analysis. Relationship of quality to use. Ground water pollution; Sources of surface and subsurface pollution; Control of ground water pollution Water contaminants and pollutants, Saline water intrusion in coastal and other aquifers and its prevention; Groundwater contamination and problems of arsenic and fluoride in Indian subcontinent with special reference to Jharkhand .	12
Unit 4: Introduction to Geomorphology, Endogenic and Exogenic processes, Geoid, Topography, Global Hypsometry; Major Morphological features Large Scale Topography - Ocean basins, Large scale mountain ranges (with emphasis on Himalaya). Surficial Processes and geomorphology: Weathering and associated landforms, Glacial, Periglacial processes and landforms,	12
Unit 5: Fluvial processes and landforms, Aeolian Processes and landforms, Landforms associated with igneous activities, Endogenic- Exogenic interactions, Rates of uplift and denudation, Tectonics and drainage development, Sea-level change, Overview of Indian Geomorphology.	12

Books Recommended:

- C.F. Tolman (1937): *Groundwater*, McGraw Hill , New York and London.
- D.K. Todd (1995): *Groundwater HydrolGeology*, John Wiley and Sons.
- F.G. Driscoll (1988): *Groundwater and Wells*, UOP, Johnson Div.St.Paul. Min. USA.
- H.M. Raghunath (1990): *Groundwater*, Wiley Eastern Ltd.,
- H.S. Nagabhushaniah (2001): *Groundwater in Hydrosphere (Groundwater hydrolGeology)*, CBS Publ..
- K. R. Karanth (1989): *HydroGeology*, Tata McGraw Hill Publ..
- S.N. Davies and R.J.N. De Wiest (1966): *HydroGeology*, John Wiley and Sons, New York.
- Patra, H. P., Adhikari, Shyamal Kumar, Kunar, Subrata(2016)*Groundwater Prospecting and Management*,Springer
- Jakeman, A.J., Barreteau, O., Hunt, R.J., Rinaudo, J.-D.,Ross, A. (2016) *Integrated Groundwater Management:Concepts, Approaches and Challenges*,Springer
- Ramanathan, A., Johnston, S., Mukherjee, A., Nath, B. (Eds.)2015,*Safe and Sustainable Use of Arsenic- Contaminated Aquifers in the Gangetic Plain*
- Robert S. Anderson and Suzzane P. Anderson (2010):
- *Geomorphology - The Mechanics and Chemistry of Landscapes*. Cambridge University Press. M.A. Summerfield (1991) *Global Geomorphology*. Wiley & Sons.

Semester VI

Major – 9 (MJ - 9) ENGINEERING GEOLOGY, REMOTE SENSING & GIS

Credit – 4

Lectures – 60 Hours

FM= 100 [75 +25]

T= 75 {60Ext. +15 Int.} (10+05)}

Instructions:

- There will be two groups of questions. **Group A** is compulsory which will contain **three** questions.
- **Question no. 1** will be **very short answer type** consisting of **five questions of 1 mark each**.
- **Question no. 2 & 3** will be of **short answer type of 5 marks each**.
- **Group B** will contain **descriptive type five questions of 15 marks each**, out of which **any three are to answer**.

Learning outcomes

1. To impart sufficient knowledge of engineering geology so as to be able to anticipate the technical problems related to geology of various engineering sites and suggest possible remedial measures.
2. This course is designed as an introduction to the use of remote imaging in geologic applications. The basic concepts of image production, processing and interpretations are covered.

Unit	Topic	Total no. of Lectures
Unit 1: Engineering Geology and its applications, Scope of Engineering Geology; Elementary concepts of rock mechanics - Strength and Elastic properties. Engineering properties and characteristics of soils. Properties of building stones. Basic concept of-Rock Quality Designation (RQD), Rock Structure Rating (RSR), Rock Mass Rating (RMR), Tunneling Quality Index (Q)		12
Unit 2: Dams and reservoirs: Types of Dams-masonry or concrete dams-gravity, arch and buttress. Earth Dams and composite dams. Geological considerations- topography, structure and lithology. Foundation and seepage problems in dams and their treatment. Reservoir: Reservoir problems- seepage and silting		12
Unit 3: Tunnels: terminology, definition, types- hard rock and soft rock tunnels. Geological considerations- topography, structure and		12

lithology Bridge sites: Terminology, Bridge structure, types, bridge problems, and stability of bridges. Geology of bridge sites. Classification of slopes- stable and unstable slopes- Geological parameters. Measures for stabilization of slopes. Foundation treatment; Grouting, Rock Bolting and other support mechanisms; soil stabilization.	
Unit 4: Photogeology: Types and acquisition of aerial photograph, Scale and resolution, Elements of air photo interpretation. Identification of sedimentary, igneous and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms Remote Sensing: Concepts in remote sensing, Sensors and scanners, Satellites and their characteristics, Data formats- Raster and Vector. Digital Image Processing: Fundamentals of Image processing, Image Correction, Image enhancement, Image classification, FCC and Image Ratioing	12
Unit 5: GIS: Datum, Coordinate systems and Projection systems, Introduction to DEM analysis; GIS integration and Case studies- Indian Examples GPS, Concepts of GPS: Integrating GPS data with GIS, Applications in earth system sciences	12

Books Recommended:**MJ 8**

- Krynin, D.P. and Judd W.R. 1957. *Principles of Engineering Geology and Geotechnique*, McGraw Hill (CBS Publ).
- Johnson, R.B. and De Graf, J.V. 1988. *Principles of Engineering Geology*, John Wiley.
- Goodman, R.E., 1993. *Engineering Geology: Rock in Engineering constructions*. John Wiley & Sons, N.Y. Waltham, T., 2009. *Foundations of Engineering Geology (3rd Edn.)* Taylor & Francis.
- Bell, F.G., 2006. *Basic Environmental and Engineering Geology* Whittles Publishing.
- Bell, F.G., 2007. *Engineering Geology*, Butterworth-Heineman

MJ 9

- Demers, M.N., 1997. *Fundamentals of Geographic Information System*, John Wiley & sons. Inc.
- Hoffmann-Wellenhof, B., Lichtenegger, H. and Collins, J., 2001. *GPS: Theory & Practice*, Springer Wien New York.
- Jensen, J.R., 1996. *Introductory Digital Image Processing: A Remote Sensing Perspective*, Springer- Verlag.

**Practical
Semester VI****Major – 8 & 9 (MJ –8 & 9) (Practical) ENGINEERING GEOLOGY, REMOTE SENSING & GIS****Credit – 4****Lectures – 30 Hours****P = 50 (40Ext. +10Int.)****Practical****Marks Distribution**

1. Engineering Geological Experiment	10
2. Photo Geology Experiment:	10
3. Remote Sensing & GIS Experiment:	10
4. Record	05
5. Viva voce	05

Total=40**Suggested Practical**

1. Computation of reservoir area, catchment area, reservoir capacity and reservoir life.
2. Merits, demerits & remedial measures based upon geological cross sections of project sites.
3. Computation of index properties of rocks.
4. Computation of RQD, RSR, RMR and 'Q'
5. Plotting of Major Dams/ Tunnels on the outline map of India.
6. Study of Seismic / landslide zones of India.
7. Aerial Photo/ imagery interpretation, identification of sedimentary, igneous and metamorphic rocks
8. Identification of structural features in Aerial Photo/Satellite imagery
9. Identification of geomorphic features in Aerial Photo/Satellite imagery

**Advance Major
Semester VII**

Advance Major – 1 (AMJ – 1a) FUEL GEOLOGY

Credit – 4

FM= 100 [75 +25]

Lectures – 60 Hours

T= 75 {60Ext. +15 Int.} (10+05)}

Instructions:

- There will be two groups of questions. **Group A** is compulsory which will contain **three** questions.
- **Question no. 1** will be **very short answer type** consisting of **five** questions of **1** mark each.
- **Question no. 2 & 3** will be of **short answer type** of **5** marks each.
- **Group B** will contain **descriptive type** five questions of **15** marks each, out of which any **three** are to answer.

Learning outcomes

After successfully completing this course, the students will be able to understand:

1. The course aims at understanding the various types of mineral deposits, classification, their mode of occurrence, geologic & geographical distribution and genesis.
2. It primarily focuses on the processes of formation of ore deposits. Furthermore, it also aims at identification of economic minerals in hand specimens.

Unit	Topic	Total no. of Lectures
Unit 1: Coal:	Definition and origin of Coal; Basic classification of coal; Fundamentals of Coal Petrology - Introduction to lithotypes, microlithotypes and macerals in coal. Proximate and Ultimate analysis	12
Unit 2: Coal as a fuel	Coal Bed Methane (CBM): global and Indian scenario. Underground coal gasification, Coal liquefaction	12
Unit 3: Petroleum	Chemical composition and physical properties of crudes in nature. Origin of petroleum.	12

Unit 4: Petroleum Reservoirs and Traps Reservoir rocks: general attributes, Classification of reservoir rocks Cap rocks - definition and general properties. Hydrocarbon traps: definition, Classification of hydrocarbon traps - structural, stratigraphic and combination. Nuclear Fuel & Gas Hydrate	12
Unit 5: Indian Occurrences: Coalfields of India with special reference to Jharkhand	12

Books Recommended

- Chandra D. (2007). *Chandra's Textbook on applied coal petrology*. Jijnasa Publishing House.
- Shelly R. C. (2014). *Elements of Petroleum geology: Third Edition*, Academic Press
- Bjorlykke, K. (1989). *Sedimentology and petroleum geology*. Springer-Verlag.
- Bastia, R., & Radhakrishna, M. (2012). *Basin evolution and petroleum prospectivity of the continental margins of India (Vol. 59)*. Newnes



Semester VII

Advance Major – 2 (AMJ – 2a) ORE GEOLOGY

Credit – 4

FM= 100 [75 +25]

Lectures – 60 Hours

T= 75 {60Ext. +15 Int.} (10+05)}

Instructions:

- There will be two groups of questions. **Group A** is compulsory which will contain **three** questions.
- **Question no. 1** will be **very short answer type** consisting of **five** questions of **1** mark each.
- **Question no. 2 & 3** will be of **short answer type** of **5** marks each.
- **Group B** will contain **descriptive type** **five** questions of **15** marks each, out of which **any three** are to answer.

Learning outcomes

After successfully completing this course, the students will be able to understand:

2. On completion of the course the students are expected to gain knowledge about various economic minerals, their processes of formation, mode of occurrence and uses.

Unit	Topic	Total no. of Lectures
Unit 1: Ore deposits and ore minerals. Classification of ore deposits. Magmatic processes of mineralization. Porphyry, skarn and hydrothermal mineralization.		12
Unit-2 Structure and texture of ores, Paragenesis, Controls of ore localisation. Spatial and temporal distribution of ore deposits.		12
Unit-3 Plate tectonics and ore genesis. Ore bearing fluids, movement of ore bearing fluids, Fluid inclusion studies of ores, Geothermometry.		12

Unit-4 Mineralization associated with ultramafic, mafic and acidic rocks, Wall rock alteration, Magma related mineralization through geological time.	12
Unit-5 Mineralization associated with sedimentary rocks, submarine volcanism, and metamorphic processes. Strati-form and strata-bound ores.	12

Books Recommended:

- Edwards, R. and Atkinson, K. (1986) *Ore Deposit Geology*. Chapman and Hall, London.
- Craig, J.M. and Vaughan, D.J. (1981) *Ore Petrography and Mineral Geology*. John Wiley.
- Evans, A.M. (2012) *Ore Geology and Industrial Minerals*. Third Edition (Reprint), Blackwell
- Sawkins, F.J. (1984) *Metal Deposits in relation to Plate Tectonics*. Springer Verlag.
- Stanton, R.L. (1972) *Ore Petrology*. McGraw Hill.
- Torling, D.H. (1981) *Economic Geology and Geotectonics*. Blackwell Sci. Publ.
- Barnes, H.L (1979) *Geochemistry of Hydrothermal Ore Deposits*. John Wiley.
- Klemm, D.D. and Schneider, H.J. (1977) *Time and Strata Bound Ore Deposits*. Springer Verlag.
- Guilbert, J.M. and Park, Jr. C.F. (1986) *The Geology of Ore Deposits*. Freeman.
- Mookherjee, A. (2000) *Ore genesis -a Holistic Approach*. Allied Publishers.
- Wolf, K.H. (1981) *Hand book of Strata Bound and Stratiform Ore Deposits*. Elsevier.

**Practical
Semester VII**

Advance Major – 1 & 2(AMJ – 1a & 2a) FUEL GEOLOGY & ORE GEOLOGY**Credit – 4****Lectures – 30 Hours****F.M. = 50**

Practical**Marks Distribution**

1. Fuel Geology	20
2. Ore Geology	20
3. Class record	05
4. Viva Voce	05
	<hr/>
	Total=50

Suggested Practical:**AMJ 1a : FUEL GEOLOGY**

1. Study of hand specimens of coal
2. Reserve estimation of coal and economic mineral deposits
3. Study of Geological Section Coal and Petroleum fields and identification of hydrocarbon prospect

AMJ 2a : ORE GEOLOGY

1. Study of Geological cross-section of important mineral deposits
2. Study of distribution of important ore deposits in India
3. Megascopic & microscopic study of important ores and their textures.
4. Megascopic study of important industrial, metallic and non-metallic, precious and semi-precious stones.
5. Exercises on ore reserve calculations.
6. Estimation of grade of ores.

Advance Major – 1 (AMJ – 1b) EARTH & CLIMATE**Credit – 4****FM= 100 [75 +25]****Lectures – 60 Hours****T= 75 {60Ext. +15 Int.} (10+05)}****Instructions:**

- There will be two groups of questions. **Group A** is compulsory which will contain **three** questions.
- **Question no. 1** will be **very short answer type** consisting of **five** questions of **1** mark each.
- **Question no. 2 & 3** will be of **short answer type** of **5** marks each.
- **Group B** will contain **descriptive type** **five** questions of **15** marks each, out of which any **three** are to answer.

Learning outcomes

After completion of this course students will be able to understand and comprehend the connectivity and dynamics of atmosphere, lithosphere, and hydrosphere of the Earth. A thorough understanding of Geology, its various branches and overall scope of Earth Science will be possible through this course.

Unit	Topic	Total no. of Lectures
Unit 1: Climate system: Forcing and Responses, Components of the climate system, Climate forcing, Climate controlling factors, Climate system response, response rates and interactions within the climate system Feedbacks in climate system		12
Unit 2: Heat budget of Earth Incoming solar radiation, receipt and storage of heat Heat transformation Earth's heat budget. Interactions amongst various sources of earth's heat		12
Unit 3: Atmosphere – Hydrosphere, Layering of atmosphere and atmospheric Circulation, Atmosphere and ocean interaction and its effect on climate, Heat transfer in ocean, Global oceanic conveyor belt and its control on earth's climate, Surface and deep circulation, Sea ice and glacial ice		12

Unit 4: Response of biosphere to Earth's climate, Climate Change: natural vs. anthropogenic effects, Humans and climate change, Future perspectives, Brief introduction to archives of climate change, Archive based climate change data from the Indian continent	12
Unit 5: Orbital cyclicity and climate, Milankovitch cycles and variability in the climate, Glacial-interglacial stages, The Last Glacial maximum (LGM), Pleistocene Glacial-Interglacial cycles, Younger Dryas, Marine isotope stages, Monsoon, Mechanism of monsoon, Monsoonal variation through time, Factors associated with monsoonal intensity, Effects of monsoon	12

Books Recommended

- Rudiman, W.F., 2001. Earth's climate: past and future. Edition 2, Freeman Publisher.
- Rohli, R.V., and Vega, A.J., 2007. Climatology. Jones and Barlett
- Lutgens, F., Tarbuck, E., and Tasa, D., 2009. The Atmosphere: An Introduction to Meteorology. Pearson Publisher
- Aguado, E., and Burt, J., 2009. Understanding weather



Advance Major – 2 (AMJ – 2b) SOIL GEOSCIENCE**Credit – 4****FM= 100 [75 +25]****Lectures – 60 Hours****T= 75 {60Ext. +15 Int.} (10+05)}****Instructions:**

- There will be two groups of questions. **Group A** is compulsory which will contain **three questions**.
- **Question no. 1** will be **very short answer type** consisting of **five questions of 1 mark each**.
- **Question no. 2 & 3** will be of **short answer type of 5 marks each**.
- **Group B** will contain **descriptive type five questions of 15 marks each**, out of which **any three are to answer**.

Learning outcomes

After completion of this course students will be able to understand and comprehend the connectivity

1. Students will have idea on soil forming processes
2. Students will come to know recognizing criteria of palaeosol
3. Students will have idea on geological record of fossil soils

Unit	Topic	Total no. of Lectures
Unit 1: Soil forming processes: Chemical weathering, major buffer maintaining ocean/atm/biosphere O ₂ and CO ₂ , new compounds/minerals of greater volume and lower density; Oxidation; Carbonation; Hydrolysis; Hydration; Base Exchange; Chelation; Microbial weathering		12
Unit 2: General soil forming regimes: Gleization; podzolization; lessivage; ferrallitization; calcification; salinization, Soil forming processes: Physical weathering, loosening and particle size reduction; pressure release; thermal expansion; growth of foreign crystal, Modern soils and key pedofeatures: Soil structures; horizons; roots; Fe-Mn mottles and concretions; pedogenic carbonate		12
Unit 3: Introduction to paleopedology and paleosols; role of factors controlling paleosol formation- parent material, climate, vegetation, topography, time. Introduction to soil taxonomy and paleosol taxonomy, Micromorphology: Thin section analysis of paleosols		12

Unit 4: Geochemistry: molecular rations; chemical weathering indices, Stable isotope geochemistry: carbon13 and oxygen18 system for vegetation, temperature, pCO ₂ , Diagenetic overprinting in fossil soils: compaction; oxidation of organic matter; cementation; illitization, Geological record of fossil soils- Precambrian paleosols- evolution of paleoatmospheric conditions	12
Unit 5: Geological record of fossil soils- Paleozoic paleosols- evolution of land animals and plants, coal, Permian-Triassic transition paleosols and extinction events, Geological record of fossil soils- Mesozoic-Cenozoic paleosols- fossil soils at K-T extinction event, Paleogene fossil soils at green house to ice house transition, evolution of Asian monsoon system.	12

Books Recommended

- *Micromorphic detailing of the paleosols- structure, horizonation, color, rhizcretions, pedogenic carbonate etc.*
- *Particle size analysis and clay mineral analysis of the paleosols*
- *Micromorphological analysis- thin section preparation, description, and interpretation*
- *Geochemical analysis- bulk geochemistry, molecular rations and weathering indices*
- *Field trip to examine modern and fossil soils- field characterization and sampling procedures*





**Practical
Semester VII**

Advance Major – 1 & 2 (AMJ – 1b & 2b) EARTH & CLIMATE & SOIL GEOSCIENCE
Credit – 4

Lectures – 30 Hours
F.M. = 50

Practical	Marks Distribution
1. Earth & Climate	20
2. Soil Geoscience	20
3. Class record	05
4. Viva Voce	05
	<hr/> Total=50

Suggested Practical:

AMJ 1a : EARTH & CLIMATE

1. Study of distribution of major climatic regimes of India on map
2. Distribution of major wind patterns on World map
3. Preparation of paleogeographic maps (distribution of land and sea) of India during specific geological time intervals
4. Numerical exercises on interpretation of proxy records for paleoclimate

AMJ 2a : SOIL GEOSCIENCE

1. Micromorphic detailing of the paleosols- structure, horizonation, color, rhizocretions, pedogenic carbonate etc.
2. Particle size analysis and clay mineral analysis of the paleosols
3. Micromorphological analysis- thin section preparation, description, and interpretation
4. Geochemical analysis- bulk geochemistry, molecular ratios and weathering indices
5. Field trip to examine modern and fossil soils- field characterization and sampling procedures.

Advance Major – 1 (AMJ – 1c) SEDIMENTOLOGY

Credit – 4

FM= 100 [75 +25]

Lectures – 60 Hours

T= 75 {60Ext. +15 Int.} (10+05)}

Instructions:

- There will be two groups of questions. **Group A** is compulsory which will contain **three** questions.
- **Question no. 1** will be **very short answer type** consisting of **five** questions of **1 mark** each.
- **Question no. 2 & 3** will be of **short answer type** of **5 marks** each.
- **Group B** will contain **descriptive type** **five** questions of **15 marks** each, out of which **any three** are to answer.

Learning outcomes

After completion of this course students will be able to understand and comprehend the connectivity

1. Application of the Principle of Uniformitarianism in field
2. Basement cover relationships - identifications and interpretations
3. Establishing order of superposition of geological units especially with the help of fossils

Unit	Topic	Total no. of Lectures
Unit-1	Concept of soil, components of soil, soil profile; Process of soil formation, pedogenic processes, Factors of soil formation;	12
Unit 2	Classification of soil, mineral and chemical composition of soils, mineral stability during weathering; Soil organic matter form and function;	12
Unit-3	Fabric analysis - size and shape, concepts of size and shape, grade scale, methods of analysis, presentation of data, analysis and field grading; Concepts of structure fabric: Soil fabric, soil structure, soil texture and field grading units;	12
Unit-4	Paleosols - field recognition, description, origin and causes; Paleosol in stratigraphic records; Significance of paleosol study; Paleosols and human evolution. Causes of Soil erosion and degradation, A brief introduction to methods of soil conservation.	12

Unit-5 Calcrete - definition, classification, calcrete formation, pedogenic calcrete soil profile, macro features in calcretes, micromorphoGeology (petrography), calcretes from Quaternary and ancient sedimentary sequences; significance of calcretes; Laterite - characteristics, genesis, Indian occurrences.	12
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Books Recommended

- Boul, S.W., Hole, F.D., Mc Craken, R.J. and South, R.J. (1997): *Soil Genesis and classification*. 4th Edn, State University Press.
- Braddy, N.C. (2002): *Nature and Properties of Soils*.
- Govinda Rajan, S.V. and Gopala Rao, K. H.G. (1979): *Studies of Soils of India*.
- Sposito, Garrison. (1989): *The Chemistry of Soils*, Oxford Univ. Press.
- Terzaghi, K. and Pock, R.G. 1996): *Soil Mechanics in Engineering* (3rd Ed.), John Wiley.
- Wright; V. Paul (1992): *Paleosols: their recognition and interpretation*, Blackwell Scientific Publ.
- Wright, V. Paul and Tucker, M.E. (1991): *Calcretes*. Blackwell Scientific Publ.

Advance Major – 2 (AMJ – 2c) RIVER SCIENCE**Credit – 4****FM= 100 [75 +25]****Lectures – 60 Hours****T= 75 {60Ext. +15 Int.} (10+05)}****Instructions:**

- There will be two groups of questions. **Group A** is compulsory which will contain **three** questions.
- **Question no. 1** will be **very short answer type** consisting of **five** questions of **1** mark each.
- **Question no. 2 & 3** will be of **short answer type** of **5** marks each.
- **Group B** will contain **descriptive type** five questions of **15** marks each, out of which **any three** are to answer.

Learning outcomes

After completion of this course students will be able to understand and comprehend the connectivity

- 1 Rivers through geological time
2. Fluvial degradational and aggradational processes
3. Landforms associated with the rivers

Unit	Topic	Total no. of Lectures
Unit –1	Stream hydrology : Basic stream hydrology , Physical properties of water, sediment and channel flow, River discharge, River hydrographs (UH, IUH, SUH, GIUH) and its application in hydrological analysis, Flood frequency analysis	12
Unit-2	River basin: Sediment source and catchment erosion processes, Sediment load and sediment yield, Sediment transport processes in rivers, Erosion and sedimentation processes in channel.	12
Unit-3	Drainage: Drainage network, Quantitative analysis of network organization – morphometry, Random Topology (RT) model and fractal analysis, Role of drainage network in flux transfer, Evolution of drainage network in geological time scale.	12
Unit 4	Rivers in time and space : River diversity in space, Patterns of alluvial rivers - braided, meandering and anabranching channels, Dynamics of alluvial rivers, Channel patterns in stratigraphic sequences, Different classification approaches in fluvial geomorphology and its applications.	12

Unit-5 Bedrock channels, Bedrock incision process, River response to climate, tectonics and human disturbance, Bedrock channel processes and evolution of fluvial landscapes, Integrated approach to stream management, Introduction to river ecology.	12
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Books Recommended

- Davies, T. (2008) *Fundamentals of hydrology*. Routledge Publications.
- Knighton, D. (1998) *Fluvial forms and processes: A new perspective*. Arnold Pubs.
- Richards, K. (2004) *Rivers: Forms and processes in alluvial channels*. Balckburn Press.
- Bryirely and Fryirs (2005) *Geomorphology and river management*. Blackwell Pub.,
- Julien, P.Y. (2002) *River Mechanics*. Cambridge University Press.
- Robert, A. (2003) *River Processes: An introduction to fluvial dynamics*. Arnold Publications.
- Vanoni, V.A. (2006) *Sedimentation Engineering*. ASCE Manual, Published y American Society of Civil Engineering,
- Tinkler, K.J., Wohl, E.E. (eds.) 1998. *Rivers over rock*. American Geophysical Union Monogrpah, Washington, DC.



**Practical
Semester VII**

Advance Major – 1 & 2 (AMJ – 1c & 2c) SEDIMENTOLOGY & RIVER SCIENCE
Credit – 4

Lectures – 30 Hours

F.M. = 50

Practical

Marks Distribution

5. Sedimentology	20
6. River Science	20
7. Class record	05
8. Viva Voce	05
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Total=50	

Suggested Practical:

AMJ 1a : SEDIMENTOLOGY

1. Graphic plot of size data and calculation of statistical parameters.
2. Study of Mechanical, Chemical and Biogenic Sedimentary structures and their Sedimentological significance
3. Megascopic and microscopic study of clastic and non-clastic rocks.
4. Study of vertical profile sections of selected sedimentary environments;
5. Study of Heavy Minerals.
6. Graphic representation of Trace Element data and Heavy Minerals

AMJ 2a : RIVER SCIENCE

7. Stream power calculation
8. Longitudinal profile analysis
9. Hydrograph analysis and other related problems.

Semester VIII

Advance Major – 3 (AMJ – 3a) EXPLORATION GEOLOGY**Credit – 4****FM= 100 [75 +25]****Lectures – 60 Hours****T= 75 {60Ext. +15 Int.} (10+05)}****Instructions:**

- There will be two groups of questions. **Group A** is compulsory which will contain **three** questions.
- **Question no. 1** will be **very short answer type** consisting of **five questions of 1 mark each**.
- **Question no. 2 & 3** will be of **short answer type** of **5 marks each**.
- **Group B** will contain **descriptive type five questions of 15 marks each**, out of which **any three are to answer**.

Learning outcomes

After successfully completing this course, the students will be able to understand:

1. Understanding of industrial and non-industrial resources and distinction between reserve and resource
2. Natural resource consumption patterns through historical times
3. Principles of prospecting of exploration 3. Techniques of mineral exploration 4. Reserve

Unit	Topic	Total no. of Lectures
Unit 1: Mineral Resources	Resource reserve definitions, Mineral resources in industries – historical perspective and present, A brief overview of classification of mineral deposits with respect to processes of formation in relation to exploration strategies, UNFC Scheme	12
Unit 2: Prospecting and Exploration	Principles of mineral exploration, Prospecting and exploration-conceptualization, methodology and stages, Sampling, subsurface sampling including pitting, trenching and drilling, Geochemical exploration.	12
Unit 3: Evaluation of data	Evaluation of sampling data Mean, mode, median, standard deviation and variance	12

Geophysical Technique: Gravity, Seismic, Magnetic, IP & SP	
Unit 4: Drilling and Logging Core and non-core drilling Planning of bore holes and location of boreholes on ground Core-logging , Application of Geostatistics in Exploration	12
Unit 5: Reserve estimations and Errors Principles of reserve estimation, density and bulk density Factors affecting reliability of reserve estimation Reserve estimation based on geometrical models (square, rectangular, triangular and polygon blocks) Regular and irregular grid patterns, statistics and error estimation	12

Books Recommended:

- Clark, G.B. 1967. *Elements of Mining*. 3rd Ed. John Wiley & Sons.
- Arogyaswami, R.P.N. 1996 *Courses in Mining Geology*. 4th Ed. Oxford-IBH
- Moon, C.J., Whateley, M.K.G., Evans, A.M., 2006, *Introduction to Mineral Exploration*, Blackwell Publishing

Advance Major – 4 (AMJ – 4a) ENVIRONMENTAL GEOLOGY**Credit – 4****FM= 100 [75 +25]****Lectures – 60 Hours****T= 75 {60Ext. +15 Int.} (10+05)}****Instructions:**

- There will be two groups of questions. **Group A** is compulsory which will contain **three** questions.
- **Question no. 1** will be very short answer type consisting of **five** questions of **1** mark each.
- **Question no. 2 & 3** will be of short answer type of **5** marks each.
- **Group B** will contain **descriptive** type **five** questions of **15** marks each, out of which **any three** are to answer.

Learning outcomes

After successfully completing this course, the students will be able to understand:



To develop an understanding of s near-surface processes of the planet 'Earth Learning to decode signatures of exogenic processes including climate and tectonics.

Unit	Topic	Total no. of Lectures
Unit 1	Basics of Environment; Type of Environment; Man and Environment; Components of environmental Geology, Concepts and principles of Environmental Geology; Time scales of global changes in the ecosystem and climate;	12
Unit 2	Atmosphere, structure and composition of atmosphere; Global warming. Greenhouse effect: CO ₂ increase and global warming in the present and past atmospheres;	12
Unit 3	Environmental Pollution: Sources of Air Pollution, emission of major industrial air pollutants, effects of air pollution on atmospheric processes, oxides of carbon as pollutants, greenhouse effect, global warming, chlorofluoro carbons (CFC's), depletion of ozone layer, effects of ozone depletion, smog, acid rain;	12
Unit 4	Components of Hydrosphere; Water cycle; solubility of gases in water, Acidification of Ocean; Impact of oceanic and atmospheric	12

circulation on climate and rain fall. Fluctuation of water table due to anthropogenic and geogenic causes.	
Unit 5 Water Pollution: Types of water pollution, groundwater pollution and its effects, sources of water pollution; organic and inorganic contamination of groundwater and its remedial measures.	12

Books Recommended:

- *Abhijit Dutta. Environmental Issues and Challenges*
- *K. Sharma Environmental Pollution*
- *Bell, F.G. (1999): ogical Hazards, Routledge, London.*
- *Bryant, E. (1985): Natural Hazards, Cambridge Univ. Press.*
- *Keller, E.A. (1978) Environmental Geology*
- *Rekha Ghosh and D. S. Chatterjee :Environmental Geology*
- *Valdiya, K.S. (1987) Environmental Geology- Indian Context*



**Practical
Semester VII**

**Advance Major – 3 & 4 (AMJ – 3a & 4a) EXPLORATION GEOLOGY &
ENVIRONMENTAL GEOLOGY**

Credit – 4**Lectures – 30 Hours****F.M. = 50****Practical****Marks Distribution****9. Exploration Geology****20****10. Environmental Geology****20****11. Class record****05****12. Viva Voce****05**

Total=50**Suggested Practical:****AMJ 1a : EXPLORATION GEOLOGY**

1. Identification of anomaly
2. Concept of weighted average in anomaly detection
3. Geological cross-section
4. Models of reserve estimation
5. Study of Metallogenic provinces of India.

AMJ 2a : ENVIRONMENTAL GEOLOGY

6. Analyses of alkalinity, acidity etc. in water samples.
7. Analyses of pH and Electrical Conductivity in water.
8. Preparation of ocean and atmospheric circulation maps.
9. Preparation of seismic and volcanic zonation maps of India and world.
10. Demarcation of flood prone areas in the outline map of India
11. Presentation of chemical analyses data

Semester VIII

Advance Major – 3 (AMJ – 3b) INTRODUCTION OF GEOPHYSICS**Credit – 4****Lectures – 60 Hours****FM= 100 [75 +25]****T= 75 {60Ext. +15 Int.} (10+05)}****Instructions:**

- There will be two groups of questions. **Group A** is compulsory which will contain **three** questions.
- **Question no. 1** will be **very short answer type** consisting of **five questions of 1 mark each**.
- **Question no. 2 & 3** will be of **short answer type** of **5 marks each**.
- **Group B** will contain **descriptive type five questions of 15 marks each**, out of which **any three are to answer**.

Learning outcomes

After successfully completing this course, the students will be able to understand:

To develop an understanding of solid earth and interior of earth and to learn about the basic geophysical exploration techniques.

Unit	Topic	Total no. of Lectures
Unit 1: Geology and Geophysics Interrelationship between geology and geophysics, Role of geological and geophysical data in explaining internal structure of the earth.		12
Unit 2: General and Exploration geophysics Different types of geophysical methods - gravity, magnetic, electrical and seismic; their principles and applications		12
Unit 3: Basics of subsurface geophysical logging: Basic principles of SP log, Resistivity log, Sonic log, Gamma log, Neutron log etc. and their applications		12
Unit 4: Geophysical field operations Different types of surveys, grid and route surveys, profiling and sounding techniques Scales of survey, Presentation of geophysical data		12

Unit 5: Applications:

Application of Geophysical methods in oil and gas, ore and groundwater investigations;

12**Books Recommended:**

- *Outlines of Geophysical Prospecting - A manual for geologists* by Ramachandra Rao, M.B., Prasaraanga, University of Mysore, Mysore, 1975.
- *Exploration Geophysics - An Outline* by Bhimasarikaram V.L.S., Association of Exploration Geophysicists, Osmania University, Hyderabad, 1990.
- Dobrin, M.B. (1984) *An introduction to Geophysical Prospecting*. McGraw-Hill, New Delhi.
- Telford, W. M., Geldart, L. P., & Sheriff, R. E. (1990). *Applied geophysics (Vol. 1)*. Cambridge University press.
- Lowrie, W. (2007). *Fundamentals of geophysics*. Cambridge University Press. Jensen, J.R., 1996. *Introductory Digital Image Processing: A Remote Sensing Perspective*, Springer-Verlag.



Advance Major – 4 (AMJ – 4b) EVOLUTION OF LIFE THROUGH TIME**Credit – 4****Lectures – 60 Hours****FM= 100 [75 +25]****T= 75 {60Ext. +15 Int.} (10+05)}****Instructions:**

- There will be two groups of questions. **Group A** is compulsory which will contain **three** questions.
- **Question no. 1** will be **very short answer type** consisting of **five** questions of **1** mark each.
- **Question no. 2 & 3** will be of **short answer type** of **5** marks each.
- **Group B** will contain **descriptive type** **five** questions of **15** marks each, out of which **any three** are to answer.

Learning outcomes

After successfully completing this course, the students will be able to understand:

To understand the evolution of life through geological time

To understand the role of geological processes in the evolution of life

To learn about major biological events of the geological past

Unit	Topic	Total no. of Lectures
Unit 1 Life through ages Fossils and chemical remains of ancient life. Geological Time Scale with emphasis on major bio-events. Fossilization processes and modes of fossil preservation. Exceptional preservation sites- age and fauna		12
Unit 2 Geobiology Biosphere as a system, processes and products, Biogeochemical cycles, Abundance and diversity of microbes, extremophiles, Microbes-mineral interactions, microbial mats		12
Unit 3 Origin of life Possible life sustaining sites in the solar system, life sustaining elements and isotope records, Archean life: Earth's oldest life, Transition from Archean to Proterozoic, the oxygen revolution and radiation of life, Precambrian macrofossils – The garden of Ediacara, The Snow Ball Earth Hypothesis		12
Unit 4 Paleozoic Life The Cambrian Explosion. Biomineralization and skeletalization, Origin of vertebrates and radiation of fishes		12

<p>Origin of tetrapods - Life out of water, Early land plants and impact of land vegetation</p> <p>Mesozoic Life: Life after the largest (P/T) mass extinction, life in the Jurassic seas, Origin of mammals, Rise and fall of dinosaurs , Origin of birds; and spread of flowering plants</p>	
<p>Unit 5 Cenozoic Life</p> <p>Aftermath of end Cretaceous mass extinction – radiation of placental mammals, Evolution of modern grasslands and co-evolution of hoofed grazers, Rise of modern plants and vegetation, Back to water – Evolution of Whales,</p> <p>The age of humans: Hominid dispersals and climate setting, Climate Change during the Phanerozoic - continental break-ups and collisions, Plate tectonics and its effects on climate and life, Effects of life on climate and geology</p>	12

Books Recommended:

- Stanley, S.M., 2008 *Earth System History*
- Jonathan I. Lumine W.H.Freeman *Earth-Evolution of a Habitable World*, Cambridge University Press.
- Canfield, D.E. & Konhauser, K.O., 2012 *Fundamentals of Geobiology* Blackwell
- Cowen, R., 2000 *History of Life*, Blackwell





**Practical
Semester VII**

Advance Major – 3 & 4 (AMJ – 3b & 4b) INTRODUCTION OF GEOPHYSICS & EVOLUTION OF LIFE THROUGH TIME

Credit – 4**Lectures – 30 Hours****F.M. = 50****Practical****Marks Distribution**

- 13. Introduction Of Geophysics
- 14. Evolution Of Life Through Time
- 15. Class record
- 16. Viva Voce

20**20****05****05**

Total=50**Suggested Practical:****AMJ 3b : INTRODUCTION OF GEOPHYSICS**

1. Study of various surface and subsurface geophysical data.
2. Identification of anomalies by Graphical methods: (a) Data obtained from equipotential method, (b) Data obtained from self-potential method.
3. Geophysical calculation based on seismic method: refraction, reflection
4. Problems based on electrical resistivity methods:
(a) Wenner's array (b) Schlumberger's array

AMJ 4b: EVOLUTION OF LIFE THROUGH TIME

1. Study of modes of fossil preservation
2. Study of fossils from different stratigraphic levels
3. Exercises related to major evolutionary trends in important groups of animals and plants



Semester VIII

Advance Major – 3 (AMJ – 3c) URBAN GEOLOGY

Credit – 4

FM= 100 [75 +25]

Lectures – 60 Hours

T= 75 {60Ext. +15 Int.} (10+05)}

Instructions:

- There will be two groups of questions. **Group A** is compulsory which will contain **three** questions.
- **Question no. 1** will be **very short answer type** consisting of **five** questions of **1** mark each.
- **Question no. 2 & 3** will be of **short answer type** of **5** marks each.
- **Group B** will contain **descriptive type** **five** questions of **15** marks each, out of which **any three** are to answer.

Learning outcomes

After successfully completing this course, the students will be able to understand:

Urban geology draws on the all branches of the earth sciences, from stratigraphy to geochemistry and hydrogeology to geophysical exploration techniques; and it often makes linkages to the biological and environmental sciences.

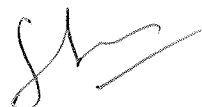
Unit	Topic	Total no. of Lectures
Unit 1 Geology and Society		12
Necessity of Geology in Urban life. Geology in Urban Constructions, Geotechnical feature and mapping for subsurface in Metropolitan areas, Building materials, Excavation and cutting in urban areas.		
Unit 2 Geology and Urban Agriculture		12
Soil studies, Chemistry and geochemistry of soil in relation to ground water and fertilizer, Effect of pollutants on vegetable contamination, Urban land use: Geotechnical site characterization, Geotechnical and land use mapping, Decision making in urban landuse, Geological problems in construction of underground structures in urban areas, Urban Tunneling: Tunneling for road and rail in urban areas, Method, Equipments, Importance of Geology		
Unit 3 Urban water		12
Water lagging in built-up areas, Source of water, Standards for various uses of water,		

Sources of contamination, Waste waters: Sources and its disinfection and treatment, Ground water surveys and resource development	
Unit 4 Urban wastes and Treatment, Geotechnical characterization for waste sites, Domestic waste, Industrial waste, Mine drainage, Power production waste, Radioactive waste, Need for special purpose mapping for selection of waste disposal sites.	12
Unit 5 GIS in Urban Geology GIS-An introduction, Application in Urban development, Application in landuse, Application in GW Exploration Precaution from seismic hazard in Urban planning : Seismic Hazards: Micro-zonations of hazard based on engineering geological features, Urban-subservice network.	12

Books Recommended:

- Huggenberger, P. and Eptin, J. 2011 *Urban Geology: Process-Oriented Concepts for Adaptive and Integrated Resource Management*. Springer
- Lollino, G. et al. (Ed.), *Engineering Geology for Society and Territory*. Springer





Advance Major – 4 (AMJ – 4c) FOSSILS & THEIR APPLICATIONS**Credit – 4****Lectures – 60 Hours****FM= 100 [75 +25]****T= 75 {60Ext. +15 Int.} (10+05)}****Instructions:**

- There will be two groups of questions. **Group A** is compulsory which will contain **three** questions.
- **Question no. 1** will be **very short answer type** consisting of **five** questions of **1** mark each.
- **Question no. 2 & 3** will be of **short answer type** of **5** marks each.
- **Group B** will contain **descriptive type** **five** questions of **15** marks each, out of which **any three** are to answer.

Learning outcomes

After successfully completing this course, the students will be able to understand:

To study different groups of invertebrate, vertebrate and plant fossils.

To learn the utility of some of these fossils in determining the relative age of sedimentary rocks.

To know the utility of various fossil groups in palaeoecological, palaeoenvironmental, palaeobiogeographical reconstructions.

To understand the role of fossils in hydrocarbon exploration.

Unit	Topic	Total no. of Lectures
Unit 1: Introduction to fossils Definition of fossil, fossilization processes, modes of fossil preservation and uses.		12
Unit 2: Species concept Definition of species, methods of description and naming of fossils.		12
Unit 3: Introduction to various fossils groups Brief introduction of important fossils groups: morphology and geological history of Brachiopoda, Gastropoda and lamellibranchia Important age diagnostic fossiliferous horizons of India.		12
Unit 4: Application of fossils Application of fossils in the study of paleoecology, paleobiogeography and paleoclimate.		12

Unit 5: Societal importance of fossils Implication of larger benthic and micropaleontology in hydrocarbon exploration: identification of reservoirs and their correlation. Application of spore and pollens in correlation of coal seams. Fossils as an indicator of pollution	12
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Books Recommended:

- Schoch, R.M. 1989. *Stratigraphy, Principles and Methods*. VanNostrand Reinhold.
- Clarkson, E.N.K. 1998. *Invertebrate Palaeontology and Evolution* George Allen & Unwin
- Prothero, D.R. 1998. *Bringing fossils to life - An introduction to Palaeobiology*, McGraw Hill.
- Benton, M.J. 2005. *Vertebrate palaeontology (3rd edition)*. Blackwell Scientific, Oxford.
- Colbert's *Evolution of the Vertebrates: A History of the Backboned Animals Through Time*, Edwin H.
- Colbert, Michael Morales, Eli C. Minkoff, John Wiley & Sons, 1991.



**Practical
Semester VII**

Advance Major – 3 & 4 (AMJ – 3c & 4c) URBAN GEOLOGY & FOSSILS & THEIR APPLICATIONS

Credit – 4

Lectures – 30 Hours

F.M. = 50

Practical	Marks Distribution
17. Urban Geology	20
18. Fossils & Their Applications	20
19. Class record	05
20. Viva Voce	05
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	Total=50

Suggested Practical:

AMJ 3c : URBAN GEOLOGY

1. Map Reading
2. Ground water flow direction estimation
3. Case studies of Urban flood; Flood hydrographs
4. Case studies of urban planning

AMJ 4c : FOSSILS & THEIR APPLICATIONS

5. Study of fossils showing various modes of fossilization.
6. Distribution of diagnostic fossils in India.
7. Study of morphological characters of important Invertebrate fossils.
8. Drawing and labeling of important invertebrate fossils.

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MINOR PAPERS

SEMESTER IV

Geology-MN 1

(Credits: Theory-04, Practicals-02)

MN 1:Theory: Petrology, Geochemistry & Structural Geology

Credit: 04 Lectures: 60

Marks: 75 (End Semester Examination=60, Semester Internal Examination=10, Class Performance & Attendance =05)

Pass Marks: = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10 marks):

There will be two group of questions. Question No.1 will be very short answer type in Group A consisting of five questions of 1 mark each. Group B will contain descriptive type two questions of five marks each, out of which any one to answer.

End Semester Examination (ESE 60 marks):

There will be two group of questions. Group A is compulsory which will contain three questions. Question No.1 will be very short answer type consisting of five questions of 1 mark each. Question No.2 & 3 will be short answer type of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to answer.

Note: There may be subdivisions in each question asked in Theory Examinations.

Unit 1: Rocks- Definitions and types, Basics of rock formation. (12-Lectures)

Igneous rock- texture and Structure, magma: origin and composition, Bowen's reaction series and magmatic differentiation.

Sedimentary rocks- process of formation, texture and Structure.

Metamorphic rocks- Agents and types of metamorphism, texture and Structure.

Unit 2: Concepts of geochemistry (12-Lectures)

Introduction to properties of elements: The periodic table. Chemical bonding, states of matter and atomic environment of elements. Geochemical classification of elements, Distribution of elements in solar system, Composition of Crust, Mantle & Core

Unit 3: Structural Geology (12-Lectures)

Effects of topography on structural features, Topographic and structural maps; Concept of dip and strike; Outcrop patterns of different structures.

Unit 4: Folds (12-Lectures)

Fold morphology; Geometric and genetic classification of folds; Recognition of fold in Field

Unit 5: Fractures, faults, Joints and Unconformity (12-Lectures)

Geometric and genetic classification of fractures and faults, Effects of faulting on the outcrops
Geologic/geomorphic criteria for recognition of faults and fault plane solutions, Joints & its types, Unconformity & its types.

Reference Books:

- *Earth Materials- Introduction to Mineralogy and Petrology, Cornelis Klein and Anthony Philpotts, Cambridge University Press, 2013.*

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- *Understanding Earth (Sixth Edition), John Grotzinger and Thomas H. Jordan, 2010, W.H. Freeman and company, New York.*
- *Davis, G. R. (1984) Structural Geology of Rocks and Region. John Wiley Billings, M. P. (1987) Structural Geology, 4th edition, Prentice-Hall.*
- *Park, R. G. (2004) Foundations of Structural Geology. Chapman & Hall.*
- *Mason, B. (1986) Principles of Geochemistry. 3rd Edition, Wiley New York.*
- *Rollinson, H. (2007) Using geochemical data – evaluation, presentation and interpretation. 2nd Edition. Publisher Longman Scientific & Technical.*

MN 1:Practical

Credit: 04 Lectures: 60

**Instruction to Question Setter for
End Semester Examination (ESE):**

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:

<i>Experiment</i>	<i>= 15 marks</i>
<i>Practical record notebook</i>	<i>= 05 marks</i>
<i>Viva-voce</i>	<i>= 05 marks</i>

1. Observation and documentation of important structures of sedimentary and metamorphic rocks.
2. Observation and documentation of forms of igneous rocks.
3. Study of rocks in hand specimen.
4. Basic idea of topographic contours, Topographic sheets of various scales.
5. Introduction to Geological maps: Lithological and Structural maps

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SEMESTER V

GEOLOGY-MN 2**(Credits: Theory-04, Practicals-02)****MN 2:Theory: EARTH RESOURCES****Credit: 04 Lectures: 60**

Marks: 75 (End Semester Examination=60, Semester Internal Examination=10, Class Performance & Attendance =05)
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Pass Marks: = 30***Instruction to Question Setter for******Semester Internal Examination (SIE 10 marks):***

There will be two group of questions. Question No.1 will be very short answer type in Group A consisting of five questions of 1 mark each. Group B will contain descriptive type two questions of five marks each, out of which any one to answer.

End Semester Examination (ESE 60 marks):

There will be two group of questions. Group A is compulsory which will contain three questions. Question No.1 will be very short answer type consisting of five questions of 1 mark each. Question No.2 & 3 will be short answer type of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to answer.

Note: There may be subdivisions in each question asked in Theory Examinations.

Unit 1: Earth Resources & Essentials of Geology**(12-Lectures)**

Definition: Mineral, Ore and Gangue, Tenor, Grade. Introduction to Essential, Critical and Strategic minerals.

A brief overview of Classification of Mineral deposits with respect to processes of formation and mode of occurrences. Sources of different fluid for ore deposition

Unit 2: Major Types and Sources of Energy**(12-Lectures)**

Resources of Natural Oil and Gas.

Coal and Nuclear Minerals: Types and distribution. Petroleum: Source, formation, distribution

Introduction to Hydroelectric Power, Solar Energy, Wind, Wave and Biomass based power and Energy

Unit 3:**(12-Lectures)**

Isostasy, continental drift, Mid Oceanic Ridges, trenches, transform faults and island arcs, Origin of oceans, continents, mountains and rift valleys; Earthquake: causes, effects and distribution; Volcanoes: types, products and distribution.

Unit 4:**(12-Lectures)**

Elementary ideas about crystal morphology in relation to internal structures Crystal parameters and indices Crystal symmetry and classification of crystals into six systems and 32 point groups, Minerals - definition and classification, physical and chemical properties Composition of common rock-forming minerals, Silicate Structure

Unit 5:**(12-Lectures)****Properties of light and optical microscopy**

Nature of light and principles of optical mineralogy, Isotropic & Anisotropic, Birefringence, Interference color, Extinction,

Introduction to the petrological microscope and identification of common rock-forming minerals

Reference Books:


- *Energy and the Environment* by Fowler, J.M 1984. McGraw-Hill
- *Global Energy Perspectives* by Nebojsa Nakicenovic 1998, Cambridge University Press.
- *Energy Resources and Systems: Fundamentals and Non-Renewable Resources* by Tushar K. Ghosh and M. A. Prelas. 2009, Springer
- *Introduction to Wind Energy Systems: Hermann-Josef Wagner and Jyotirmay Mathur.* 2009, Springer.
- *Renewable Energy Conversion, Transmission and Storage.* Bent Sorensen, 2007, Springer.
- *Holme's Principles of Physical Geology.* 1992. Chapman & Hall.
- *Emiliani, C, 1992. Planet Earth, Cosmology, Geology and the Evolution of Life and Environment.* Cambridge University Press.
- *Gross, M.G., 1977. Oceanography: A view of the Earth, Prentice Hall.*

MN 2: Practical**Credit: 04 Lectures: 60****Instruction to Question Setter for
End Semester Examination (ESE):**

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:

<i>Experiment</i>	<i>= 15 marks</i>
<i>Practical record notebook</i>	<i>= 05 marks</i>
<i>Viva-voce</i>	<i>= 05 marks</i>

1. Plotting of major Indian oil fields on map of India.
2. Plotting of major Indian coalfields on the map of India / Jharkhand.
3. Plotting of natural hazards on the map of India.
4. Megascopic study of important ore forming minerals.
Physical properties of minerals: Study and Documentation.
5. Study of physical properties of important rock forming minerals in hand specimen:
6. Plotting of major Dams on the outline map of India, mention name of the river and utility of the dam.
7. Study of Seismic Zones of India.



SEMESTER VI

GEOLOGY-MN 3**(Credits: Theory-04, Practicals-02)****MN 3:Theory: STRATIGRAPHY & PALAENTOLOGY****Credit: 04 Lectures: 60**

Marks: 75 (End Semester Examination=60, Semester Internal Examination=10, Class Performance & Attendance =05)
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Pass Marks: = 30

Instruction to Question Setter for***Semester Internal Examination (SIE 10 marks):***

There will be two group of questions. Question No.1 will be very short answer type in Group A consisting of five questions of 1 mark each. Group B will contain descriptive type two questions of five marks each, out of which any one to answer.

End Semester Examination (ESE 60 marks):

There will be two group of questions. Group A is compulsory which will contain three questions. Question No.1 will be very short answer type consisting of five questions of 1 mark each. Question No.2 & 3 will be short answer type of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to answer.

Note: There may be subdivisions in each question asked in Theory Examinations.

Unit 1: Principles of stratigraphy**(12-Lectures)**

Introduction to the concepts of lithostratigraphy, biostratigraphy, chronostratigraphy, Introduction to the physiographic and tectonic sub divisions of India, Geological Time Scale

Unit 2: Pre-Cambrian Stratigraphy of India**(12-Lectures)**

Pre-Cambrian geology of Singhbhum and Dharwar; Introduction to Proterozoic basins of India; Geology of Vindhyan and Cudappah basins of India

Unit 3: Phanerozoic Stratigraphy of India**(12-Lectures)**

Geology, Structure and hydrocarbon potential of Gondwana basins. Deccan Traps, Important Stratigraphic boundaries in India - a. Precambrian-Cambrian boundary, b. Permian-Triassic boundary, and c. Cretaceous-Tertiary boundary

Unit 4: Fossilization and fossil record**(12-Lectures)**

Nature and importance of fossil record; Fossilization processes and modes of preservation, Brief introduction of important fossils groups: morphology and geological history of Trilobita, Brachiopoda, Gastropoda

Unit 5.**(12-Lectures)**

Gondwana Flora, Biozones, index fossils, Evolution of horse and intercontinental migrations. Human evolution, Index fossils, correlation Fossils and Paleo-environmental analysis, Fossils and paleobiogeography, biogeographic provinces

Reference Books:

- Krishnan, M. S. (1982) *Geology of India and Burma*, CBS Publishers,
- Delhi Doyle, P. & Bennett, M. R. (1996) *Unlocking the Stratigraphic Record*. John Wiley
- Ramakrishnan, M. & Vaidyanadhan, R. (2008) *Geology of India Volumes 1 & 2*, Geological Society of India, Bangalore.
- Valdiya, K. S. (2010) *The making of India*, Macmillan India Pvt. Ltd.

- *Raup, D. M., Stanley, S. M., Freeman, W. H. (1971) Principles of Paleontology*
- *Clarkson, E. N. K. (2012) Invertebrate paleontology and evolution 4th Edition by Blackwell Publishing.*
- *Benton, M. (2009). Vertebrate paleontology. John Wiley & Sons.*
- *Shukla, A. C., & Misra, S. P. (1975). Essentials of paleobotany. Vikas Publisher*
- *Armstrong, H. A., & Brasier, M.D. (2005) Microfossils. Blackwell Publishing.*

MN 3:Practical**Credit: 04 Lectures: 60****Instruction to Question Setter for****End Semester Examination (ESE):**

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:

<i>Experiment</i>	<i>= 15 marks</i>
<i>Practical record notebook</i>	<i>= 05 marks</i>
<i>Viva-voce</i>	<i>= 05 marks</i>

1. Study of geological map of India and identification of major stratigraphic units;
2. Study of rocks in hand specimens from known Indian stratigraphic horizons.
3. Study of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate, vertebrate and plant fossils.



INTRODUCTORY REGULAR COURSE: GEOLOGY

SEMESTER I/II/III

GEOLOGY -IRC

(Credits: Theory-03 Lectures-45)

Marks: 100 (End Semester Examination=75, Semester Internal Examination=20, Class Performance & Attendance =05)

Pass Marks: = 40

Instruction to Question Setter for

Semester Internal Examination (SIE 20 marks):

There will be two group of questions. Group A is compulsory which will contain two questions. Question No.1 will be very short answer type consisting of five questions of 1 mark each. Question No.2 will be short answer type of 5 marks. Group B will contain descriptive type two questions of ten marks each, out of which any one to answer.

End Semester Examination (ESE 60 marks):

There will be two group of questions. Group A is compulsory which will contain three questions. Question No.1 will be very short answer type consisting of five questions of 1 mark each. Question No. 2 & 3 will be short answer type of 5 marks. Group B will contain descriptive type six questions of fifteen marks each, out of which any four are to answer.

Unit-I:

Introduction to geology and its scope, Earth and solar system: origin, size, shape, mass, density and its atmosphere. A brief account of various theories regarding the origin and age of the earth; Brief idea of interior of earth and its composition.

Unit-II:

Weathering and erosion: factors, types and their effects, Earthquakes: types, origin, nature of seismic waves, their intensity and magnitude scale; Volcanoes: types, products and causes of volcanism, Plate Tectonics & its types with example, Continental drift, Isostasy & Mid Oceanic Ridge.

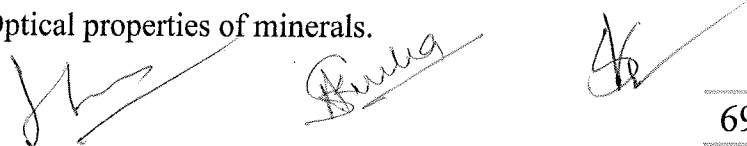
Unit-III:

Introduction to Structural Geology; contours, topographic and geological maps; Elementary idea of bed, dip and strike, Fold, Fault, joints, unconformity: its types & recognition in the field. Principle of stratigraphy, Stratigraphy of Gondwana, Vindhyan & Cuddapah supergroup & its type area; Geological Time Scale, definition of Fossils and Mode of preservation condition of fossilization and significance of fossils. Invertebrate and Plant Fossil.

Unit-IV:

Crystal form, face, edge, solid angle; Interfacial angle and their measurements; Crystallographic axes, angles & symmetry elements with different crystallographic system. Introduction to Mineralogy, Definition and characters of mineral. Common physical properties of minerals- Talc, Gypsum, Calcite, Fluorite, Apatite, Orthoclase, Quartz, Topaz, Corundum, Diamond, Muscovite, Biotite, Hypersthene, Olivine, Hornblende. Optical properties of minerals.

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Unit-V:

Magma: definition, composition, types and origin; Forms of igneous rocks; textures, structure & classification of igneous rocks. Processes of formation of sedimentary rocks; Classification, textures and structures of sedimentary rocks, Definition of metamorphism; Type of metamorphism. Factors, zones, grade & facies of metamorphism, textures and structures of metamorphic rocks.

Unit-VI:

Concept of ore and ore deposits, ore minerals and gangue minerals; Tenor of ores; Strategic, Critical and essential minerals, Origin, mode of occurrence & distribution of Metallic and non-metallic ore minerals in India- Iron, Copper, Aluminium, Gold, Uranium, Lead, Zinc, Chromite & Manganese. Coal: origin, types & distribution, Petroleum: origin, occurrence & distribution, Nuclear minerals & its uses

Reference Books:

- *Earth Materials- Introduction to Mineralogy and Petrology, Cornelis Klein and Anthony Philpotts, Cambridge University Press, 2013.*
- *Understanding Earth (Sixth Edition), John Grotzinger and Thomas H. Jordan, 2010, W.H. Freeman and company, New York.*
- *Davis, G. R. (1984) Structural Geology of Rocks and Region. John Wiley Billings, M. P. (1987) Structural Geology, 4th edition, Prentice-Hall.*
- *Park, R. G. (2004) Foundations of Structural Geology. Chapman & Hall.*
- *Mason, B. (1986) Principles of Geochemistry. 3rd Edition, Wiley New York.*
- *Rollinson, H. (2007) Using geochemical data – evaluation, presentation and interpretation. 2nd Edition. Publisher Longman Scientific & Technical.*
- *Energy and the Environment by Fowler, J.M 1984. McGraw-Hill*
- *Global Energy Perspectives by Nebojsa Nakicenovic 1998, Cambridge University Press.*
- *Energy Resources and Systems: Fundamentals and Non-Renewable Resources by Tushar K. Ghosh and M. A. Prelas. 2009, Springer*
- *Introduction to Wind Energy Systems: Hermann-Josef Wagner and Jyotirmay Mathur. 2009, Springer.*
- *Renewable Energy Conversion, Transmission and Storage. Bent Sorensen, 2007, Springer.*

