FYUGP

GEOLOGY HONOURS/ RESEARCH SYLLABUS

UP TO SEMESTER-IV

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

Implemented from
Academic Session 2023-2027

UNIVERSITY DEPARTMENT OF GEOLOGY

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

Memo No: BBMKU/R/1264/2023, dated on 21.07.23

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. J. N. Singh** Dean, Faculty of Science, Head, Geology Dept. BBMK Univ. Dhanbad	**-Chairman**	
2.	**Dr. Atul Kumar Sinha,** University Dept. of Geology, BBMK Univ. Dhanbad	**- Member**	
3.	**Dr. Sagar Kumar Swain,** HoD, Dept. of Geology, PKRMC, BBMK Univ. Dhanbad	**-Member**	
4.	**Dr. Krishna Gopal,** University Dept. of Geology, BBMK Univ. Dhanbad	**-Member**	
5.	**Prof. Prem Prakash Singh** Former Head, Department of Geology, Utkal University, Bhubaneswar	**-External expert**	

COURSE STUCTURE FOR FYUGP **'HONOURS/ RESEARCH'**

Table 1: Credit Framework for Four Year Undergraduate Programme (FYUGP) under State Universities of Jharkhand [Total Credits =160]

Level of Courses	**Semester**	**MJ:** Discipline specific courses-Core or Major (80)	**MN**: Minor from discipline (16)	**MN**: Minor from discipline (16)	**MDC**: Multidisciplinary Courses [Life Sciences, Phys, Mathematical and Computer Sciences, Data Analysis, Social Sciences, Humanities, etc., (9)	**AEC:** Ability Enhancement Courses (8)	**SEC:** Ability Enhancement Courses (9)	**VAC:** Value added Courses (6)	**IAP:** Internship / Dissertation (4)	**RC:** Research Courses (12)	**AMJ:** Advanced Courses in lie **of** Research (12)	**Credits**	**Double Major (DMJ)**
1	2	3	4	5	6	7	8	9	10	11	12	13	14
100-199: Foundation or Introductory courses	**I**	4	4		3	2						**20**	4+4
	II	4+4		4	3	2	3					**20**	4+4
	Exit Point: Undergraduate Certificate provided with Summer Internship/Project (4 credits)												
200-299: Intermediate-level courses	**III**	4+4	4		3	2	3					**20**	
	IV	4+4+4		4		2		2				**20**	4+4
	Exit Point: Undergraduate Diploma Certificate provided with Summer Internship in 1st or 2nd year /Project (4 credits)												
300-399: Higher-level courses	**V**	4+4+4	4						4			**20**	4+4
	VI	4+4+4+4		4								**20**	4+4
	Exit Point: Bachelor's Degree												
400-499: Advanced courses	**VII**	4+4+4+4	4									**20**	4+4
	VIII	4		4						12	4+4+4	**20**	4+4
	Exit Point: Bachelor's Degree with Hons. /Research											**160**	**224**

Note: Honours students not undertaking research will do 3 courses for 12 credits in lieu of a Research project /Dissertation.

SEMESTER WISE COURSES OF STUDY FOR FOUR YEAR UNDERGRADUATE PROGRAMME **2023 onwards**

Table 2: Semester wise Course Code and Credit Points:

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		
	Code	Papers	Credits
I	AEC-1	Language and Communication Skills (Modern Indian language including TRL)	2
	VAC-1	Value Added Course-1	4
	SEC-1	Skill Enhancement Course-1	3
	MDC-1	Multi-disciplinary Course-1	3
	MN-1A	Minor from Discipline-1	4
	MJ-1	Major paper 1 (Disciplinary/Interdisciplinary Major)	4
II	AEC-2	Language and Communication Skills (English)	2
	SEC-2	Mathematical & Computation Thinking Analysis	3
	MDC-2	Multi-disciplinary Course-2	3
	MN-2A	Minor from Vocational Studies/Discipline-2	4
	MJ-2	Major paper 2 (Disciplinary/Interdisciplinary Major)	4
	MJ-3	Major paper 3 (Disciplinary/Interdisciplinary Major)	4
III	AEC-3	Language and Communication Skills (Modern Indian language including TRL)	2
	SEC-3	Skill Enhancement Course-3	3
	MDC-3	Multi-disciplinary Course-3	3
	MN-1B	Minor from Discipline-1	4
	MJ-4	Major paper 4 (Disciplinary/Interdisciplinary Major)	4
	MJ-5	Major paper 5 (Disciplinary/Interdisciplinary Major)	4
IV	AEC-3	Language and Communication Skills (MIL-2/English-2)	4
	VAC-2	Value Added Course-2	2
	MN-2B	Minor from Vocational Studies/Discipline-2	4
	MJ-6	Major paper 6 (Disciplinary/Interdisciplinary Major)	4
	MJ-7	Major paper 7 (Disciplinary/Interdisciplinary Major)	4
	MJ-8	Major paper 8 (Disciplinary/Interdisciplinary Major)	4
V	MN-1C	Minor from Discipline-1	4
	MJ-9	Major paper 9 (Disciplinary/Interdisciplinary Major)	4
	MJ-10	Major paper 10 (Disciplinary/Interdisciplinary Major)	4
	MJ-11	Minor Paper 3 (Disciplinary/Interdisciplinary Minor)	4
	IAP	Internship/Apprenticeship/ Field work / Dissertation/ Project	4
VI	MN-2C	Minor from Vocational Studies/Discipline-2	4
	MJ-12	Major paper 12 (Disciplinary/Interdisciplinary Major)	4
	MJ-13	Major paper 13 (Disciplinary/Interdisciplinary Major)	4
	MJ-14	Minor Paper 14 (Disciplinary/Interdisciplinary Minor)	4
	MJ-15	Minor Paper 15 (Disciplinary/Interdisciplinary Minor)	4
VII	MN-1D	Minor from Discipline-1	4
	MJ-16	Major paper 16 (Disciplinary/Interdisciplinary Major)	4
	MJ-17	Major paper 17 (Disciplinary/Interdisciplinary Major)	4
	MJ-18	Minor Paper 18 (Disciplinary/Interdisciplinary Minor)	4
	MJ-19	Minor Paper 19 (Disciplinary/Interdisciplinary Minor)	4
VIII	MJ-20	Major paper 20 (Disciplinary/Interdisciplinary Major)	4
	RC/ AMJ-1 AMJ-2 AMJ-3	Research Internship/ Field work/ Dissertation Advanced Major paper-1 (Disciplinary/Interdisciplinary Major) Advanced Minor Paper 18 (Disciplinary/Interdisciplinary Minor) Advanced Minor Paper 19 (Disciplinary/Interdisciplinary Minor)	12/ 4 4 4
		Total Credits	**160**

Abbreviations:

AEC Ability Enhancement Courses

SEC Skill Enhancement Courses

IAP Internship/Apprenticeship/ Project
MDC Multidisciplinary Courses
MJ Major Disciplinary/Interdisciplinary Courses
DMJ Double Major Disciplinary/Interdisciplinary Courses
AMJ Advance Major Disciplinary/Interdisciplinary Courses
MN Minor Disciplinary/Interdisciplinary Courses
RC Research Courses

AEC (Ability enhancements courses)- 2 Credits

- *Full marks – 50, Pass Marks – 20*
- *In AEC the students of all faculties will have to select either Hindi or English in Semester -1 and those students who have opted Hindi will have to select English as AEC in Semester -2 and vice versa. For 3rd and 4th semester student can opt Sanskrit, Urdu, Bengali, English, Hindi or TRL.*
- *In 4th semester there will be AEC-3 will include Language and Communication Skill in Hindi and English.*
- *No internal examination will be conducted.*

VAC (Value added Courses)- 2 Credits

- *Full marks – 50, Pass Marks – 20*
- *For 1st semester – "Understanding India"*
- *For 4th Semester – "Environmental Studies"*
- *No internal examination will be conducted.*

SEC (Skill Enhancement Courses) – 3 Credits

- *Full Marks – 75, Pass Marks – 30*
- *Digital Education or Mathematical & Computational Thinking Analysis is selected as SEC. Student will have to select or opt either of the two subjects for semester – I, II and III in no case both subjects will be allowed to opt.*
- *No internal examination will be conducted.*

MDC (Multidisciplinary Courses) – 3 credits

- *Full Marks – 75, Pass Marks – 30*
- *A student will study three different subjects in the multidisciplinary courses during first three semesters.*
- *No internal examination will be conducted.*

SEMESTER WISE COURSES OF STUDY FOR FOUR YEAR UNDERGRADUATE PROGRAMME **2023 onwards**

Table 3: Semester wise Course Code and Credit Points and Marks distribution of Major Papers:

S.N.	Semester	Paper	Credit	Full Marks-100			Pass Marks		
				Internal Theory (Mid Sem.)	End sem. Theory	End sem. Practical	Internal Theory (Mid Sem.)	End Sem. Theory	End sem. Practical
1.	I	MJ-1: Theory	4	25	75	-	10	30	-
2.	II	MJ-2: Theory	4	25	75	-	10	30	-
		MJ-3: Practical- I	4	-	-	100	-	-	40
3.	III	MJ-4: Theory	4	25	75	-	10	30	-
		MJ-5: Practical- II	4	-	-	100	-	-	40
4.	IV	MJ-6: Theory	4	25	75	-	10	30	-
		MJ-7: Theory	4	25	75	-	10	30	-
		MJ-8: Practical-III	4	-	-	100	-	-	40
5.	V	MJ-9: Theory	4	25	75	-	10	30	-
		MJ-10: Theory	4	25	75	-	10	30	-
		MJ-11: Practical-IV	4	-	-	100	-	-	40
6.	VI	MJ-12: Theory	4	25	75	-	10	30	-
		MJ-13: Theory	4	25	75	-	10	30	-
		MJ-14: Theory	4	25	75	-	10	30	-
		MJ-15: Practical-V	4	-	-	100	-	-	40
7.	VII	AMJ-01: Theory	4	25	75	-	10	30	-
		AMJ-02: Theory	4	25	75	-	10	30	-
		AMJ-03: Theory	4	25	75	-	10	30	-
		AMJ-04: Practical-VI	4	-	-	100	-	-	40
8.	VIII	AMJ-05: Theory	4	25	75	-	10	30	-

- *Total theory papers will be 14 and practical papers will be 6.*
- *No internal or mid semester examination will be conducted for practical papers.*

Table 4: Semester wise Course Code and Credit Points and Marks distribution of Minor Papers:

S.N.	Semester	Paper	Credit	Full Marks		Pass Marks	
				Theory (Internal+ End Sem)	Practical End Sem.	Theory (Internal+ End Sem	Practical
1.	I	MN-1A	3+1	15+60	25	30	10
2.	III	MN-1B	3+1	15+60	25	30	10
3.	V	MN-1C	3+1	15+60	25	30	10
4.	VII	MN-1D	3+1	15+60	25	30	10

- *No internal or mid semester examination will be conducted for practical papers.*

Table 5: Semester wise Papers and Examination Structure for Geology Major:

Semester	Geology Major		Examination Structure				Pass Marks		
	Code	Papers	Credits	Internal (Mid Semester) Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical (F.M.)	Internal Theory (Mid Sem.)	End Sem. Theory	End sem. Practical
I	MJ-1: Theory	Earth System Science	4	25	75		10	30	-
II	MJ-2: Theory	Structural Geology	4	25	75		10	30	-
	MJ-3: Practical	Practical				100	-	-	40
III	MJ-4: Theory	Igneous Petrology	4	25	75		10	30	-
	MJ-5: Practical	Practical				100	-	-	40
IV	MJ-6: Theory	Sedimentary Petrology	4	25	75		10	30	-
	MJ-7: Theory	Metamorphic Petrology	4	25	75		10	30	-
	MJ-8: Practical	Practical				100	-	-	40

Table 6: Semester wise Papers and Examination Structure for Geology Minor:

Semester	Code	Minor Papers	Credits	Full Marks		Pass Marks	
				Theory (Internal+ End Sem)	Practical End Sem.	Theory (Internal+ End Sem	Practical
I	MN-1A	Introductory Geology	3+1	15+60	25	30	10
III	MN-1B	Essentials of Geology, Rocks & Minerals	3+1	15+60	25	30	10

NEP UG Syllabus
Semester I

Major – 1 (MJ - 1) EARTH SYSTEM SCIENCE
Credit – 4 **Lectures – 60 Hours**
FM= 100 **T= 100 {75Ext. +25 Int.}**

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 six questions** of **15 marks** each, out of which **any four are to answer**.

Course Objective:

This course aims in helping the students:

- To know the basic of geology, its scope and its various branches
- To introduce fundamental aspects of Earth and Planetary system and its related changes with time.
- This course will emphasize the knowledge on the solar system and planets, interior of Earth, Plate Tectonics
- Knowledge on Hydrosphere and Atmosphere, Soil, Understanding the past from stratigraphic records
- Learn the basics of crystallography and its application to optical mineralogy;
- Understand the fundamental concepts of crystal structure, morphology and its application to mineral sciences. Optical mineralogy part will help the student to understand microscopic techniques applicable to mineralogical and petrographic studies.

Learning Outcomes:

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

- 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.
- 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.
- Focus is given on the physical and chemical properties of minerals, from macroscopic to microscopic.
- The course will investigate how geologic materials and processes influence mineral occurrence, stability, and composition.
- 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.

Skills to be Learned

- Problem-solving skills and creativity thinking
- The ability to recognize and understand complex patterns systems

COURSE CONTENT:

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** **1.2.1**: Internal Structure of the earth & Composition	**02**
	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** **1.3.1:** Concept of plate tectonics, sea-floor spreading, Isostacy and continental drift	**04**
	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** **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.	**04**
	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 geo-chronological 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

- D*uff, 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.*

Semester II

Major – 2 (MJ - 2) STRUCTURAL GEOLOGY
Credit – 4 **Lectures – 60 Hours**
FM= 100 **T= 100 {75Ext. +25 Int.}**

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 six questions** of **15 marks** each, out of which **any four are to answer**.

Course Objective:

The primary objective of the course is:

- To provide student the fundamental ideas about different structures in structural geology.
- To provide fundamentals of plate tectonics

Learning outcomes

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

- This course helps the students to understand how to use structures and appreciate the dynamic nature of the Earth's lithosphere.
- 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.

Skills to be Learned

- Know basic terminologies and concepts in structural geology
- Get familiar with clinometers and measure dip and strike;
- Significance of folds and faults
- Evaluate the geological significance of joints and unconformity;
- Recognize the importance of geological fieldwork;
- Safety measures and field equipment's needed for fieldwork; and
- Discuss about planning and collection of field data and its documentation.

COURSE CONTENT:

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 & it significance	**02**

Unit 2: Stress and strain in rocks		
2.1	Concept of rock deformation: Stress & their type, Strain& their type in rocks, Strain & Stress ellipses of different types and their geological significance. Ductile and brittle deformation, Young's modulus of Elasticity, Concept of dip and strike; pitch and plunge, Outcrop patterns of different structures.	**04**
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, Ramsay & Fleuty classification of Fold	**10**
Unit 4: Foliation and lineation		
4.1	Description, origin & types of foliations and relationship with the major structures and its tectonic significance, Description, origin & types of lineation and relationship with the major structures and its tectonic significance.	**06**
Unit 5: Fractures, faults and Joints		
5.1	Geometric and genetic classification of 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 – 3 (MJ - 3) P (Practical) EARTH SYSTEM SCIENCE & STRUCTURAL GEOLOGY

Credit – 4 **Lectures – 60 x 2= 120 Hours**
FM= 100 marks

Practical Marks	Distribution
1. Experiments from 1-8	**10**
2. Experiments from 9-10	**10**
3. Experiments from 11	**10**
4. Experiments from 12-16	**10**
5. Experiments from 17-21	**10**
6. Field Visit Report	**10**
7. Practical record	**20**
8. Viva Voce	**20**
	Total=100

Suggested Practical:
EARTH SYSTEM SCIENCE

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, SilIimanite, 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.

STRUCTURAL GEOLOGY

12. Basic idea of topographic contours, Topographic sheets of various scales.
13. Introduction to Geological maps: Lithological and Structural maps

14. Structural contouring and 3-point problems of dip and strike
15. Drawing profile sections and interpretation of geological maps of different complexities, Exercises of stereographic projections of mesoscopic structural data (planar, linear, folded etc.)
16. Completion of outcrop of maps from partial data.
17. Outcrop pattern of horizontal and dipping beds, fold, fault, unconformity, dyke and sill.
18. Graphical solutions of simple structural problems: dip-strike, true dip-apparent dip.
19. Three-point problems and determination of dip and strike from borehole data.
20. Determination of vertical and true thickness of inclined beds.
21. Drawing of vertical geological sections to illustrate different geological structures.
22. Geological Mapping of two weeks duration in a geologically complex area and Field Work Report based on it

Semester III

Major – 4 (MJ - 4) IGNEOUS PETROLOGY
Credit – 4 **Lectures – 60 Hours**
FM= 100 **T= 100 {75Ext. +25 Int.}**

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 six questions** of **15 marks** each, out of which **any four are to answer**.

Course Objective:

The primary objective of the course is:

- To provide student the fundamental ideas about igneous rocks.
- To help the student to learn in detail the different igneous rocks, the petrogenetic processes and tectonic environments for their emplacement.

Learning outcomes

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

- understanding of the processes involved in the formation of igneous rocks, their textures, structures, classifications.
- to identify, describe and classify rocks using hand specimens and in thin sections.
- Understand the petrogenesis of igneous rocks

Skills to be Learned

- Know basic terminologies and concepts in igneous petrology
- Significance of magma & igneous rocks
- Understand the diversity of igneous rocks and the variety of tectonic environments for their emplacement.

COURSE CONTENT:

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 & its different stages, Assimilation and factors affecting assimilation.		**12**

Unit 2: Phase diagrams Uni component magma, 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 and its petrological significance.	**12**
Unit 5: Petrogenesis of Igneous rocks Petrogenesis, Origin & tectonic settings of I-, S-, A- type granites, Komatites, Granitoids, Basalt, Gabbros, Anorthosite, 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 – 5 (MJ - 5) IGNEOUS PETROLOGY
Credit – 4 **Lectures – 60 x 2= 120 Hours**
FM= 100 marks

Practical	**Marks Distribution**
1. Experiments from 1	**20**
2. Experiments from 2	**20**
3. Experiments from 3	**20**
4. Class record	**20**
5. Viva Voce	**20**
	Total=100

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 – 6 (MJ - 6) SEDIMENTARY PETROLOGY
Credit – 4 **Lectures – 60 Hours**
FM= 100 **T= 100 {75Ext. +25 Int.}**

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 six questions** of **15 marks** each, out of which **any four are to answer**.

Course Objective:

The primary objective of the course is:

- The students will get to know the different types of sedimentary, metamorphic rocks and fundamentals of sedimentary and metamorphic petrology.
- The students will able to understand the texture, structures and process of their formation.
- The primary objective of the course of metamorphic petrology is to introduce fundamental understanding of processes, reaction, mineral assemblages formed in different protoliths during metamorphism.

Learning outcomes:

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

- understanding of the processes involved in the formation of sedimentary & metamorphic rocks, their textures, structures, classifications.
- to identify, describe and classify rocks using hand specimens and in thin sections.

Skills to be Learned:

- Identify and study various types sedimentary rocks in field and under microscope
- Can understand the difference between various types of sedimentary rocks
- Know the Process and control of physico-chemical and compositional control on metamorphism of rocks.
- Corelating tectonic setting with metamorphism.

COURSE CONTENT:

Unit	Topic	Total no. of Lectures
Unit 1: Origin of sediments Weathering and sedimentary flux: Physical and chemical weathering, soils and their types and paleosols.		**12**
Unit 2: Sediment granulometry Grain size scale, particle size distribution, Environmental connotation; particle shape and fabric, Grain size scales Udden-Wentworth and Krumbein (phi) scale, particle size distribution, Environmental		**12**

connotation; particle shape and fabric, components and classification of limestone & sandstones	
Unit 3: Sedimentary textures, structures and environment Fluid flow, sediment transport and sedimentary structures: Types of fluids, Laminar vs. turbulent flow, Particle entrainment, transport and deposition, Sedimentary facies and their types, Sedimentary textures, types and its significance, Sedimentary Structures, types and its significance - Primary and syn-sedimentary structures.	**12**
Unit 4: Varieties of sedimentary rocks Siliciclastic rocks: Conglomerates, sandstones, mudrocks. Carbonate rocks, controls of carbonate deposition, components and classification of limestone, sandstones, dolomite and dolomitisation	**12**
Unit 5: Diagenesis Process of formation of sedimentary rocks: sediment generation, transportation, deposition, lithification, Concepts of diagenesis, Stages of diagenesis, Compaction and cementation	**12**

Books Recommended:

- *Prothero, D. R., & Schwab, F. (2004). Sedimentary geology. Macmillan.*
- *Tucker, M. E. (2006) Sedimenary 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.*
- *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.*

Semester IV

Major – 7 (MJ - 7) METAMORPHIC PETROLOGY
Credit – 4 **Lectures – 60 Hours**
FM= 100 **T= 100 {75Ext. +25 Int.}**

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 six questions** of **15 marks** each, out of which **any four are to answer**.

Course objective:

The primary objective of the course of Economic Geology is

- to introduce fundamental aspects of origin, mode of occurrences and the distribution of ore deposits to the students.

Learning outcomes:

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

- 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.

Skills to be Learned:

- To know the basic concepts of the processes of the formation of the ore deposits
- To know the different types of ore deposits in India and in various parts of the world Spatio-temporal distribution of the different kinds of mineral deposits in India

COURSE CONTENT:

Unit	Topic	Total no. of Lectures
Unit 1: Metamorphism: controls and types. Definition of metamorphism. Factors controlling metamorphism Types and agents of metamorphism - contact, regional, fault zone metamorphism, impact metamorphism.		**12**
Unit 2: Metamorphic facies and grades Index minerals, Chemographic projections, Metamorphic zones. Grade of metamorphism and isograde. Concept of metamorphic facies and grade, Mineralogical phase rule of closed and open system, Structure and textures and classification of metamorphic rocks and significance.		**12**
Unit 3: Metamorphism and Tectonism Relationship between metamorphism and deformation, Metamorphic mineral reactions (prograde and retrograde)		**12**

Unit 4: Migmatites and their origin Migmatites and its origin, Metasomatism and role of different fluids in metamorphism	**12**
Unit 5: Metamorphic rocks, types, tectonic setting of Schists, Gneisses, Khondalites, Charnockites, Blueschists and Eclogites	**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.*
- *Yardley, B. W., & Yardley, B. W. D. (1989). An introduction to metamorphic petrology. Longman Earth Science Series.*

Semester IV

Major – 8 (MJ – 8) (Practical) Sedimentary & Metamorphic Petrology
Credit – 4 **Lectures – 60 x 2 =120 Hours**
P = 100 marks

Practical	**Marks Distribution**
1. **Sedimentary Petrology Experiment:**	**30**
2. Metamorphic Petrology Experiment	**30**
3. Field Report	**20**
4. Practical record & Viva Voce	**20**
	Total=100

Suggested Practical

MJ 6: 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.

MINOR PAPERS

SEMESTER I

Geology-MN 1A: Introductory Geology

(Credits: Theory-03, Practicals-01)

MN-1A: Theory

Credit: 03 Lectures: 45

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

Course Objective:

The primary objective of the course is:

- To provide student the fundamental ideas about igneous rocks.
- The students will get to know the different types of sedimentary, metamorphic rocks and fundamentals of sedimentary and metamorphic petrology.
- The students will able to understand the texture, structures and process of their formation.

Learning outcomes

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

- This course helps the students to understand how to use structures and appreciate the dynamic nature of the Earth's lithosphere.
- The students will learn the skills of identifying different structures.

Skills to be Learned

- Know basic terminologies and concepts in structural geology
- Get familiar with clinometers and measure dip and strike;
- Significance of folds and faults
- Evaluate the geological significance of joints and unconformity;
- Can understand the difference between various types of sedimentary rocks
- Know the Process and control of physico-chemical and compositional control on metamorphism of rocks.

COURSE CONTENT:

Unit 1: (10-Lectures)

Holistic understanding of dynamic planet 'Earth" through Geology, Introduction of various branches of Earth Sciences, Application of Geology in various fields.

Unit 2: (10-Lectures)

Earth in Solar System: Origin, the internal constitution of the Earth: core, mantle, crust. Atmosphere

and Hydrosphere, Physiographic division of India, Earthquake and volcano, Major engineering projects of India:
Type of Dam/Reservoir, Tunnel, Bridges.

Unit 3: (05-Lectures)

Energy: Renewable and Non-renewable energy, use of alternate energy sources, growing energy needs.

Unit 4: (10-Lectures)

Mineral: Definition, Classification and physical properties, distribution of important economic minerals
of India.
Rocks: definition and types, and basics of formation
Igneous: Magma, their types, origin and composition,
Sedimentary: Weathering and Erosion, a process of formation
Metamorphic: agents and types of metamorphism

Unit 5: (10-Lectures)

Fossils and their application: Definition, processes, modes of preservation and uses, application of Fossils, Gondwana fossils and their types.

Reference Books:

- *1. Emiliani, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge*
- *University Press.*
- *2. Duff, P. M. D., & Duff, D. (Eds.). (1993). Holmes' principles of physical geology. Taylor & Francis.*
- *3. Lutgens, F., Tarbuck, E., and Tasa, D., (2009). The Atmosphere: An Introduction to Meteorology. Pearson*
- *Publisher*
- *4. Johnson, R.B. and De Graf, J.V. (1988). Principles of Engineering Geology, John Wiley.*
- *5. Goodman, R.E., 1993. Engineering Geology: Rock in Engineering constructions. John Wiley & Sons, N.Y.*
- *6. Waltham, T., (2009). Foundations of Engineering Geology (3rd Edn.) Taylor & Francis.*
- *7. Bateman, A.M. and Jensen, M.L. (1990). Economic Mineral Deposits. John Wiley.*
- *8. Gokhale, K.V.G.K. and Rao, T.C. (1978). Ore deposits of India their distribution and processing, Tata McGraw*
- *Hill, New Delhi*
- *9. Earth Materials- Introduction to Mineralogy and Petrology, Cornelis Klein and Anthony Philpotts, Cambridge*
- *University Press, 2013.*
- *10. Understanding Earth (Sixth Edition), John Grotzinger and Thomas H. Jordan, 2010, W.H. Freeman and Company,*
- *New York.*
- *11. Schoch, R.M. (1989). Stratigraphy, Principles and Methods. Van Nostrand Reinhold*
- *12. Prothero, D.R. (1998). Bringing fossils to life - An introduction to Palaeobiology, McGraw Hill.*

MN-1A:Practical

Credit: 01 Lectures: 30 (15X2)

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:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

1. Distribution of Seismic zone in India
2. Locate the major engineering projects in India: Dam/Reservoir, Tunnel, Bridges.
3. Physiographic division of India
4. Distribution of renewable and non-renewable energy sources of India
5. Megascopic study of Igneous, Sedimentary and Metamorphic rocks.
6. Distribution of important economic minerals in India with special reference to Jharkhand.
7. Megascopic study of Invertebrate fossils.
8. Megascopic study of Plant fossils.

Reference Books

1. Sen, A.K.: Laboratory Manual of Geology (Modern Book Agency Pvt. Ltd. Calcutta).
2. Sinha, R.K. and Sharma, N.L. (1993): An introduction to Mineral Economics, Wiley Eastern.
3. Mahadevan, T.M. (2002): Geology of Bihar and Jharkhand, GSI, Bangalore.
4. Krishnan, M.S. (1982): Geology of India and Burma, CBS publication and distributors, Delhi.

SEMESTER III

GEOLOGY- MN-1B: Essentials of Geology, Rocks & Minerals

(Credits: Theory-03, Practicals-01)

MN-1B: THEORY

Credit: 03 Lectures: 45

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

Course Objective:

This course aims in helping the students:

- To know the basic of geology, its scope and its various branches
- This course will emphasize the knowledge on the solar system and planets, interior of Earth, Plate Tectonics
- Learn the basics of crystallography and its application to optical mineralogy;
- Understand the fundamental concepts of crystal structure, morphology and its application to mineral sciences. Optical mineralogy part will help the student to understand microscopic techniques applicable to mineralogical and petrographic studies.

Learning Outcomes:

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

- 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.
- Focus is given on the physical and chemical properties of minerals, from macroscopic to microscopic.
- The course will investigate how geologic materials and processes influence mineral occurrence, stability, and composition.

Skills to be Learned

- Problem-solving skills and creativity thinking
- The ability to recognize and understand complex patterns systems

COURSE CONTENT:

Unit 1: (10-Lectures)

Introduction to Geology, scope, sub-disciplines and relationship with other branches of Sciences, Earth in the solar system: Origin. Solar System- Introduction to Various planets- Terrestrial and Jovian Planets, Internal constitution of the Earth: core, mantle and crust.

Unit 2: (10-Lectures)

Conventions in the Earth's core and production of the magnetic field; Earthquake: causes, effects and distribution; Volcanoes: types, products and distribution, Introduction to hydrosphere, biosphere and atmosphere; Origin of mountains; Elementary idea about Plate Tectonics.

Unit 3: **(10-Lectures)**

Age of the Earth: Radioactivity and its application in determining the age of the Earth. Basic concept of:

a. Rocks: types with examples

b. Minerals: Definition and Classification.

c. Fossils: mode of preservation and uses

Unit 4: **(10-Lectures)**

Minerals: Definitions, Classification and Physical properties of minerals. Mineral structures. Silicate Structure. Nature of light and principles of optical mineralogy. Classification of minerals based on optical properties; Petrological Microscope.; Optical properties of minerals. Nature of light and principles of optical mineralogy, Isotropic & Anisotropic, Birefringence, Interference color, Extinction, Twinning and its types

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

Unit 5: **(05-Lectures)**

Rocks: Definitions and types, Basics of rock formation.

Igneous rock: texture and Structure, magma: Origin and Composition, Bowen's reaction series and magmatic differentiation.

Sedimentary rocks: the process of formation, texture and Structure.

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

Reference Books:

1. Holme's Principles of Physical Geology (1992). Chapman & Hall

2. Emiliani, C. (1992). Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge
University Press.

3. Gross, M.G. (1977). Oceanography: A view of the Earth, Prentice Hall.

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

5. Understanding Earth (Sixth Edition), John Grotzinger and Thomas H. Jordan, 2010, W.H. Freeman and Company,
New York.

MN-1B: Practical

Credit: 01 Lectures: 30(15X2)

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:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

1. Contour maps: profile drawing, identification and description of important topographical features.

2. Physical properties of minerals: Study and Documentation.

3. Study of physical properties of important rock-forming minerals in hand specimen:

4. Plotting of major Dams on the outline map of India, mention the name of the river and utility of the dam.

5. Study of Seismic Zones of India.

6. Observation and documentation of important structures of sedimentary and metamorphic Rocks.

7. Observation and documentation of forms of igneous rocks.

8. Study of optical properties of minerals.

9. Study of rocks in hand specimens.

Reference Books:

1. Laboratory Manual of Geology - A.K. Sen (Modern Book Agency Pvt. Ltd. Calcutta)

2. Singh, R.P. (1995) Structural Geology: A Practical Approach, Ganga Kaveri Publication House, Varanasi. 133p.

3. Bennison, G.M. (1990): An Introduction to Geological Structures and Maps, Fifth Edition, Edward Arnold. London. 5th edition, 67p.

MDC (Multidisciplinary Course): GEOLOGY

SEMESTER I/II/III

MDC-1/2/3: GEOLOGY

(Credits: Theory-03 Lectures-45)

Marks: 75 (End Semester Examination=75 **Pass Marks: = 30**
No Internal Examination

Instruction to Question Setter for

End Semester Examination (ESE 75 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.*

COURSE CONTENT:

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. 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

Unit-II:

Introduction to Structural Geology, 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.

Unit-III:

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.

Unit-IV:

Magma: definition, composition, types and origin; Forms of igneous rocks; textures, structure & classification of igneous 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-V:

Concept of ore and ore deposits, ore minerals and gangue minerals; Tenor, cutoff grade; Origin, mode of occurrence & distribution of Metallic and non-metallic ore minerals in India- Iron, Copper, Aluminium, Gold, Lead, Zinc, Chromite & Manganese. Coal: origin, types & distribution, Petroleum: origin, occurrence & distribution.

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.*

Semester V

Major – 9 (MJ - 9) ECONOMIC GEOLOGY
Credit – 4 **Lectures – 60 Hours**
FM= 100 **T= 100 {75Ext. +25 Int.}**

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 six questions** of **15 marks** each, out of which **any four are to answer**.

Course objective:

The primary objective of the course of Economic Geology is

- to introduce fundamental aspects of origin, mode of occurrences and the distribution of ore deposits to the students.

Learning outcomes:

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

- 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.

Skills to be Learned:

- To know the basic concepts of the processes of the formation of the ore deposits
- To know the different types of ore deposits in India and in various parts of the world Spatio-temporal distribution of the different kinds of mineral deposits in India

COURSE CONTENT:

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, Sedimentary 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: Metallic 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	**12**
Unit 4: **Nonmetallic ores** Mode of Occurrence, chemical composition, uses and distribution in India of following: 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.*

Semester V

Major – 10 (MJ - 10) STRATIGRAPHIC PRINCIPLES & INDIAN STRATIGRAPHY
Credit – 4 **Lectures – 60 Hours**
FM= 100 **T= 100 {75Ext. +25 Int.}**

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 six questions** of **15 marks** each, out of which **any four are to answer**.

Course objective:
The primary objective of the course is

- To learn a basic understanding of rock superposition of beds through time and their relative age; understanding of stratigraphy to apply in exploration of energy and mineral resources, codes of stratigraphy

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

- On completion of the course the students are expected to gain knowledge about identification of potential zones of mineral and energy resources; Application of stratigraphy to characterize evolution of life through time and mass extinctions.

Skills to be Learned:

- Identification of potential zones of mineral and energy resources.
- Application of stratigraphy to characterize evolution of life through time and mass extinctions.

COURSE CONTENT:

Unit	Topic	Total no. of Lectures
Unit 1: Principles of stratigraphy, Introduction to the concepts of lithostratigraphy, biostratigraphy, chronostratigraphy, seismic stratigraphy, chemostratigraphy, Magnetostratigraphy; International Stratigraphic Code – development of a standardized stratigraphic nomenclature. Concepts of Stratotypes. Global Stratotype Section and Point (GSSP).		**12**
Unit 2: Principles of stratigraphic analysis and Physiographic and tectonic subdivisions of India Walther's Law of Facies. Concept of paleogeographic reconstruction; Sequence stratigraphy and their subdivisions with Indian examples. Introduction to the physiographic and tectonic sub divisions of India. Introduction to Indian Shield.		**12**

Unit 3: Pre-Cambrian Stratigraphy of India Pre-Cambrian geology of Singhbhum and Karnataka; Introduction to Proterozoic basins of India; Geology of Vindhyan and Cudappah basins of India	**12**
Unit 4: Phanerozoic Stratigraphy of India Geology, Structure and hydrocarbon potential of Gondwana basins. ***Mesozoic stratigraphy of India:*** a. Triassic successions of Spiti, b. Jurassic of Kutch, c. Cretaceous successions of Cauvery basins ***Cenozoic stratigraphy of India:*** a. Siwalik successions, b. Assam basins. Stratigraphy and structure of Krishna-Godavari basin, Cauvery basin, Bombay offshore basin, Kutch and Saurashtra basins and their potential for hydrocarbon exploration	**12**
Unit 5: Volcanic provinces of India and Stratigraphic boundaries a. Deccan Traps, b. Rajmahal, Important Stratigraphic boundaries in India - a. Precambrian-Cambrian boundary, b. Permian-Triassic boundary, and c. Cretaceous-Tertiary boundary	**12**

Suggested Readings:

- *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.*

Semester V

Major – 11 (MJ – 11) (Practical) Economic Geology, Stratigraphic Principles & Indian Stratigraphy
Credit – 4 **Lectures – 60 x 2 =120 Hours**
P = 100 marks

Practical	**Marks Distribution**
1. **Economic Geology Experiment:**	**20**
2. **Stratigraphy Experiment**	**20**
3. **Field Report**	**20**
4. **Class record**	**20**
5. **Viva Voce**	**20**
	Total=100

Suggested Practical

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.

Stratigraphy

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. Drawing various Paleo-geographic maps of Precambrian time;
4. Study of different Proterozoic supercontinent reconstructions.

Geological Mapping of two weeks duration of Economic Geology and Field Work Report based on it.

Semester VI

Major – 12 (MJ - 12) PALEONTOLOGY
Credit – 4 **Lectures – 60 Hours**
FM= 100 **T= 100 {75Ext. +25 Int.}**

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 six questions** of **15 marks** each, out of which **any four are to answer**.

Course objective:

The primary objective of the course is

- To study the remains of animals and plants (fossils) of the geological past preserved in the rocks and how life forms had responded to climate and environments.

Learning outcomes:

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

- On completion of the course the students are expected to gain knowledge the evolution of life through time; appreciating how fossils provide information on the paleoenvironments; understanding the adaptability of life in different environments, paleoenvironmental crises and mass extinctions;

Skills to be Learned:

- To know the remains of animals and plants (fossils) of the geological past preserved in the rocks and how life forms had responded to climate and environments.

COURSE CONTENT:

Unit	Topic	Total no. of Lectures
Unit 1:	**Fossilization and fossil record** Nature and importance of fossil record; Fossilization processes and modes of preservation	**12**
Unit 2:	**Taxonomy and Species concept** Species concept with special reference to paleontology, Theory of organic evolution.	**12**
Unit 3:	**Invertebrates** Brief introduction of important fossils groups: morphology and	**12**

geological history of Trilobita, Brachiopoda, Gastropoda, Cephalopoda, Lamellibranch, and Corals.	
Unit 4: **Vertebrates and other fossils** Evolution of horse and intercontinental migrations. Human evolution. Gondwana Flora, Introduction to Ichnology.	**12**
Unit 5: **Application of fossils in Stratigraphy** Biozones, index fossils, correlation Fossils and paleo-environmental analysis, Fossils and paleobiogeography, biogeographic provinces Paleoecology – fossils as a window to the evolution of ecosystems	**12**

Books Recommended:

- *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 VI

Major – 13 (MJ - 13) GEOMORPHOLOGY
Credit – 4 **Lectures – 60 Hours**
FM= 100 **T= 100 {75Ext. +25 Int.}**

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 six questions** of **15 marks** each, out of which **any four are to answer**.

Course objective:
The primary objective of the course is

- To introduce a fundamental understanding of various landforms formed by different agents, exogenic and endogenic forces, earths and its spheres along with generation and movement of several plates.

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

- On completion of the course the students are expected to gain knowledge of the earth and its spheres, various forces operating on it and geological work of various agents and concept of plate tectonics.

Skills to be Learned:

- To know various landforms formed by different agents, exogenic and endogenic forces, earths and its spheres along with generation and movement of several plates.

COURSE CONTENT:

Unit	Topic	Total no. of Lectures
Unit 1:	Introduction to Geomorphology, Endogenic and Exogenic processes, Basic principles of Geomorphology, geomorphological cycles, weathering and erosion; Geomorphic mapping- tools and techniques.	**12**
Unit 2:	Geoid, Topography, Hypsometry, Global Hypsometry; Major Morphological features Large Scale Topography - Ocean basins, Large scale mountain ranges (with emphasis on Himalaya).	**12**
Unit 3:	Surficial Processes and geomorphology: Weathering and associated landforms, Glacial, Periglacial processes and landforms, Fluvial processes and landforms, Aeolian Processes and landforms, Beach/Coastal Processes and	**12**

landforms, Landforms associated with igneous activities	
Unit 4: Endogenic- Exogenic interactions, Rates of uplift and denudation, Tectonics and drainage development, Sea-level change, Long-term landscape development, Types of Drainage Patterns, and Drainage analysis in Geological Interpretation	**12**
Unit 5: Overview of Indian Geomorphology. Application of Geomorphology in groundwater, mineral and oil exploration and Engineering projects.	**12**

Suggested Readings:

- *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.*
- Allen, P., 1997. Earth Surface Processes. Blackwell
- Bloom, A.L., 1998. Geomorphology: A systematic Analysis of Late Cenozoic Landforms (3rd Edition). Pearson Education, Inc.
- Keary, P. and Vine, F.J., 1997. Global Tectonics. Blackwell and crustal evolution. Butterworth-Heinemann.
- Kale, V.S. and Gupta, A., 2001. Introduction to Geomorphology. Orient Longman Ltd.

Semester VI

Major – 14 (MJ - 14) HYDRO GEOLOGY
Credit – 4 **Lectures – 60 Hours**
FM= 100 **T= 100 {75Ext. +25 Int.}**

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 six questions** of **15 marks** each, out of which **any four are to answer**.

Course objective:

The primary objective of the course is

- to introduce fundamental aspects of nature, occurrence and movement of groundwater in geological context; water bearing properties of formations, aquifer types and aquifer parameters;
- to understand about ground water exploration and management.

Learning outcomes:

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

- On completion of the course the students are expected to gain knowledge of the fundamental concepts of hydrogeology, occurrence of groundwater, water bearing properties of formations, aquifer types and aquifer parameters;
- Apply the concepts of groundwater exploration in an integrated way; groundwater exploration methods, aspects of groundwater chemistry and groundwater management;

Skills to be Learned:

- To know the basic concepts of the fundamental concepts of hydrogeology, occurrence of groundwater, water bearing properties of formations, aquifer types and aquifer parameters
- To know the concepts of groundwater exploration in an integrated way; groundwater exploration methods, aspects of groundwater chemistry and groundwater management.

COURSE CONTENT:

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, transmissivity, storage coefficient.	**12**

Unit 2: Forces and laws of groundwater movement; Darcy law and its application in hydrogeology; Confined, unconfined, steady, unsteady and radial flows of groundwater; Methods of pumping test and evaluation of aquifer parameters. Springs: types, origin and movement of water; Water Table map and its significance.	**12**
Unit 3: 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. Wells: types, drilling methods, construction, design and development of wells.	**12**
Unit 4: 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	**12**
Unit 5: Chemical characteristics of groundwater in relation to various uses – domestic, industrial and irrigation; Water contaminants and pollutants, natural (geogenic) and anthropogenic contaminants; 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**

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*
- *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- Contam*

Semester VI

Major – 15 (MJ – 15) (Practical) Paleontology, Geomorphology & Hydro Geology
Credit – 4 **Lectures – 60 x 2 =120 Hours**
P = 100 marks

Practical	**Marks Distribution**
1. **Paleontology Experiment:**	**20**
2. **Geomorphology Experiment**	**20**
3. **Hydro Geology practical**	**20**
4. **Class record**	**20**
5. **Viva Voce**	**20**
	Total=100

Suggested Practical

MJ 12: Paleontology

1. Study of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate, vertebrate and plant fossils

MJ 13: Geomorphology

1. Reading topographic maps, Concept of scale Preparation of a topographic profile, Preparation of longitudinal profile of a river; Preparing Hack Profile; Calculating Stream length gradient index, Morphometry of a drainage basin, Calculating different morphometric parameters, Preparation of geomorphic map, Interpretation of geomorphic processes from the geomorphology of the area.

MJ 14: Hydro Geology

1. Plotting of Ground water provinces of India in political map of India.
2. Study, preparation and analysis of hydrographs for differing groundwater conditions
3. Water potential zones of India (map study).
4. Hydrological Properties of rocks

FYUGP

GEOLOGY MINOR PAPERS FROM DISCIPLINE-1 & VOCATIONAL STUDIES/ DISCIPLINE-2

FOR UNDER GRADUATE COURSES UNDER

BINOD BIHARI MAHTO KOYALANCHAL UNIVERSITY, DHANBAD

Implemented from
Academic Session 2023-2027

UNIVERSITY DEPARTMENT OF GEOLOGY

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

Memo No: BBMKU/ / /2024, dated on

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. Leelawati Kumari** Dean, Faculty of Science, Head, Geology Dept. BBMK Univ. Dhanbad	**-Chairman**	
2. **Dr. Atul Kumar Sinha,** University Dept. of Geology, BBMK Univ. Dhanbad	**- Member**	
3. **Dr. Sagar Kumar Swain,** HoD, Dept. of Geology, PKRMC, BBMK Univ. Dhanbad	**-Member**	
4. **Dr. Krishna Gopal,** University Dept. of Geology, BBMK Univ. Dhanbad	**-Member**	
5. **Prof. Pradeep Kumar Adhikari** Head, Department of Geology, K.C.B. College, Bero, Ranchi University, Ranchi	**-External expert**	

COURSE STUCTURE FOR FYUGP **'HONOURS/ RESEARCH'**

Table 1: Credit Framework for Four Year Undergraduate Programme (FYUGP) under State Universities of Jharkhand [Total Credits =160]

Level of Courses	Semester	MJ: Discipline specific courses-Core or Major (80)	MN: Minor from discipline (16)	MN: Minor from vocational (16)	MDC: Multidisciplinary Courses [Life Sciences, Physical Sciences, Mathematical and Computer Sciences, Data Analysis, Social Sciences, Humanities, etc.] (9)	AEC: Ability Enhancement Courses (Modern Indian Language and English (8)	SEC: Ability Enhancement Courses (9)	VAC: Value added Courses (6)	IAP: Internship / Dissertation (4)	RC: Research Courses (12)	AMJ: Advanced Courses in lie of Research (12)	Credits	Double Major (DMJ)
1	2	3	4	5	6	7	8	9	10	11	12	13	14
100-199: Foundation or Introductory courses	I	4	4		3	2	3					20	4+4
	II	4+4		4	3	2	3					20	4+4
	Exit Point: Undergraduate Certificate provided with Summer Internship/Project (4 credits)												
200-299: Intermediate-level courses	III	4+4	4		3	2	3					20	
	IV	4+4+4		4		2		2				20	4+4
	Exit Point: Undergraduate Diploma Certificate provided with Summer Internship in 1st or 2nd year /Project (4 credits)												
300-399: Higher-level courses	V	4+4+4	4						4			20	4+4
	VI	4+4+4+4		4								20	4+4
	Exit Point: Bachelor's Degree												
400-499: Advanced courses	VII	4+4+4+4	4									20	4+4
	VIII	4		4						12	4+4+4	20	4+4
	Exit Point: Bachelor's Degree with Hons. /Research											160	224

Note: Honours students not undertaking research will do 3 courses for 12 credits in lieu of a Research project / Dissertation

SEMESTER WISE COURSES OF STUDY FOR FOUR YEAR UNDERGRADUATE PROGRAMME **2023 onwards**

Table 2: Semester wise Course Code and Credit Points:

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses Code	Papers	Credits
I	AEC-1	Language and Communication Skills (Modern Indian language including TRL)	2
	VAC-1	Value Added Course-1	4
	SEC-1	Skill Enhancement Course-1	3
	MDC-1	Multi-disciplinary Course-1	3
	MN-1A	Minor from Discipline-1	4
	MJ-1	Major paper 1 (Disciplinary/Interdisciplinary Major)	4
II	AEC-2	Language and Communication Skills (English)	2
	SEC-2	Skill Enhancement Course-2	3
	MDC-2	Multi-disciplinary Course-2	3
	MN-2A	Minor from Vocational Studies/Discipline-2	4
	MJ-2	Major paper 2 (Disciplinary/Interdisciplinary Major)	4
	MJ-3	Major paper 3 (Disciplinary/Interdisciplinary Major)	4
III	AEC-3	Language and Communication Skills (Modern Indian language including TRL)	2
	SEC-3	Skill Enhancement Course-3	3
	MDC-3	Multi-disciplinary Course-3	3
	MN-1B	Minor from Discipline-1	4
	MJ-4	Major paper 4 (Disciplinary/Interdisciplinary Major)	4
	MJ-5	Major paper 5 (Disciplinary/Interdisciplinary Major)	4
IV	AEC-3	Language and Communication Skills (MIL-2/English-2)	2
	VAC-2	Value Added Course-2	2
	MN-2B	Minor from Vocational Studies/Discipline-2	4
	MJ-6	Major paper 6 (Disciplinary/Interdisciplinary Major)	4
	MJ-7	Major paper 7 (Disciplinary/Interdisciplinary Major)	4
	MJ-8	Major paper 8 (Disciplinary/Interdisciplinary Major)	4
V	MN-1C	Minor from Discipline-1	4
	MJ-9	Major paper 9 (Disciplinary/Interdisciplinary Major)	4
	MJ-10	Major paper 10 (Disciplinary/Interdisciplinary Major)	4
	MJ-11	Major Paper 11 (Disciplinary/Interdisciplinary Minor)	4
	IAP	Internship/Apprenticeship/ Field work / Dissertation/ Project	4
VI	MN-2C	Minor from Vocational Studies/Discipline-2	4
	MJ-12	Major paper 12 (Disciplinary/Interdisciplinary Major)	4
	MJ-13	Major paper 13 (Disciplinary/Interdisciplinary Major)	4
	MJ-14	Major Paper 14 (Disciplinary/Interdisciplinary Minor)	4
	MJ-15	Major Paper 15 (Disciplinary/Interdisciplinary Minor)	4
VII	MN-1D	Minor from Discipline-1	4
	MJ-16	Major paper 16 (Disciplinary/Interdisciplinary Major)	4
	MJ-17	Major paper 17 (Disciplinary/Interdisciplinary Major)	4
	MJ-18	Major Paper 18 (Disciplinary/Interdisciplinary Minor)	4
	MJ-19	Major Paper 19 (Disciplinary/Interdisciplinary Minor)	4
VIII	MN-2D	Minor from Vocational Studies/Discipline-2	4
	MJ-20	Major paper 20 (Disciplinary/Interdisciplinary Major)	4
	RC/	Research Internship/ Field work/ Dissertation	12/
	AMJ-1	Advanced Major Paper-1 (Disciplinary/Interdisciplinary Major)	4
	AMJ-2	Advanced Minor Paper-2 (Disciplinary/Interdisciplinary Major)	4
	AMJ-3	Advanced Minor Paper-3 (Disciplinary/Interdisciplinary Major)	4
		Total Credits	**160**

Abbreviations:

AEC Ability Enhancement Courses

SEC Skill Enhancement Courses

IAP Internship/Apprenticeship/ Project
MDC Multidisciplinary Courses
MJ Major Disciplinary/Interdisciplinary Courses
DMJ Double Major Disciplinary/Interdisciplinary Courses
AMJ Advance Major Disciplinary/Interdisciplinary Courses
MN Minor Disciplinary/Interdisciplinary Courses
RC Research Courses

AEC (Ability enhancements courses)- 2 Credits

- *Full marks – 50, Pass Marks – 20*
- *In AEC the students of all faculties will have to select either Hindi or English in Semester -1 and those students who have opted Hindi will have to select English as AEC in Semester -2 and vice versa. For 3rd and 4th semester student can opt Sanskrit, Urdu, Bengali, English, Hindi or TRL.*
- *In 4th semester there will be AEC-3 will include Language and Communication Skill in Hindi and English.*
- *No internal examination will be conducted.*

VAC (Value added Courses)- 2 Credits

- *Full marks – 50, Pass Marks – 20*
- *For 1st semester – "Understanding India"*
- *For 4th Semester – "Environmental Studies"*
- *No internal examination will be conducted.*

SEC (Skill Enhancement Courses) – 3 Credits

- *Full Marks – 75, Pass Marks – 30*
- *Digital Education or Mathematical & Computational Thinking Analysis is selected as SEC. Student will have to select or opt either of the two subjects for semester – I, II and III in no case both subject will be allowed to opt.*
- *No internal examination will be conducted.*

MDC (Multidisciplinary Courses) – 3 credits

- *Full Marks – 75, Pass Marks – 30*
- *A student will study three different subjects in the multidisciplinary courses during first three semesters.*
- *No internal examination will be conducted.*

Table3: Semester wise Course Code and Credit Points and Marks distribution of Minor Papers from Discipline-1:

S.N.	Semester	Paper	Credits	Full Marks		Pass Marks	
				Theory (Internal+ End Sem)	Practical End Sem.	Theory (Internal+ End Sem	Practical
1.	I	MN-1A	3+1	15+60	25	30	10
2.	III	MN-1B	3+1	15+60	25	30	10
3.	V	MN-1C	3+1	15+60	25	30	10
4.	VII	MN-1D	3+1	15+60	25	30	10

- *No internal or mid semester examination will be conducted for practical papers.*

Table 4: Semester wise Course Code and Credit Points and Marks distribution of Minor Papers from Vocational Studies/Discipline-2:

S.N.	Semester	Paper	Credits	Full Marks		Pass Marks	
				Theory (Written test)	Practical/ Demonstration/ Skill test & Viva voce	Theory	Practical/ Demonstration/ Skill test & Viva voce
1.	II	MN-2A	4	75	25	30	10
2.	IV	MN-2B	4	75	25	30	10
3.	VII	MN-2C	4	75	25	30	10
4.	VIII	MN-2D	4	75	25	30	10

- *No internal or mid semester examination will be conducted.*

SEMESTER WISE COURSES IN GEOLOGY FOR FYUGP **2023 onwards**

Table 5: Semester wise Papers and Examination Structure for GEOLOGY Minor from Discipline-1:

Semester	Code	Minor Papers	Credits	Full Marks		Pass Marks	
				Theory (Internal+ End Sem)	Practical End Sem	Theory (Internal+ End Sem	Practical End Sem
I	MN-1A	Introductory Geology	3+1	15+60	25	30	10
III	MN-1B	Essentials of Geology, Rocks & Minerals	3+1	15+60	25	30	10
V	MN-1C	Earth Resources	3+1	15+60	25	30	10
VII	MN-1D	Fossils & their Applications	3+1	15+60	25	30	10

Table 6: Semester wise Papers and Examination Structure for GEOLOGY Minor from Vocational Studies/Discipline-2:

Semester	Code	Minor Papers	Credits	Full Marks		Pass Marks	
				Theory (Written test)	Practical/ Demonstration / Skill test & Viva voce	Theory	Practical/ Demonstration / Skill test & Viva voce
II	MN-2A	Gemmology and Gem Testing	4	75	25	30	10
IV	MN-2B	Applications of Remote Sensing in Geosciences	4	75	25	30	10
VII	MN-2C	X-Ray Diffraction and phase identification & XRF	4	75	25	30	10
VIII	MN-2D	Geographic Information System in Geology	4	75	25	30	10

MINOR PAPERS

SEMESTER I

Geology-MN 1A: Introductory Geology

(Credits: Theory-03, Practicals-01)

MN-1A: Theory

Credit: 03 Lectures: 45

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

Course Objective:

The primary objective of the course is:

- To provide student the fundamental ideas about igneous rocks.
- The students will get to know the different types of sedimentary, metamorphic rocks and fundamentals of sedimentary and metamorphic petrology.
- The students will able to understand the texture, structures and process of their formation.

Learning outcomes

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

- This course helps the students to understand how to use structures and appreciate the dynamic nature of the Earth's lithosphere.
- The students will learn the skills of identifying different structures.

Skills to be Learned

- Know basic terminologies and concepts in structural geology
- Get familiar with clinometers and measure dip and strike;
- Significance of folds and faults
- Evaluate the geological significance of joints and unconformity;
- Can understand the difference between various types of sedimentary rocks
- Know the Process and control of physico-chemical and compositional control on metamorphism of rocks.

COURSE CONTENT:

Unit 1: **(10-Lectures)**

Holistic understanding of dynamic planet 'Earth" through Geology, Introduction of various branches of Earth Sciences, Application of Geology in various fields.

Unit 2: **(10-Lectures)**

Earth in Solar System: Origin, the internal constitution of the Earth: core, mantle, crust. Atmosphere and Hydrosphere, Physiographic division of India, Earthquake and volcano, Major engineering projects of India:

Type of Dam/Reservoir, Tunnel, Bridges.

Unit 3: **(05-Lectures)**

Energy: Renewable and Non-renewable energy, use of alternate energy sources, growing energy needs. **Unit 4:** **(10-Lectures)**

Mineral: Definition, Classification and physical properties, distribution of important economic minerals

of India.

Rocks: definition and types, and basics of formation

Igneous: Magma, their types, origin and composition,

Sedimentary: Weathering and Erosion, a process of formation

Metamorphic: agents and types of metamorphism

Unit 5: **(10-Lectures)**

Fossils and their application: Definition, processes, modes of preservation and uses, application of

Fossils, Gondwana fossils and their types.

Reference Books:

- *1. Emiliani, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge*
- *University Press.*
- *2. Duff, P. M. D., & Duff, D. (Eds.). (1993). Holmes' principles of physical geology. Taylor & Francis.*
- *3. Lutgens, F., Tarbuck, E., and Tasa, D., (2009). The Atmosphere: An Introduction to Meteorology. Pearson*
- *Publisher*
- *4. Johnson, R.B. and De Graf, J.V. (1988). Principles of Engineering Geology, John Wiley.*
- *5. Goodman, R.E., 1993. Engineering Geology: Rock in Engineering constructions. John Wiley & Sons, N.Y.*
- *6. Waltham, T., (2009). Foundations of Engineering Geology (3rd Edn.) Taylor & Francis.*
- *7. Bateman, A.M. and Jensen, M.L. (1990). Economic Mineral Deposits. John Wiley.*
- *8. Gokhale, K.V.G.K. and Rao, T.C. (1978). Ore deposits of India their distribution and processing, Tata McGraw*
- *Hill, New Delhi*
- *9. Earth Materials- Introduction to Mineralogy and Petrology, Cornelis Klein and Anthony Philpotts, Cambridge*
- *University Press, 2013.*
- *10. Understanding Earth (Sixth Edition), John Grotzinger and Thomas H. Jordan, 2010, W.H. Freeman and Company,*
- *New York.*
- *11. Schoch, R.M. (1989). Stratigraphy, Principles and Methods. Van Nostrand Reinhold*
- *12. Prothero, D.R. (1998). Bringing fossils to life - An introduction to Palaeobiology, McGraw Hill.*

MN-1A:Practical

Credit: 01 Lectures: 30 (15X2)

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:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

1. Distribution of Seismic zone in India
2. Locate the major engineering projects in India: Dam/Reservoir, Tunnel, Bridges.
3. Physiographic division of India
4. Distribution of renewable and non-renewable energy sources of India
5. Megascopic study of Igneous, Sedimentary and Metamorphic rocks.
6. Distribution of important economic minerals in India with special reference to Jharkhand.
7. Megascopic study of Invertebrate fossils.
8. Megascopic study of Plant fossils.

Reference Books

1. Sen, A.K.: Laboratory Manual of Geology (Modern Book Agency Pvt. Ltd. Calcutta).
2. Sinha, R.K. and Sharma, N.L. (1993): An introduction to Mineral Economics, Wiley Eastern.
3. Mahadevan, T.M. (2002): Geology of Bihar and Jharkhand, GSI, Bangalore.
4. Krishnan, M.S. (1982): Geology of India and Burma, CBS publication and distributors, Delhi.

SEMESTER III

GEOLOGY- MN-1B: Essentials of Geology, Rocks & Minerals

(Credits: Theory-03, Practicals-01)

MN-1B: THEORY

Credit: 03 Lectures: 45

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

Course Objective:

This course aims in helping the students:

- To know the basic of geology, its scope and its various branches
- This course will emphasize the knowledge on the solar system and planets, interior of Earth, Plate Tectonics
- Learn the basics of crystallography and its application to optical mineralogy;
- Understand the fundamental concepts of crystal structure, morphology and its application to mineral sciences. Optical mineralogy part will help the student to understand microscopic techniques applicable to mineralogical and petrographic studies.

Learning Outcomes:

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

- 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.
- Focus is given on the physical and chemical properties of minerals, from macroscopic to microscopic.
- The course will investigate how geologic materials and processes influence mineral occurrence, stability, and composition.

Skills to be Learned

- Problem-solving skills and creativity thinking
- The ability to recognize and understand complex patterns systems

COURSE CONTENT:

Unit 1: (10-Lectures)

Introduction to Geology, scope, sub-disciplines and relationship with other branches of Sciences, Earth in the solar system: Origin. Solar System- Introduction to Various planets- Terrestrial and Jovian Planets, Internal constitution of the Earth: core, mantle and crust.

Unit 2: (10-Lectures)

Conventions in the Earth's core and production of the magnetic field; Earthquake: causes,

effects and distribution; Volcanoes: types, products and distribution, Introduction to hydrosphere, biosphere and atmosphere; Origin of mountains; Elementary idea about Plate Tectonics.

Unit 3: **(10-Lectures)**

Age of the Earth: Radioactivity and its application in determining the age of the Earth. Basic concept of:

a. Rocks: types with examples

b. Minerals: Definition and Classification.

c. Fossils: mode of preservation and uses

Unit 4: **(10-Lectures)**

Minerals: Definitions, Classification and Physical properties of minerals. Mineral structures. Silicate Structure. Nature of light and principles of optical mineralogy. Classification of minerals based

on optical properties; Petrological Microscope.; Optical properties of minerals. Nature of light and principles of optical mineralogy, Isotropic & Anisotropic, Birefringence, Interference color, Extinction, Twinning and its types

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

Unit 5: **(05-Lectures)**

Rocks: Definitions and types, Basics of rock formation.

Igneous rock: texture and Structure, magma: Origin and Composition, Bowen's reaction series and magmatic differentiation.

Sedimentary rocks: the process of formation, texture and Structure.

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

Reference Books:

1. Holme's Principles of Physical Geology (1992). Chapman & Hall

2. Emiliani, C. (1992). Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge

University Press.

3. Gross, M.G. (1977). Oceanography: A view of the Earth, Prentice Hall.

4. Earth Materials- Introduction to Mineralogy and Petrology, Cornelis Klein and Anthony Philpotts, Cambridge

University Press, 2013.

5. Understanding Earth (Sixth Edition), John Grotzinger and Thomas H. Jordan, 2010, W.H. Freeman and Company,

New York.

MN-1B: Practical

Credit: 01 Lectures: 30(15X2)

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:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

1. Contour maps: profile drawing, identification and description of important topographical features.

2. Physical properties of minerals: Study and Documentation.

3. Study of physical properties of important rock-forming minerals in hand specimen:

4. Plotting of major Dams on the outline map of India, mention the name of the river and utility of the dam.

5. Study of Seismic Zones of India.

6. Observation and documentation of important structures of sedimentary and metamorphic Rocks.

7. Observation and documentation of forms of igneous rocks.

8. Study of optical properties of minerals.

9. Study of rocks in hand specimens.

Reference Books:

1. Laboratory Manual of Geology - A.K. Sen (Modern Book Agency Pvt. Ltd. Calcutta)

2. Singh, R.P. (1995) Structural Geology: A Practical Approach, Ganga Kaveri Publication House, Varanasi. 133p.

3. Bennison, G.M. (1990): An Introduction to Geological Structures and Maps, Fifth Edition, Edward Arnold. London. 5th edition, 67p.

SEMESTER V

GEOLOGY- MN-1C: Earth Resources

(Credits: Theory-03, Practicals-01)

MN-1C: THEORY

Credit: 03 Lectures: 45

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

Course Objectives: Course Learning Outcomes: After successful completion of the course, the students are expected to have the knowledge of mineral, energy and groundwater resources, their various components, and their uses providing benefits to the society.

Course Objective:

This course aims in helping the students:

- To understand the concept of earth resources;
- Ore minerals; its types, genesis, and occurrences, components and classification;
- Knowledge of energy resources and its different types;
- Groundwater resources and its management.

Learning Outcomes:

After successfully completing this course, the students will be able to understand the knowledge of mineral, energy and groundwater resources, their various components, and their uses providing benefits to the society.

Skills to be Learned

- Problem-solving skills and creativity thinking
- The ability to recognize and understand complex patterns systems

COURSE CONTENT:

Unit 1: **(10-Lectures)**

Earth Resources: Definition: Mineral, Ore and Gangue, Tenor, Grade. Introduction to Essential, Critical and Strategic Minerals. A brief overview of the Classification of Mineral deposits concerning processes of formation and mode of occurrences.

Unit 2: **(10-Lectures)**

Definition of Energy: Primary and Secondary Energy. Renewable and Non-Renewable Sources of Energy. Environmental Dimension of Energy.

Unit 3: **(10-Lectures)**

Major Types and Sources of Energy: Resources of Natural Oil and Gas. Coal and Nuclear Minerals: Types and distribution. Introduction to Hydroelectric Power, Solar Energy, Wind, Wave and Biomass-based Power and Energy.

Unit 4: **(10-Lectures)**

Groundwater resources and their management, Groundwater resources and their role in the economic development of a country. Rainwater harvesting and artificial recharge to groundwater. Watershed management.

Unit 5: **(05-Lectures)**

Surface and subsurface water interaction, Groundwater level fluctuations, Basic concepts of water balance studies.

Reference Books:

1. Energy and the Environment by Fowler, J.M. (1984). McGraw-Hill Global Energy Perspectives by Nebojsa Nakicenovic 1998, Cambridge University Press.

2. Energy Resources and Systems: Fundamentals and Non-Renewable Resources by Tushar K. Ghosh and M.A. Prelas. 2009, Springer

3. Introduction to Wind Energy Systems: Hermann-Josef Wagner and Jyotirmay Mathur. 2009, Springer.

4. Renewable Energy Conversion, Transmission and Storage. Bent Sorensen, 2007, Springer.

MN-1C: Practical

Credit: 01 Lectures: 30(15X2)

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:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

1. Plotting of major Indian oil fields on the 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.

Reference Books:

1. Laboratory Manual of Geology - A.K. Sen (Modern Book Agency Pvt. Ltd. Calcutta)

2. Singh, R.P. (1995) Structural Geology: A Practical Approach, Ganga Kaveri Publication House, Varanasi. 133p.

3. Bennison, G.M. (1990): An Introduction to Geological Structures and Maps, Fifth Edition, Edward Arnold. London. 5th edition, 67p.

SEMESTER VII

GEOLOGY- MN-1D: Fossils & their Applications

(Credits: Theory-03, Practicals-01)

MN-1D: THEORY

Credit: 03 Lectures: 45

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

Course Objectives: Course Learning Outcomes: After successful completion of the course, the students are expected to have the knowledge of mineral, energy and groundwater resources, their various components, and their uses providing benefits to the society.

Course Objective:

This course aims in helping the students:

- To study the remains of animals and plants (fossils) of the geological past preserved in the rocks and how life forms had responded to climate, ecology and biogeography; also their application in geological field.

Learning Outcomes:

After successfully completing this course, the students will be able to understand the evolution of life through time; knowledge of different fossil groups; appreciate how fossils provide the information on the paleoclimate, paleobiogeography, and paleoecology; application in hydrocarbon exploration, reservoirs correlations, pollution indicator etc.

Skills to be Learned

- Problem-solving skills and creativity thinking
- The ability to recognize and understand complex patterns systems

COURSE CONTENT:

Unit 1: **(10-Lectures)**

Introduction to fossils: Definition of fossil, fossilization processes, modes of fossil preservation and uses.

Unit 2: **(5-Lectures)**

Species concept: Definition of species, methods of description and naming of fossils.

Unit 3: **(10-Lectures)**

Introduction to various fossil groups, Brief Introduction of important fossil groups: morphology and geological history of Brachiopoda, Gastropod and lamellibranchia, Important age diagnostic fossiliferous horizons of India.

Unit 4: **(10-Lectures)**

Application of fossils: In the study of palaeoecology, paleobiogeography and palaeoclimate.

Unit 5: **(10-Lectures)**

The 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 the correlation of coal seams. Fossils as an indicator of pollution.

Reference Books:

1. Schoch, R.M. (1989). Stratigraphy, Principles and Methods. Van Nostrand Reinhold.

2. Clarkson, E.N.K. (1998). Invertebrate Palaeontology and Evolution George Allen & Unwin

3. Prothero, D.R. (1998). Bringing fossils to life - An introduction to Palaeobiology, McGraw Hill.

4. Benton, M.J. (2005). Vertebrate palaeontology (3rd Edition). Blackwell Scientific, Oxford.

5. Colbert's Evolution of the Vertebrates: A History of the Backboned Animals Through Time, Edwin 6. H. Colbert, Michael Morales, Eli C. Minkoff, John Wiley & Sons, 1991.

MN-1D: Practical

Credit: 01 Lectures: 30(15X2)

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:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

1. Study of fossils showing various modes of fossilization.
2. Distribution of diagnostic fossils in India.
3. Study of morphological characters of important Invertebrate fossils.
4. Drawing and labelling of various fossils.

Reference Books:

1. Laboratory Manual of Geology - A.K. Sen (Modern Book Agency Pvt. Ltd. Calcutta)
2. Singh, R.P. (1995) Structural Geology: A Practical Approach, Ganga Kaveri Publication House, Varanasi. 133p.
3. Bennison, G.M. (1990): An Introduction to Geological Structures and Maps, Fifth Edition, Edward Arnold. London. 5th edition, 67p.

MINOR PAPERS FROM VOCATIONAL STUDIES/ DISCIPLINE-2

SEMESTER II

GEOLOGY-MN-2A: Gemmology and Gem Testing

Credits: 04 (Theory + Practical/Demonstration/ Skill test & Viva voce)

Theory + Practical/ Demonstration/ Skill test & Viva voce *Marks*: 100	**Pass Marks= 40**

Instruction to External examiner for Written Test (Theory): 75 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.*
***Note:** There may be subdivisions in each question asked in Theory Examinations.*
Practical/ Demonstration/ Skill test & Viva voce: 25 marks

Course learning outcome: The basic idea is to make students well versed with the different terminologies used in the gem industry and to provide skills to become a successful gemmologist.

Skills to be learned: The students will acquire skills which will be useful to them in the gem industry.

MN-2A: Theory **Lectures: 45**

COURSE CONTENT

Gemmology: Introduction to Gems, basic properties of gems, Formation of gem stones (4), Use of refractometers, Polariscope, Dichroscope (4), Methods of Specific Gravity determination (2), Causes of colours in gemstones (1), Introduction to special optical properties like chatoyancy, asterism, luminescence, play of colours, labradorescence, inclusions etc. (5), Distinction between synthetic and natural gem stones (3). Tectonic implications of Gemstone. Chemical & mineralogical composition of Gemstone

Reference Books:

1. Karanth R.V. (2000) Gems and Gem Industry in India, Geological society of India

2. Read, P. G. (1991) Gemmology, Butterworth-Heinemann Ltd.

3. Webster, R. and edited by Anderson, B.W. (1983) Gems: Their Sources, Descriptions and Identification, Butterworth-Heinemann Ltd

4. Sinkankas, J. (1969) Mineralogy: A First Course, Van Nostrand Reinhold Company.

5. Karanth R.V (2008) Gemstones Enchanting Gifts of Nature, Geological society of India

MN-2A: Practical/ Demonstration/ Skill test & Viva voce

Lectures: 30 (15X2)

Practical/ Demonstration/ Skill test & Viva Voce: 25 marks

Instruction to External examiner for End Semester Examination (ESE):

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

Demonstration/Experiment	= 15 marks
Practical/Demonstration record notebook	= 05 marks
Viva-voce	= 05 marks

- Megascopic properties of different Gems
- hand lens (10x), Detection of double refraction, by observing pleochroic colours with the Dichroscope (4),
- Identification of gemstones on the basis of pleochroic colours;
- Detection of double refraction, interference figures and internal strain with the Polariscope (2),
- study of the fluorescent colours exhibited by various gemstones under Ultraviolet (long wave and short wave) light (3),
- Measurement of refractive indices and birefringence tests using a gem-testing Refractometer (2),

Kumari

SEMESTER IV

GEOLOGY- MN-2B: Applications of Remote Sensing in Geosciences

Credits: 04 (Theory + Practical/ Demonstration/ Skill test & Viva voce)

Theory + Practical/ Demonstration/ Skill test & Viva voce *Marks:* 100 **Pass Marks= 40**

Instruction to External examiner for Written Test (Theory): 75 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.*
***Note:** There may be subdivisions in each question asked in Theory Examinations.*
Practical/ Demonstration/ Skill test & Viva voce: 25 marks

Course learning outcome: The course is meant to address the fundamental techniques used for remote sensing. At the end of this course, the student will be appraised with all the theoretical knowledge, information and skills to use Remotely Sensed data for geological applications.

Skills to be learned: After completion of this course, the student will be well versed with the world of Remote Sensing and the applications and Interpretation of data related to geosciences.

MN-2B: Theory **Lectures: 45**

COURSE CONTENT

Applications of Remote Sensing in Geosciences: Basic concepts in remote sensing, electro-magnetic spectrum (3), Energy sources, energy interaction in the atmosphere, atmospheric windows, atmospheric effects on remotely sensed data (4), signatures in remote sensing, sensors and sensor platforms (3). Application of Remote sensing in geomorphology, structures & Mineral exploration. Introduction to aerial photographs, history of aerial photography, aerial camera, types of aerial photographs, classification, principles of stereoscopic viewing, conditions and cause for stereovision (2). Aerial photography missions. Use of pocket and mirror stereoscope, scale of aerial photographs, stereoscopic parallax, relief displacement, measurement of height of objects (3). Aerial photo interpretation, photo-recognition elements, methods of photointerpretation, advantages and limitations of aerial photographs (5). Remote Sensing from space: space crafts and sensors. Visual image interpretation of satellite imagery, image enhancement, digital analysis, preparation of thematic maps (5). Thermal Infrared remote sensing and microwave remote sensing for geological applications. Remote sensing satellites, Indian Remote Sensing Satellite programme (5).

Reference Books:

1. Miller Victor C. Miller Calvin F. (1961) Photogeology (International Series in the Earth Sciences. McGraw-Hill Book Company, Inc.

2. Drury S.A, A Guide to Remote Sensing - Interpreting Images of Earth, Oxford Science Publications, Oxford. (1990)

3. Sabins, F.F.Jr., (1978) Remote Sensing Principles and Interpretation, Freeman, Sanfrancisco.

4. Paine, D.P (1981) Aerial photography and image interpretation for resource management, Wiley and Sons, New York. 1986.

MN-2B: Practical/ Demonstration/ Skill test & Viva voce
Lectures: 30 (15X2)

Practical/ Demonstration/ Skill test & Viva Voce: 25 marks

Instruction to External examiner for End Semester Examination (ESE):
There will be one Practical/Demonstration Examination of 3Hrs duration. Evaluation of Practical/Demonstration Examination will be as per the following guidelines:

Demonstration/Experiment	= 15 marks
Practical/Demonstration record notebook	= 05 marks
Viva-voce	= 05 marks

- Aerial photo interpretation, photo-recognition elements, methods of photointerpretation, advantages and limitations of aerial photographs (5).
- Visual image interpretation of satellite imagery, image enhancement, digital analysis, preparation of thematic maps (5).

SEMESTER VI

GEOLOGY- MN-2C: X-Ray Diffraction and phase identification & XRF

Credits: 04 (Theory + Practical/ Demonstration/ Skill test & Viva voce)

Theory + Practical/ Demonstration/ Skill test & Viva voce Marks: 100	**Pass Marks= 40**

Instruction to External examiner for Written Test (Theory): 75 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.*
***Note:** There may be subdivisions in each question asked in Theory Examinations.*
Practical/ Demonstration/ Skill test & Viva voce: 25 marks

Course learning outcome: Lean and understand the functioning of various analytical techniques using X-ray Diffraction

Skills to be learned: On completion of this course the student will be well versed with single crystal and powder diffraction techniques which will help him in characterising minerals and crystalline material.

MN-2C: Theory **Lectures: 45**

COURSE CONTENT

X-Ray Diffraction and phase identification & XRF: Introduction to X-rays (2), Instrumentation (2), Braggs equation and derivation (4), X-ray diffraction methods (4), Single crystal diffraction (2), Powder diffraction (2), JCPDS cards (2), Mineralogical investigations using X-rays– Identification of X-ray pattern (12)., XRF- Principle, Functions, Geological implications. Different International standard for XRF.

Reference Books:

1. *Cracknell, A.P. (1969) Crystals and their structure. Pergamon Press*
2. *Cullity, B.D. and Stock,S.R. (2001) Elements of X-Ray Diffraction. Third Edition, AddisonWesley, 664 p.*
3. *Suryanarayana C. and Grant,M.N. (1998) X-Ray Diffraction: A Practical Approach. Plenum Press, New York.*
4. *Bish, D.L., and Post, J.E., eds., (1989) Modern Powder Diffraction, Min. Soc. America Reviews in Mineralogy Vol. 20, 369 p.*

MN-2C: Practical/ Demonstration/ Skill test & Viva voce

Lectures: 30 (15X2)

Practical/ Demonstration/ Skill test & Viva Voce: 25 marks

Instruction to External examiner for End Semester Examination (ESE):

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

Demonstration/Experiment	= 15 marks
Practical/Demonstration record notebook	= 05 marks
Viva-voce	= 05 marks

- Mineralogical investigations using XRD
- Element composition of different minerals using XRF (Olivine, Pyroxene, Amphibole, Mica, Felspar)

SEMESTER VIII

GEOLOGY- MN-2D: Geographic Information System in Geology

Credits: 04 (Theory + Practical/ Demonstration/ Skill test & Viva voce)

Theory + Practical/ Demonstration/ Skill test & Viva voce Marks: 100 **Pass Marks= 40**

Instruction to External examiner for Written Test (Theory): 75 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.*
***Note:** There may be subdivisions in each question asked in Theory Examinations.*
Practical/ Demonstration/ Skill test & Viva voce: 25 marks

Course learning outcome: This course provides a theoretical and practical, hands-on approach to spatial database design and spatial data analysis with Geographical Information Systems as applied to the various fields of geosciences.

Skills to be learned: The course provides knowledge of the fundamentals of GIS theory, and the stages of developing and using a GIS platform of various geological applications. It also promotes proficiency in the use of the GIS software's for visualization, query, mapping, and analytical purposes.

MN-2D: Theory **Lectures: 45**

COURSE CONTENT

Geographic Information System in Geology: Introduction to GIS, Components of GIS (2), Hardware & Software Requirements (2), Spatial databases and GIS, GIS and the art of digitizing, Geographic phenomena, Geographic object (4), Regular vs. Irregular tessellations, Triangulated Irregular Network (2), Topology and spatial relationships (2), Data input, Data output and visualization (2), Data storage, Query maintenance and spatial analyses, etc. (2). Different types of vector data: point, line, polygon, Concept of topology. Raster data model and comparison with vector (2), Sourcing satellite data, non-spatial data and their types (2), Georeferencing, Map projections (4) Applications of GIS, Limitations of GIS (4), Components of GPS (2).

Reference Books:

1. *Rolf, A. de (2001) Principles of Geographic Information Systems-An introductory textbook. ITC Educational Textbook Series. Enschede, The Netherlands.*
2. *Lo C.P. and Albert K. W. Yeung, (2002) Concepts and Techniques of Geographic Information System, Prentice –Hall, India.*

3. *Heywood I, el. (2011) An Introduction to Geographical Information Systems, Pearson Education Pvt. Ltd., New Delhi.*
4. *Kang – tsung – Chang, (2002) Introduction to Geographical Information System, McGraw Hill.*

MN-2D: Practical/ Viva voce/ Demonstration/ Skill test
Lectures: 30 (15X2)

Practical/ Demonstration/ Skill test & Viva Voce: 25 marks

Instruction to External examiner for End Semester Examination (ESE):

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

Demonstration/Experiment	= 15 marks
Practical/Demonstration record notebook	= 05 marks
Viva-voce	= 05 marks

- GIS applications Georeferencing, Map projections
- Identification of landform, drainage pattern, different lithology and ore deposits using satellite/remote sensing data
- GIS applications in Mapping of any Terrane, mineral exploration & etc.

FORMAT OF QUESTION PAPER FOR SEMESTER INTERNAL EXAMINATIONS

Question format for **10 Marks:**

Subject/ Code

F.M. =10 Time=1Hr. Exam Year

General Instructions:

i. Group A carries very short answer type compulsory questions.
ii. Answer **1 out of 2** subjective/ descriptive questions given in **Group B.**
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....

Group B

2. ..... [5]
3. ..... [5]

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

FORMAT OF QUESTION PAPER FOR END SEMESTER UNIVERSITY EXAMINATIONS

Question format for 60 Marks:

Subject/ Code

F.M. =60 **Time**=3Hrs. Exam Year

General Instructions:

i. Group A carries very short answer type compulsory questions.
ii. Answer 3 out of 5 subjective/ descriptive questions given in Group B.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]

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

Question format for 75 Marks:

Subject/ Code

F.M. = 75 **Time**=3Hrs. Exam Year

General Instructions:

i. Group A carries very short answer type compulsory questions.
ii. Answer 4 out of 6 subjective/ descriptive questions given in Group B.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]
9. ..... [15]

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