FYUGP

GEOLOGY HONOURS/ RESEARCH

FOR UNDER GRADUATE COURSES UNDER RANCHI UNIVERSITY

Implemented from
Academic Session 2022-2026

UNIVERSITY DEPARTMENT OF GEOLOGY

A DST-FIST SPONSORED DEPARTMENT
Ranchi University, Ranchi - 834008 (Jharkhand)

Ref. No. : PG/Geo-151/22 Date : 26/08/2022

Meeting of Board of Studies (University Department of Geology)

A meeting of Board of Studies was held on 26/08/2022 at 2:00p.m in the University Department of Geology, Ranchi University, Ranchi under the Chairmanship of Dr. B.R.Jha, Head, University Dept. of Geology to modify the syllabus of B.Sc. 2022-23 according to NEP 2020. The syllabus was thoroughly discussed and modifications were suggested by the members present in the meeting. In the light of the suggestions of the members, the draft of the syllabus is prepared and approved. The following faculty members were present in the meeting:-

A. Chairman:

Dr. Bacha Ram Jha, HOD, Univ. Dept. of Geology..... 26/08/2022

Head
University Department of Geology
Rancni University, Ranchi

B. Internal members:

1. Dr. Bijay Singh, Professor, Univ. Dept. of Geology..... 26/8/2022
2. Dr. Suresh Kumar Samad, Assistant Professor, Univ. Dept. of Geology..... 26/08/22
3. Mrs. Neelu Priya Tirkey, Assistant Professor, Univ. Dept. of Geology..... 26/8/22
4. Mr. Amit Kumar, Assistant Professor, Univ. Dept. of Geology..... 26/08/22
5. Dr. Chakradhar Prasad Mahto, HOD, PPK College, Bundu..... 26/08/22
6. Sri. P.K.Adhikari, HOD, KCB College, Bero..... 26/8/22
7. Sri Amaresh Chandra Mishra, HOD, Gossner College, Ranchi..... 26/08/2022

C. External members:

1. Dr. P.K.Verma, Ex-HOD, Univ. Dept. of Geology..... 26.8.2022
2. Dr. Amrendra Thakur, Ex-HOD, Gossner College, Ranchi..... 26/08/2022

23/9/2022
DIRECTOR
IQAC, RANCHI UNIVERSITY
RANCHI-834 001

Contents

HIGHLIGHTS OF REGULATIONS OF FYUGP

PROGRAMME DURATION

- The Full-time, Regular UG programme for a regular student shall be for a period of four years with multiple entry and multiple exit options.
- The session shall commence from **1st of July**.

ELIGIBILITY

- The selection for admission will be primarily based on availability of seats in the Major subject and marks imposed by the institution. Merit point for selection will be based on marks obtained in Major subject at Class 12 (or equivalent level) or the aggregate marks of Class 12 (or equivalent level) if Marks of the Major subject is not available. Reservation norms of The Government of Jharkhand must be followed as amended in times.

ADMISSION PROCEDURE

- The reservation policy of the Government of Jharkhand shall apply in admission and the benefit of the same shall be given to the candidates belonging to the State of Jharkhand only. The candidates of other states in the reserved category shall be treated as General category candidates. Other relaxations or reservations shall be applicable as per the prevailing guidelines of the University for FYUGP.

ACADEMIC CALENDAR

- Each year the University shall draw out a calendar of academic and associated activities, which shall be strictly adhered to. The same is non-negotiable. Further, the Department will make all reasonable endeavors to deliver the programmes of study and other educational services as mentioned in its Information Brochure and website. However, circumstances may change prompting the Department to reserve the right to change the content and delivery of courses, discontinue or combine courses and introduce or withdraw areas of specialization.

PROGRAMME OVERVIEW/ SCHEME OF THE PROGRAMME

- Undergraduate degree programmes of either 3 or 4-year duration, with multiple entries and exit points and re-entry options within this period, with appropriate certifications such as:
  - a Certificate after completing 1 year (2 semesters) of study in the chosen fields of study,
  - a Diploma after 2 years (4 semesters) of study,
  - a Bachelor after a 3-year (6 semesters) programme of study,
  - a Bachelor (with Hons. / Research) after a 4-year (8 semesters) programme of study

VALIDITY OF REGISTRATION

- Validity of a registration for FYUGP will be for maximum for Seven years from the date of registration.

CALCULATION OF MARKS FOR THE PURPOSE OF RESULT

- Student's final marks and the result will be based on the marks obtained in Semester Internal Examination and End Semester Examination organized taken together.
- Passing in a subject will depend on the collective marks obtained in Semester internal and End Semester University Examination both. However, students must pass in Theory and Practical Examinations separately.

PROMOTION AND SPAN PERIOD

i. The Requisite Marks obtained by a student in a particular subject will be the criteria for promotion to the next Semester.
ii. No student will be detained in odd Semesters (I, III, V & VII).
iii. To get promotion from Semester-II to Semester-III a student will be required to pass in at least 75% of Courses in an academic year (a student has to pass in minimum 9 papers out of the total 12 papers. However, it will be necessary to procure pass marks in each of the paper before completion of the course.
iv. To get promotion from Semester-IV to Semester-V (taken together of Semester I, II, III & IV) a student has to pass in minimum 16 papers out of the total 22 papers.
v. Eligibility to get entry in Semester VII is to secure a minimum of 7.5 CGPA up to semester VI along with other criteria imposed by the Institution.

PUBLICATION OF RESULT

- The result if the examination shall be notified by the Controller of Examinations of the University in different newspapers and also on University website.

- If a student is found indulged in any kind of malpractice/ unfair means during examination, the examination taken by the student for the semester will be cancelled. The candidate has to reappear in all the papers of the session with the students of next coming session and his one year will be detained. However, marks secured by the candidate in all previous semesters will remain unaffected.

- There shall be no Supplementary or Re-examination for any subject. Students who have failed in any subject in an even semester may appear in the subsequent even semester examination for clearing the backlog. Similarly, the students who have failed in any subject in an odd semester may appear in the subsequent odd semester examination for clearing the backlog.

- Regulation related with any concern not mentioned above shall be guided by the Regulations of the University for FYUGP.

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

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

	Common Courses (29)									**Introductory Courses (15)**		**Internship/ Project (4)**	**Major* (54) + Adv. Major (24)**	**Minor** (32)**		**Research Courses (18)**				**Total Credit**
Semester	Language and Communication Skills (Modern Indian Language including TRL) (6)	Language and Communication Skills (English) (6)	Environmental Studies (3)	Understanding India (2)	Health & Wellness, Yoga Education, Sports & Fitness (2)	Digital Education (3)	Mathematical & Computational Thinking and Analysis (2)	Value-Based Course/ Global Citizenship Education (2)	Community Engagement/ NCC/ NSS/ (3)	Introductory Courses [Natural Sc./ Humanities/ Social Sc./Commerce] (9)	Introductory Course [Vocational Studies] (6)			Natural Sc./ Humanities/ Social Sc./ Commerce (18)	Vocational Studies (14)	Research Methodology Courses (6)	Research Proposal, Review of literature (4)	Research Internship/ Field Work (4)	Preparation of the Research Project Report (4)	**176**
1	2	3	4	5	6	7	8			9	10	11	14	15	16	17	18	19	20	21
I	6			2	2					3	3		6							**22**
II		6					2	2		3	3		6							**22**
Exit Point: Undergraduate Certificate																				
III			3			3			3	3		4	6							**22**
IV													6+6	6	4					**22**
Exit Point: Undergraduate Diploma																				
V													6+6	6	4					**22**
VI													6+6	6	4					**22**
Exit Point: Bachelor's Degree																				
VII													6+6 (Adv. Topics)			6	4			**22**
VIII													6+6 (Adv. Topics)		2			4	4	**22**
Exit Point: Bachelor's Degree with Hons. /Research																				

*There will be four disciplinary areas: A-Natural Science, B-Humanities, C-Social Science, and D-Commerce; each having basket of courses. A student will have to select a 'Major' from any of the four disciplinary areas (out of A, B, C & D). The selection for admission will be primarily based on availability of seats in Major and marks imposed by the institution.
**A student has to select three subjects for 'Introductory Regular Courses' from a pool of subjects associated with the Major offered by the institution. One of the three subjects will continue as 'Minor' from semester IV onwards, based on the academic interest and performance of the student.

COURSES OF STUDY FOR FOUR YEAR UNDERGRADUATE PROGRAMME

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

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

Total = 44 Credits

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

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

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

Total = 88 Credits

(MN: Minor; VS: Vocational Studies)

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

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

Total = 132 Credits

Table 5: Course structure for Bachelor's Degree with Hons./Research Programme

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

Total = 176 Credits

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

Table 6: Semester wise Course Code and Credit Points:

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

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

Abbreviations:

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

Table 7: Semester wise Examination Structure in Discipline Courses:

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		Examination Structure			
	Code	Papers	Credits	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I	MJ-1	Earth System Science	6	15	60	25
II	MJ-2	Crystallography & Mineralogy	6	15	60	25
III	MJ-3	Structural Geology and Geomorphology	6	15	60	25
IV	MJ-4	Elements of Geochemistry and Igneous Petrology	6	15	60	25
	MJ-5	Sedimentary and Metamorphic Petrology	6	15	60	25
V	MJ-6	Stratigraphy	6	15	60	25
	MJ-7	Paleontology	6	15	60	25
VI	MJ-8	Economic and Engineering Geology	6	15	60	25
	MJ-9	Hydrogeology and Remote Sensing & GIS	6	15	60	25
VII	AMJ-1	Geological Mapping and Exploration Geology	6	15	60	25
	AMJ-2	Fuel Geology	6	15	60	25
	RC-1	Research Methodology	6	25	75	---
	RC-2	Research Proposal	4	25	75	---
VIII	AMJ-3	Earth and Climate	6	15	60	25
	AMJ-4	Introduction of Geophysics	6	15	60	25
	RC-3	Research Internship/Field Work	4	---	---	100
	RC-4	Research Report	4	---	---	100
	VSR	Vocational Studies (Associated with Research)	2	---	---	100
		Total Credit	**98**			

Table 7: Semester wise Course Code and Credit Points:

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		Examination Structure			
	Code	Papers	Credits	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I/ II/ III	IRC	Introductory Regular Course (Disciplinary/Interdisciplinary Minor)	3	---	100	---
IV	MN-1	Minor paper 1 (Disciplinary/Interdisciplinary Minor)	6	15	60	25
V	MN-2	Minor paper 2 (Disciplinary/Interdisciplinary Minor)	6	15	60	25
VI	MN-3	Minor paper 3 (Disciplinary/Interdisciplinary Minor)	6	15	60	25
		Total Credit	**21**			

AIMS OF BACHELOR'S DEGREE PROGRAMME IN GEOLOGY

Course Objectives:

1. The curriculum of B.Sc. (Hons) Geology is framed under the National Education Policy (N.E.P. 2022) to prepare its students for society.
2. Each program vividly elaborates its nature and promises the outcomes to be accomplished by studying the courses.
3. The Geology programs also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to well-being, emotional stability, critical thinking, social justice, and also skills for employability.
4. Being a fast, economically developing country with depleting natural resources, acute shortage of energy, natural disasters, and many environmental hazards.
5. Two-third of the Indian subcontinent lies in the seismic zones of moderate to severe intensity. Solution and management of many of these problems can be met by understanding the Earth more intensively and extensively, which could be achieved by pursuing a course in Geology.
6. It is an exciting course with both fundamental and applied utility.

PROGRAM LEARNING OUTCOMES

Learning Outcomes:

1. To help students build up a progressive and successful career in Geology
2. To enrich students' knowledge and train them in the pure and applied geological sciences
3. To provide an updated education
4. To impart more field-oriented knowledge
5. To inculcate a sense of scientific responsibilities and social and environmental awareness
6. To inculcate values and knowledge
7. To make them well-being responsible citizen
8. To encourage critical thinking with skills of employability
9. To introduce the concepts of application and research in Geology
10. Create a sense of preservation and conservation of natural resources
11. To prepare students for sustainability and life-long learning
12. To inculcate values and knowledge within students that will make them well-being responsible citizens and encourage critical thinking with the skill of employability
13. In short, each program prepares students for sustainability and lifelong learning.

SEMESTER I

I. MAJOR COURSE –MJ 1: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 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.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks)

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.*

EARTH SYSTEM SCIENCE Theory: 60 Lectures

Learning Objectives

1. To provide a fundamental understanding of the Earth in the solar system along with its origin, evolution, and different components; to understand the potential fields associated with earth; the evolution of life through geological time scale.

Learning Outcomes

After the completion of the course, the students will be able to:

1. Acquire the fundamental understanding of the Earth and its components, thorough an understanding of materials and processes of the earth, and apply the knowledge of earth science to address societal issues.

Course Content:

The emphasis of course is on applications in solving problems of interest to physicists.The students are to be examined entirely on the basis of problems, seen and unseen.

Unit 1:

Earth as a planet: Holistic understanding of dynamic planet ‘Earth’ through Geology. Introduction to various branches of Earth Sciences. General characteristics and Origin of the Universe, Solar System, and its planets. The terrestrial and Jovian planets. Meteorites and Asteroids. Earth in the solar system - Origin, size, shape, mass, density, rotational and revolution parameters, and age.

Unit 2:

Interior of Earth: Internal Structure of the early Earth’s magnetic field: Convection in Earth’s core and production of its magnetic field.

Unit 3:

Plate Tectonics: Concept of plate tectonics, sea-floor spreading and continental drift, Geodynamic elements of Earth- Mid Oceanic Ridges, trenches, transform faults and island arcs Origin of oceans, continents, mountains and rift valleys, Earthquake and earthquake belts, Volcanoes- types, products and their distribution.

Unit 4:

Hydrosphere and Atmosphere: Introduction to hydrosphere and atmosphere; Oceanic current system and effect of Coriolis force; Wave erosion and beach processes; Atmospheric circulation; Earth's heat budget.

Soils: processes of formation, soil profile and soil types.

Unit 5:

Understanding the past from stratigraphic records, Stratigraphy: Introduction and scope; Geological Time Scale, Standard stratigraphic time scale Introduction to geochronological methods and their application in geological studies; Laws of superposition and faunal succession; Concepts of uniformitarianism.

Reference Books:

1. Duff, P. M. D., & Duff, D. (Eds.). (1993). Holmes' principles of physical geology. Taylor & Francis.
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.
4. Krishnan, M. S. (1982). Geology of India and Burma, C.B.S. Publishers, Delhi.
5. Kumar, R. (1991). Fundamentals of Historical Geology and Stratigraphy of India. New Age International Publishers.
6. Wadia, DN (1919). Geology of India, Macmillan publishers.
7. Holmes, A. (1945). Principles of Physical Geology. Thomas Nelson and Sons Ltd., London Edinburgh Paris Melbourne, Toronto and New York.

GEOLOGY PRACTICAL- MJ 1 LAB

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

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

PRACTICALS: 60 Lectures

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 (Jharkhand)
4. Study of distribution of major lithostratigraphic units on the map of India
5. Study of distribution of major dams on the 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.

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 II

I. MAJOR COURSE- MJ 2: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 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.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks)

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.*

CRYSTALLOGRAPHY & MINERALOGY

Theory: 60 Lectures

Learning Objectives:

1. To provide fundamental understanding of crystal system, symmetry and its chemistry to understand the importance of minerals in our daily life; to provide comprehensive knowledge on the structure of silicates and different groups of minerals.

Learning Outcomes:
After the completion of the course, students will be able to:

1. Have a good understanding about the different symmetry elements, a comprehensive understanding on the importance and application of minerals/mineral groups, knowledge on the structure and composition, economic importance of minerals and building an overall knowledge in geology, knowledge on application and usage of minerals in industries.

Course Content:

Unit 1:
Crystallography: Elementary ideas about crystal morphology concerning internal structures, Crystal parameters and indices, Symmetry element, Crystal symmetry and Classification of crystals into six systems (Normal Class) and 32-point groups.

Unit 2:
Crystal symmetry and projections, Elements of crystal chemistry and aspects of crystal structures, Stereographic projections of symmetry elements and forms.

Unit 3:

Rock-forming minerals: Minerals-definition and Classification, physical and chemical properties, Composition of common rock-forming minerals, Silicate and non-silicate structures; C.C.P. and H.C.P. structures.

Unit 4:

Properties of light and optical microscopy, Nicol Prism: Construction and Principle, Nature of light and principles of optical mineralogy

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

Unit 5:

Description of physical, chemical and optical properties of following mineral groups: Olivine, Pyroxene, Amphibole, Quartz, and Feldspar.

Reference Books:

1. 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.
2. Kerr, P. F. (1959). Optical Mineralogy. McGraw-Hill.
3. Verma, P. K. (2010). Optical Mineralogy (Four Colour). Ane Books Pvt Ltd.
4. Deer, W. A., Howie, R. A., & Zussman, J. (1992). An introduction to the rock-forming minerals (Vol. 696). London: Longman.
5. Read, H.H. (1988). Elements of Mineralogy. Surjeet Publication.

GEOLOGY PRACTICAL- MJ 2 LAB:

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

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

PRACTICALS: 60 Lectures

1. Observation and documentation of the symmetry of crystals
2. Study of physical properties of minerals in hand specimen: Silicates: Olivine, Garnet, Andalusite, Sillimanite, Kyanite, Staurolite, Beryl, Tourmaline, Augite, Actinolite, Tremolite, Hornblende, Serpentine, Talc, Muscovite, Biotite, Phlogopite, Quartz, Orthoclase, Plagioclase, Microcline, Nepheline, Sodalite, Zeolite, Quartz varieties: Chert, Flint, Chalcedony, Agate, Jasper, Amethyst, Rose quartz, Smoky quartz, Rock crystal.
3. Native Metals/non-metals, Sulfides, Oxides- Copper, Sulfur, Graphite, Pyrite, Corundum, Magnetite Hydroxides, Halides, Carbonates, Sulfates, Phosphates: Psilomelane, Fluorite, Calcite, Malachite, Gypsum, Apatite.
4. Study of some essential silicate minerals under an optical microscope and their characteristic properties

FIELDWORK:

1. Geological Mapping of one week's duration in a geologically complex area and Field Work Report based on it.

Reference Books:

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

SEMESTER III

I. MAJOR COURSE- MJ 3: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 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.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks)

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.*

STRUCTURAL GEOLOGY AND GEOMORPHOLOGY

Theory: 60 Lectures

Learning Objectives:

1. To have an understanding of the structural elements and steps in structural analysis, stress-strain relationships, deformation patterns, and strain distribution in the crust; a basic understanding on the deformation and structures in different tectonic settings.
2. To introduce the comprehensive knowledge on the fundamentals of Geomorphology and Earth surface processes and their interactions between exogenic and endogenic forces; to learn about the various landforms by different agents.

Learning Outcomes:

After completion of the course the student will be able to develop:

1. Understanding of the geometry, kinematics and dynamics of deformation in Earth crust. Knowledge about the instability of the lithosphere produced by complex plate tectonic movements, and deformation patterns and structures developed during deformation. Also, able to identify the linear and planar fabrics (L-S Tectonites) and their relation to major geological structures.
2. Knowledge of the formation of various landforms, interplay of climate, tectonics and denudation on the landscapes, the interaction between exogenic and endogenic processes; applying the knowledge of geomorphology to land use and land cover planning.

Course Content:

Unit 1:

Structure and Topography, Effects of topography on structural features, Topographic and structural maps; Importance of representative factors of the map, Stress and strain in rocks, Concept of rock deformation: Stress and Strain in rocks, Strain ellipses of different types and their geological

significance. Planar and linear structures; Concept of dip and strike; Outcrop patterns of different structures.

Unit 2:

Folds: Fold morphology; Geometric and genetic Classification of folds; Introduction to the mechanics of folding: Buckling, Bending, Flexural slip and flow folding, Fractures and faults: Geometric and genetic Classification of fractures and faults, Effects of faulting on the outcrops, Geologic/geomorphic criteria for recognition of faults and fault plane solutions.

Unit 3:

Foliation and lineation: Description and Origin of foliations: axial plane cleavage and its tectonic significance Description and Origin of lineation and relationship with the significant structures.

Unit 4:

Introduction to Geomorphology, Endogenic and Exogenic processes, Endogenic- Exogenic interactions, Rates of uplift and denudation, Tectonics and drainage development, Sea-level change, Long-term landscape development.

Geoid, Topography, Hypsometry, Global Hypsometry; Major Morphological features Large Scale Topography - Ocean basins, large scale mountain ranges (with emphasis on the Himalayas).

Unit 5:

Surficial Processes and geomorphology: Weathering and associated landforms, Glacial, Periglacial processes and landforms, Fluvial processes and landforms, Aeolian Processes and landforms, Coastal Processes and landforms, Landforms associated with igneous activities, Overview of Indian Geomorphology.

Reference Books:

1. Davis, G. R. (1984). Structural Geology of Rocks and Region. John Wiley
2. Billings, M. P. (1987). Structural Geology, 4th Edition, Prentice-Hall.
3. Park, R. G. (2004). Foundations of Structural Geology. Chapman & Hall.
4. Pollard, D. D. (2005). Fundamental of Structural Geology. Cambridge University Press.
5. Ragan, D. M. (2009). Structural Geology: an introduction to geometrical techniques (4th Ed). Cambridge University Press (For Practical)
6. Lahee, F. H. (1962). Field Geology. McGraw Hill
7. Robert S. Anderson and Suzzane P. Anderson (2010). Geomorphology - The Mechanics and Chemistry of Landscapes. Cambridge University Press.
8. M.A. Summerfield (1991). Global Geomorphology. Wiley & Sons.

GEOLOGY PRACTICAL- MJ 3 LAB:

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for

End Semester Examination (ESE):

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

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

PRACTICALS: 60 Lectures

1. The basic idea of topographic contours, Topographic sheets of various scales
2. Introduction to Geological maps: Lithological and Structural maps
3. Structural contouring and 3-point problems of dip and strike
4. Drawing profile sections and interpreting geological maps of different complexities Exercises of stereographic projections of mesoscopic structural data (planar, linear, folded etc.)
5. 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 the geomorphic map, Interpretation of geomorphic processes from the geomorphology of the area.

Reference Books:

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

SEMESTER IV

I. MAJOR COURSE- MJ 4: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 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.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks)

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.*

ELEMENTS OF GEOCHEMISTRY AND IGNEOUS PETROLOGY

Theory: 60 Lectures

Learning Objectives:

1. To provide a comprehensive knowledge on how chemical principles are used to explain the mechanisms that control the large geological systems such as the Earth's mantle, crust, ocean and atmosphere, and the formation of the solar system; understanding of qualitative and quantitative composition of planet Earth and solar system material; knowledge on geological processes and their geochemical signatures; understanding of geochemical behavior of elements and isotopes and their applications in addressing the evolution of planet Earth through time including origin of life and long term climate variability.
2. To develop a fundamental understanding of magmas, their origin, differentiation histories; Importance of igneous rocks in continental growth and formation of ore deposits, crystallisation and emplacement history of magmas through study of textures and structures, magmatism through time in different geodynamic settings.

Learning Outcomes:

After completion of the course the student will be able to develop:

1. Understand fundamental processes in Earth science in a geochemical context; Quantify the geological processes through trace element modeling; Understanding the human influence and impacts on surface processes; Apply basic geochemical techniques to explain, interpret and predict common processes in Earth science; Develop the ability to explain, interpret and predict common processes in Earth sciences in a geochemical context; Acquire the ability to solve applied quantitative problems in Earth Sciences using geochemical principles.
2. Understanding of magmas, their origin, differentiation histories; Importance of igneous rocks in continental growth and formation of ore deposits, crystallisation and emplacement history of magmas; ability to understand through magmatism through time in different geodynamic settings, crust mantle system; gain knowledge of the economic potential of igneous rocks.

Course Content:

Unit 1:

Concepts of geochemistry: Introduction to properties of elements: The periodic table. Chemical bonding, states of matter and atomic environment of elements. Geochemical Classification of elements, Layered Structure of Earth and geochemistry: Composition of different Earth reservoirs and the nuclides and radioactivity, conservation of mass, isotopic and elemental fractionation, Concept of radiogenic isotopes in geochronology and isotopic tracers, Element transport, Advection and diffusion. Chromatography, Aqueous geochemistry- fundamental concepts and speciation in solutions, Eh, pH relations.

Unit 2:

Geochemistry of solid Earth: The solid Earth – geochemical variability of magma and its products, The Earth in the solar system, the formation of the solar system, Composition of the bulk silicate Earth. Meteorite, Cosmic abundance of elements: Distribution of elements in the solar system and Earth, Chemical differentiation and Composition of the Earth, General concepts about geochemical cycles and mass balance Properties of elements. Geochemical behaviour of major elements Mass conservation of elements and isotopic fractionation.

Unit 3:

Concepts of Igneous petrology: Introduction to petrology: Heat flow, geothermal gradients through time, Origin and nature of magma, Bowen's Reaction Series and Magmatic Differentiation and Assimilation.

Forms: IUGS Classification of igneous rocks. Textures and structures of igneous rocks, mode of occurrence of Igneous rocks.

Unit 4:

Phase diagrams and petrogenesis: Binary Phase diagrams in understanding crystal-melt equilibrium – An-Ab, Or-Ab, Di-An Magma generation in crust and mantle, their emplacement and evolution

Magmatism in different tectonic settings: Magmatism in the oceanic domains (MORB, O.I.B.) Magmatism along the plate margins (Island arcs/continental arcs).

Unit 5:

Petrogenesis of Igneous rocks: Petrogenesis of Felsic and Mafic igneous rocks Komatiites, Granitoides, Basalt, Gabbros, Alkaline rocks, Kimberlites and Lamproites.

Reference Books:

1. Mason, B. (1986). Principles of Geochemistry. 3rd Edition, Wiley New York.
2. Rollinson, H. (2007). Using geochemical data – evaluation, presentation and Interpretation. 2nd Edition. Publisher Longman Scientific & Technical.
3. Walther, J. V. (2009). Essentials of geochemistry. Jones & Bartlett Publishers.
4. Albarède, F. (2003). Geochemistry: an introduction. Cambridge University Press.
5. Faure, Gunter and Teresa M. Mensing (2004). Isotopes: Principles and Applications, Wiley India Pvt.
6. Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
7. Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
8. Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, Interpretation. Routledge.
9. Raymond, L. A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks. McGraw-Hill Science Engineering.

10. McBirney, A. R. (1984). Igneous Petrology. San Francisco (Freeman, Cooper & Company) and Oxford (Oxford Univ. Press),
11. Myron G. Best (2001). Igneous and Metamorphic Petrology, K. G. Cox, J. D. Bell. (1979). The Interpretation of Igneous Rocks. Springer/Chapman & Hall.
12. Bose M.K. (1997). Igneous Petrology.
13. G W Tyrrell. (1926). Principles of Petrology. Springer.

GEOLOGY PRACTICAL- MJ 4 LAB:

Marks : Pr (ESE: 3Hrs) =25	**Pass Marks: Pr (ESE) = 10**

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

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

PRACTICALS: **60 Lectures**

1. Types of geochemical data analysis and Interpretation of typical geochemical plots
2. Geochemical analysis of geological materials
3. Geochemical variation diagrams and their interpretations
4. Study of important igneous rocks in hand specimens and thin sections
5. QAP and QAPF Diagrams.

FIELDWORK:

1. Geological Mapping of one week's duration in a geologically complex area and Field Work Report based on it.

Reference Books:

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

I. MAJOR COURSE- MJ 5: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 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.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks)

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.*

SEDIMENTARY AND METAMORPHIC PETROLOGY

Theory: 60 Lectures

Learning Objectives:

1. To understand fundamentals of sedimentary processes and their products, formation and filling history of sedimentary basins in different tectonic regions; comprehensive understanding of both clastic and chemical sedimentation processes; comprehensive understanding of varieties of sedimentary rocks.
2. To understand the thermal history of the crust mantle system and tectonics, factors controlling the metamorphism and metamorphism as a chemical system, kinetics of reactions, metamorphic facies, grade as well as comprehensive details of various metamorphic rocks.

Learning Outcomes:

After completion of the course the student will be able to develop:

1. To describe scales of sedimentary grain size measurement and transportation history or depositional environment; To understand texture and structure of clastic sedimentary rocks; procedure and importance of paleocurrent analysis; To comprehend concept of sedimentary environment and description of processes and products of different sedimentary environments.
2. To understand the nature of metamorphic rocks and the factors controlling the metamorphism; Knowledge of phase rule as a basic tool in study of the metamorphic assemblages; Deduce the pressure-temperature-time paths of metamorphism and its link to tectonics; Understanding the spatial link between the metamorphism, fluid flow, and mineralization.

Course Content:

Unit 1:

Origin of sediments: Weathering and sedimentary flux: Physical and chemical weathering, soils and paleosols Sediment granulometry: Grain size scale, particle size distribution, Environmental connotation; particle shape and fabric Sedimentary textures, structures and environment: Fluid flow, sediment transport and sedimentary structures: Types of fluids, Laminar vs turbulent flow, Particle entrainment, transport and deposition. Paleocurrent analysis- Paleocurrents for different sedimentary environments, Sedimentary Structure- Primary and syn-sedimentary structures.

Unit 2:

Varieties of sedimentary rocks: Siliciclastic rocks: Conglomerates, sandstones, mudrocks. Carbonate rocks, controls of carbonate deposition, Components and Classification of Sandstones, limestone, dolomite and dolomitization

Diagenesis: Concepts of diagenesis, Stages of diagenesis, Compaction and cementation.

Unit 3:

Metamorphism: controls and types. Definition of metamorphism. Factors controlling metamorphism, Types of metamorphism - contact, regional, fault zone metamorphism, impact metamorphism, Metasomatism and role of fluids in metamorphism, Metamorphism and Tectonism, Relationship between metamorphism and deformation, Metamorphic mineral reactions (prograde and retrograde).

Unit 4:

Metamorphic facies and grades, Metamorphic zones and isograd, Index minerals, Mineralogical phase rule of the closed and open system, Structure and textures of metamorphic rocks, Concepts of Chemographic projections.

Unit 5:

Migmatites and their Origin, Metamorphic rock associations- Schists, Gneisses, Khondalites, Charnockites, Blue schists and Eclogites.

Reference Books:

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

GEOLOGY PRACTICAL- MJ 5 LAB:

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

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

PRACTICALS: 60 Lectures

1. Megascopic study of sedimentary structures, Particle size distribution and statistical treatment
2. Paleocurrent analysis, Petrography of clastic and non-clastic rocks through hand specimens and thin sections
3. Megascopic and microscopic study (textural and mineralogical) of different metamorphic rocks
4. Graphic plots for petrochemistry and Interpretation of assemblages: A.C.F., A.K.F. and AFM diagrams.

Reference Books:

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

SEMESTER V

I. MAJOR COURSE- MJ 6: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 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.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks)

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.*

STRATIGRAPHY Theory: 60 Lectures

Learning Objectives:

1. To provide 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 and how they have been developed; To learn about precisely stratigraphy sequences through seismic, magnetic, chemical, and absolute dating methods.

Learning Outcomes:

After the completion of the course, the student will be able to:

1. Understand fundamentals of stratigraphic principles, different types of stratigraphic units; evolution of life through time; spatial and temporal relationship between litho-units and their correlation with similar units in other continents; Better understanding of stratigraphy leads to 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 1:

Principles of stratigraphy, Introduction to lithostratigraphy, biostratigraphy, chrono-stratigraphy, seismic stratigraphy, chemo-stratigraphy, Magneto-stratigraphy; International Stratigraphic Code-development of standardized stratigraphic nomenclature. Concepts of Stratotypes. Global Stratotype Section and Point (G.S.S.P.).

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 subdivisions of India, Introduction to Indian Shield.

Unit 3:

PreCambrian-Stratigraphy of India: Precambrian geology of Singhbhum and Karnataka; Introduction to Proterozoic basins of India; Geology of Vindhyan and Cuddapah basins of India.

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. 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.

Unit 5:

Volcanic provinces of India and Stratigraphic boundaries

a. Deccan, b. Rajmahal,

Important Stratigraphic boundaries in India:

a. Precambrian-Cambrian boundary, b. Permian-Triassic boundary, and c. Cretaceous-Tertiary boundary

Reference Books:

1. Krishnan, M. S. (1982). Geology of India and Burma, C.B.S. Publishers, Delhi
2. 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.
3. Valdiya, K. S. (2010). The making of India, Macmillan India Pvt. Ltd.

GEOLOGY PRACTICAL- MJ 6 LAB:

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

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

PRACTICALS: 60 Lectures

1. Study of the 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 paleogeographic maps of Precambrian time
4. Study of different Proterozoic supercontinent reconstructions.

Reference Books:

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

II. MAJOR COURSE- MJ 7: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 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.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks)

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.*

PALEONTOLOGY Theory: 60 Lectures

Learning Objectives:

1. To study the remains of animals and plants (fossils) of the geological past preserved in the rocks and how life forms had responded to climatic and environmental crises.

Learning Outcomes:

After the completion of the course, the student will be able to:

1. Understanding the evolution of life through time; appreciate how fossils provide the information on the paleo environments; understanding on the adaptability of life in different environments, paleoenvironmental crises and mass extinctions; origin and distribution of fossil fuels.

Course Content:

Unit 1:
Fossilization and fossil record: Nature and importance of fossil record; Fossilization processes and modes of preservation.

Unit 2:
Taxonomy and Species concept: Species concept with special reference to palaeontology Theory of organic evolution.

Unit 3:
Invertebrates: Brief Introduction of important fossil groups: morphology and geological history of Trilobites, Brachiopoda, Gastropod, Cephalopoda and Lamellibranchia.

Unit 4:
Vertebrates and other fossils: Evolution of horse and intercontinental migrations. Human evolution. Gondwana Flora Introduction to Ichnology.

Unit 5:
Application of fossils in Stratigraphy: Palynology: Biostratigraphy, Biozones, index fossils, correlation Fossils and paleo-environmental analysis, Fossils and paleobiogeography, biogeographic provinces, Paleoecology – fossils as a window to the evolution of the ecosystem, Microfossils, Paleoclimate and Paleogeography.

Reference Books:

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

GEOLOGY PRACTICAL- MJ 7 LAB:

Marks : Pr (ESE: 3Hrs) =25	**Pass Marks: Pr (ESE) = 10**

Instruction to Question Setter for

End Semester Examination (ESE):

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

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

PRACTICALS: 60 Lectures

1. Study of fossils showing various modes of preservation
2. Study and labelling of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate, vertebrate and plant fossils.

Reference Books:

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

SEMESTER VI

I. MAJOR COURSE- MJ 8: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 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.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks)

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.*

ECONOMIC AND ENGINEERING GEOLOGY Theory: 60 Lectures

Learning Objectives:

1. To develop a good understanding of ore forming processes in time and space, factors controlling the ore formation; understanding about the role of minerals in the national economy, spatial relationship between magnetism, sedimentation, metamorphism and ore formation; To have a sound knowledge of India's mineral wealth.
2. Develop an understanding of the significance of geology in major engineering projects; Necessity of geological inputs in designing of large infrastructural projects such as dams, tunnels, roads etc.

Learning Outcomes:

After the completion of the course, the student will be able to:

1. Understand the various processes involved in the formation of economically important mineral deposits; Build strategies to locate the mineral deposits; good knowledge about the distribution of Indian mineral deposits, national mineral policy as well as the modern method of classifying mineral deposits (UNFC); Develop skills to face the current challenges in the non-renewable mineral resources.
2. Understand the significance of geology in major engineering projects; Apply geological knowledge on major infrastructure projects; Have a good understanding about the material properties, effect of natural hazards on engineering structures.

Course Content:

Unit 1:

Ores and gangues: Ores, gangue minerals, tenor, grade and lodes, Resources and reserves: definitions; Classification of economic deposits. Structure and texture of ore deposits, Mineral deposits and concepts of Ore formation: Endogenous processes: Magmatic concentration, skarns, greisen, and hydrothermal deposits. Exogenous processes: weathering products and residual deposits, oxidation and supergene enrichment, placer deposits.

Unit 2:

Mineral exploration: Exploration techniques: Geological, Geophysical and Geochemical Explorations techniques.

Unit 3:

Metallic and Non-metallic ores: Mode of Occurrence, chemical composition, uses and distribution in India of the following: Metallic deposits: Ores of Iron, Aluminium, Copper, Manganese, Lead and Zinc. Non-metallic deposits: Mica, Asbestos and Limestone. Metallogenic provinces and epochs; An introduction to atomic minerals and gemstones.
Introduction to gemstones.

Unit 4:

Engineering Geology and its applications, Scope of Engineering Geology; Elementary concepts of rock mechanics - Strength and Elastic properties. Engineering properties and characteristics of soils. Properties of building stones. The basic concept of Rock Quality Designation (R.Q.D.), Rock Structure Rating (R.S.R.), Rock Mass Rating (R.M.R.), Tunnelling Quality Index (Q).

Unit 5:

Dams and reservoirs: Types of Dams: masonry or concrete dams- gravity, arch and buttress. Earth Dams and composite dams. Geological considerations- topography, structure and lithology, Foundation and seepage problems in dams and their treatment. Reservoir: Reservoir problems- seepage and silting, Tunnels: terminology, definition, types- hard rock and soft rock tunnels. Geological considerations- topography, structure and lithology Bridge sites: Terminology, Bridge structure, types. Geology of bridge sites. Stability of rock slopes and cutting in rocks: Classification of slopes- stable and unstable slopes.

Reference Books:

1. Guilbert, J.M. and Park Jr., C.F. (1986). The Geology of Ore deposits. Freeman & Co.
2. 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.
3. Gokhale, K.V.G.K. and Rao, T.C. (1978). Ore deposits of India their distribution and processing, Tata McGraw Hill, New Delhi.
4. Deb, S. (1980). Industrial minerals and rocks of India. Allied Publishers.
5. Sarkar, S.C. and Gupta, A. (2014). Crustal Evolution and Metallogeny in India. Cambridge Publications.
6. Krynin, D.P. and Judd W.R. (1957). Principles of Engineering Geology and Geotechnique, McGraw Hill (C.B.S. Publ).
7. Johnson, R.B. and De Graf, J.V. (1988). Principles of Engineering Geology, John Wiley.
8. Goodman, R.E. (1993). Engineering Geology: Rock in Engineering constructions. John Wiley & Sons, N.Y.
9. Waltham, T., (2009). Foundations of Engineering Geology (3rd Edn.) Taylor & Francis.
10. Bell: F.G. (2006). Basic Environmental and Engineering Geology Whittles Publishing.
11. Bell, F.G. (2007). Engineering Geology, Butterworth-Heineman

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GEOLOGY PRACTICAL- MJ 8 LAB:

Marks : Pr (ESE: 3Hrs) =25	**Pass Marks: Pr (ESE) = 10**

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

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

PRACTICALS: **60 Lectures**

1. Megascopic identification
2. Study of microscopic properties of ore-forming minerals (Oxides and sulphides).
3. Preparation of maps: Distribution of essential ores and other economic minerals in India.
4. Computation of reservoir area, catchment area, reservoir capacity and reservoir life.
5. Merits, demerits & remedial measures based upon geological cross sections of project sites.
6. Computation of index properties of rocks.
7. Computation of R.Q.D., R.S.R., R.M.R. and 'Q'
8. Plotting of Major Dams/ Tunnels on the outline map of India.
9. Study of Seismic/landslide zones of India.

Reference Books:

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

II. MAJOR COURSE- MJ 9: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 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.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks)

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.*

SOLID STATE GEOLOGY

Theory: 60 Lectures

Learning Objectives:

1. To understand about the nature, occurrence and movement of groundwater in geological context; water bearing properties of formations, aquifer types and aquifer parameters; basic understanding about ground water exploration and management.
2. Fundamentals of Remote sensing and photogeology, digital image processing, usage of GPS and GIS in geology.

Learning Outcomes:

After the completion of the course, the students will be able to:

1. Have a good understanding 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; learn about aquifers and their parameters, groundwater exploration methods, aspects of groundwater chemistry and groundwater management; apply the knowledge gained to address the societal issues related to groundwater resources and its sustainable management in the context of environmental and climate change.
2. Learn about several advanced remote sensing concepts, sensors and satellites; learn about the Geophysical remote sensing approaches covering potential fields measurement using aerial and satellite missions; Students are exposed with Digital image processing of remotely sensed data and interpretation, Recent trends in image processing visualisation and digital mapping.

Course Content:

Unit 1:

Introduction and basic concepts: Scope of hydrogeology and its societal relevance

Hydrologic cycle: precipitation, evapotranspiration, run-off, infiltration and subsurface water movement. Rock properties affecting groundwater, Vertical distribution of subsurface water Types of an aquifer, aquifer parameters.

Unit 2:

Groundwater flows: Darcy's law and validity, Intrinsic permeability and hydraulic conductivity, Laminar and turbulent groundwater flow, Well hydraulics and Groundwater exploration, Basic Concepts (drawdown; specific capacity etc.) Surface-based groundwater exploration methods Introduction to subsurface borehole logging methods.

Unit 3:

Groundwater chemistry: Physical and chemical properties of water and water quality, Introduction to methods of interpreting groundwater quality data using standard graphical plots Sea water intrusion in coastal aquifers

Groundwater management: Surface and subsurface water interaction, Groundwater level fluctuations, Basic concepts of water balance studies, issues related to groundwater resources development and management, Rainwater harvesting and artificial recharge of groundwater.

Unit 4:

Photogeology: Types and acquisition of aerial photograph, scale and resolution, Elements of air photo interpretation. Identification of sedimentary, igneous and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms.

Remote Sensing: Concepts in remote sensing, Sensors and scanners, Satellites and their characteristics, Data formats- Raster and Vector.

Unit 5:

Digital Image Processing: Fundamentals of Image processing, Image Correction, Image enhancement, Image classification, F.C.C. and Image Rationing,

G.I.S.: Datum, Coordinate systems and Projection systems, Introduction to D.E.M. analysis; G.I.S. integration and Case studies-Indian Examples

G.P.S.: Concepts of G.P.S. and DGPS, Applications in earth system sciences. Applications in earth system sciences.

Reference Books:

1. Todd, D. K. (2006). Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.
2. Davis, S. N. and De Weist, R.J.M. (1966). Hydrogeology, John Wiley & Sons Inc., N.Y.
3. Karanth, K.R. (1987), Groundwater: Assessment, Development and Management, Tata McGraw-Hill Pub. Co. Ltd.
4. Demers, M.N. (1997). Fundamentals of Geographic Information System, John Wiley & sons. Inc.
5. Hoffmann-Wellenhof, B., Lichtenegger, H. and Collins, J. (2001). G.P.S.: Theory & Practice, Springer Wien New York.
6. Jensen, J.R. (1996). Introductory Digital Image Processing: A Remote Sensing Perspective, Springer-Verlag.
7. Lillesand, T. M. & Kiefer, R.W. (2007). Remote Sensing and Image Interpretation, Wiley.
8. Richards, J.A. and Jia, X., (1999). Remote Sensing Digital Image Analysis, Springer-Verlag.

GEOLOGY PRACTICAL- MJ 9 LAB:

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for

End Semester Examination (ESE):

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

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

PRACTICALS: 60 Lectures

1. Preparation and Interpretation of water level contour maps and depth to water level maps
2. The study, preparation and analysis of hydrographs for differing groundwater conditions
3. Water potential zones of India (map study).
4. Graphical representation of chemical quality data and water classification (C-S and Trilinear diagrams)
5. Simple numerical problems related to determining permeability in field and laboratory, Groundwater flow, Well hydraulics etc.
6. Aerial Photo/ imagery interpretation, identification of sedimentary, igneous and metamorphic rocks
7. Identification of geomorphic and structural features in Aerial Photo/Satellite imagery

FIELDWORK:

1. Geological Mapping of two week's duration in a geologically complex area and Field Work Report based on it.

Reference Books:

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

SEMESTER VII

I. ADVANCE MAJOR COURSE- AMJ 1: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 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.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks)

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.*

GEOLOGICAL MAPPING AND EXPLORATION GEOLOGY

Theory: 75 Lectures

Course Objectives:

1. The course is intended to familiarize students with outcrops and basic techniques of field work, geological structure mapping by measuring the structural elements (bedding, cleavage, foliation, lineation, pitch, plunge etc.); Provide understanding on the reading of toposheets and locating themselves in the field; Introduce students to the field geology to identify the different rocks and fabrics; Provide knowledge of lithological mapping techniques; Also students learn to project structural data on the maps and stereo-net.
2. To understand the basic principles of mineral exploration; good knowledge on the different methods of sampling; understanding of different exploration strategies including geological and geochemical mapping.

Course Learning Outcomes:

1. Understanding the importance of toposheets and google maps in geological mapping;Knowledge on identification of various rock types and their fabrics; Comprehensive knowledge on measuring the fabrics; Projection of the lithological and fabrics data on the topographic maps; Writing the cross-section of studied corridors using the lithological fabric data.
2. Develop skills and expertise on exploration of ore deposits and industrial minerals; Good understanding of exploration techniques including sampling, drilling and evaluation of reserves.

Course Content:

Unit 1:

Toposheets: Definition, scale, and reading various components of a toposheet. Geological map definition, various components of a geological map including scale, legend, structures etc. Geological Fieldwork instruments, Use of clinometer compass, Brunton compass, strike and dip measurements.

Unit 2:

Basic field measurement techniques: Bedding dip and strike, Reading contours and topography, Trend, plunge, Rake/Pitch; Stereo plots of linear and planar structures, Identification of rock types in the field; structures and texture of rocks, Sampling and oriented sample and its significance; Geological mapping of igneous, sedimentary and metamorphic terrains.

Unit 3:

Mineral Resources: Resource reserve definitions, Mineral resources in industries – historical perspective and present.

Unit 4:

Prospecting and Exploration, Principles of mineral exploration, Prospecting and exploration-conceptualization, methodology and stages; Sampling and sampling techniques; Geochemical exploration.

Evaluation of data: Evaluation of sampling data: Mean, mode, median, standard deviation and variance Drilling and Logging Core and non-core drilling Planning of boreholes and location of boreholes on the ground, Core-logging.

Unit 5:

Reserve estimation and Errors: Principles of reserve estimation, density and bulk density, Factors affecting the reliability of reserve estimation, Reserve estimation based on geometrical models (square, rectangular, triangular and polygon blocks).

Reference Books:

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

GEOLOGY PRACTICAL- AMJ 1 LAB:

Marks : Pr (ESE: 3Hrs) =25	**Pass Marks: Pr (ESE) = 10**

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

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

PRACTICALS: 60 Lectures

1. Plane table and Prismatic survey
2. Identification of anomaly
3. Study of Geological cross-section
4. Megascopic study of important industrial, metallic and non-metallic minerals
5. Principle of Reserve estimation
6. Study of rocks in hand specimens from Indian Stratigraphy horizons and type localities

Reference Books:

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

II. ADVANCE MAJOR COURSE- AMJ 2: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (SIE + ESE) = 30**

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 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.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks)

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.*

FUEL GEOLOGY

Theory: 60 Lectures

Course Objectives:

1. To have a good understanding of source, reservoir and cap-rocks, characterization of reservoir rocks, classification of reservoir pore space, permeability, migration and entrapment;
2. To gain knowledge about the temperature-pressure conditions for the generation of oil and gas from sediments;
3. To understand the global significance and distribution of oil/gas reservoirs;
4. To gain knowledge of occurrence in India with special reference to Jharkhand state.

Course Outcomes:

After successful completion of the course, the students are expected to:

1. Acquire a good understanding about petroleum source and reservoir rocks, their physical and chemical properties;
2. Describe the mechanism responsible for origin and accumulation of hydrocarbons;
3. Develop good understanding about coal formation and its properties and Coal bed methane;
4. Evaluate and map the economic potential of sedimentary basins;
5. Apply the knowledge to address the environmental issues and challenges during the exploration of fossil fuels.

Course Content:

Unit 1:
Coal: Definition and Origin of Coal; Basic Classification of coal; Fundamentals of Coal Petrology - Introduction to lithotypes, microlithotype and macerals in coal, Proximate and Ultimate analysis.

Unit 2:
Coal as a fuel Coal Bed Methane (C.B.M.): global and Indian scenario, Underground coal gasification, Coal liquefaction.

Unit 3:
Petroleum: Chemical Composition and physical properties of crudes in nature. Origin of petroleum.

Unit 4:
Petroleum Reservoirs and Traps Reservoir rocks: general attributes, Classification of reservoir rocks, Cap rocks - definition and general properties, Hydrocarbon traps: definition, Classification of hydrocarbon traps - structural, stratigraphic and combination. Plate tectonics and global distribution of hydrocarbon reserves.

Unit 5:
Indian Occurrences: Coalfields of India with special reference to Jharkhand.

Reference Books:

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

GEOLOGY PRACTICAL- AMJ 2 LAB:

Marks : Pr (ESE: 3Hrs) =25	**Pass Marks: Pr (ESE) = 10**

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

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

PRACTICALS: **60 Lectures**

1. Megascopic identification of coal horizon samples
2. Reserve estimation of coal and petroleum
3. Study of Geological Section Coal and Petroleum fields and identification of hydrocarbon prospect
4. Location of coalfields and petroliferous basins on the outline map of India

FIELDWORK:

1. Students will be required to carry out Field Work for a week in a suitable geological terrain to study the basic aspect of geological mapping and submit a report there on

SUGGESTED READINGS:

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

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 VIII

I. ADVANCE MAJOR COURSE- AMJ 3: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 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.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks)

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.*

EARTH & CLIMATE

Theory: 60 Lectures

Course Objectives:

1. To have a good understanding of various components of climate change and its controlling factors, comprehensive understanding of atmospheric and hydrospheric circulation; good knowledge of impact of climate change.

Course Outcomes:

After successful completion of the course, the students are expected to:

1. Acquire a good understanding about the components of climate, controlling factors and interaction with the climate system; its circulation; proper understanding of effects of climate change on Earth and mankind.

Course Content:

Unit 1:

Climate system: Components of the climate system climate controlling factors and interactions with the climate system.

Unit 2:

Heat budget of Earth's Incoming solar radiation and Green House Effect. Heat transformation. Earth's heat budget.

Unit 3:

Atmosphere – Hydrosphere Layering of atmosphere and Atmospheric Circulation; Atmosphere and ocean interaction and its effect on climate, Global oceanic conveyor belt and its control on Earth's climate.

Unit 4:

Response of biosphere to Earth's climate, Climate Change: natural vs anthropogenic effects. Impacts of climate change; Pleistocene Glaciation.

Unit 5:

Monsoon Mechanism of monsoon, Monsoonal variation through time, Factors associated with monsoonal intensity, Effects of monsoon.

Reference Books:

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

GEOLOGY PRACTICAL- AMJ 3 LAB:

Marks : Pr (ESE: 3Hrs) =25	**Pass Marks: Pr (ESE) = 10**

Instruction to Question Setter for

End Semester Examination (ESE):

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

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

PRACTICALS: **60 Lectures**

1. Study of distribution of major climatic regimes of India on map
2. Distribution of significant wind patterns on the World map
3. Study of paleogeographic maps (distribution of land and sea) of India during specific geological time intervals

SUGGESTED READINGS:

1. Rudiman, W.F. (2001). Earth's climate: past and future. Edition 2, Freeman Publisher.

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.

II. ADVANCE MAJOR COURSE- AMJ 4: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 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.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks)

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.*

INTRODUCTION OF GEOPHYSICS **Theory: 60 Lectures**

Course Objectives:

1. To impart knowledge of Geogeologyand applications of geologyin geology; To learn the basic principles of different geophysical methods and well logging along with their operation techniques are used in field and how would these help to address various geologic problems associated with the Planet Earth; To enhance knowledge and applications of geogeologyin exploration of earth resources.

Course Outcomes:

After successful completion of the course, the students are expected to:

1. Understand the basic principles of Earth's gravity, gravity corrections and interpretation of gravity data, magnetic fields, electrical methods, seismic survey and well logging techniques and their application in geology such as exploration and resource mapping.

Course Content:

Unit 1:
Geology and Geophysics: Interrelationship between geology and geophysics, the role of geological and geophysical data in explaining the Internal Structure of the Earth.

Unit 2:
General and Exploration geophysics: Different types of geophysical methods - gravity, magnetic, electrical and seismic; their principles and applications.

Unit 3:
Basics of subsurface geophysical logging: Basic principles of S.P. log, Resistivity log, Sonic log, Gamma log, Neutron log etc. and their applications.

Unit 4:
Geophysical field operations: Different types of surveys, grid and route surveys, profiling and sounding techniques, Scales of a survey, Presentation of geophysical data.

Unit 5:
Applications: Application of Geophysical methods in oil and gas, ore and groundwater investigations.

Reference Books:

1. Outlines of Geophysical Prospecting - A manual for geologists by Ramachandra Rao, M.B., Prasaranga, University of Mysore, Mysore, 1975.
2. Exploration Geogeology- An Outline by Bhimasarikaram V.L.S., Association of Exploration Geophysicists, Osmania University, Hyderabad, 1990.
3. Dobrin, M.B. (1984). An introduction to Geophysical Prospecting. McGraw-Hill, New Delhi.
4. Telford, W. M., Geldart, L. P., & Sheriff, R. E. (1990). Applied geogeology(Vol. 1). Cambridge University Press.
5. Lowrie, W. (2007). Fundamentals of geophysics. Cambridge University Press.

GEOLOGY PRACTICAL- AMJ 4 LAB:

Marks : Pr (ESE: 3Hrs) =25	**Pass Marks: Pr (ESE) = 10**

Instruction to Question Setter for

End Semester Examination (ESE):

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

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

PRACTICALS: **60 Lectures**

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

SUGGESTED READINGS:

1. Outlines of Geophysical Prospecting - A manual for geologists by Ramachandra Rao, M.B., Prasaranga, University of Mysore, Mysore, 1975.

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.

COURSES OF STUDY FOR **INTRODUCTORY/ MINOR ELECTIVE** FYUGP IN **"GEOLOGY"**

SEMESTER I/ II/ III INTRODUCTORY REGULAR COURSE 1 Paper

I. INTRODUCTORY REGULAR COURSE (IRC)

(Credits: Theory-02, Practicals-01)

- All Four Introductory & Minor Papers of Geology to be studied by the Students of **Other than Geology Honours.**
- Students of **Geology Honours** must Refer Content from the **Syllabus of Opted Introductory & Minor Elective Subject**.

Marks: 100 (ESE: 3Hrs) = 100	**Pass Marks: Th (ESE) = 40**

Instruction to Question Setter for

End Semester Examination (ESE 100 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 ten 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 twenty marks each, out of which any four are to answer.*

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

INTRODUCTORY GEOLOGY **Theory: 45 Lectures**

Course Objectives:

1. To provide a fundamental understanding of Geology; Earth in the solar system along with its components and various processes, concepts of energy resources and engineering geology; baic understanding of minerals and rocks; the evolution of life through geological time scale.

Course Outcomes:

After the completion of the course, the students will be able to:

1. Acquire the fundamental understanding of the Geology and its various branches; Earth and its components, thorough an understanding of materials (minerals, rocks and fossils), energy resources and processes of the earth, apply the knowledge of earth science to address societal issues.

Course Content:

Unit 1:
Holistic understanding of dynamic planet 'Earth" through Geology, Introduction of various branches of Earth Sciences, Application of Geology in various fields.

Unit 2:
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: Dam/Reservoir, Tunnel, Bridges.

Unit 3:

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

Unit 4:

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, Igneous texture, forms and structure

Sedimentary: Weathering and Erosion, a process of formation, texture and Structure

Metamorphic: agents and types of metamorphism, Texture and Structure.

Unit 5:

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

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.

SEMESTER IV MINOR ELECTIVE-1 1 Paper

I. MINOR ELECTIVE (MN 1) (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 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.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks)

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.*

ESSENTIALS OF GEOLOGY AND ROCKS & MINERALS Theory: 60 Lectures

Course Objectives:

1. To provide a fundamental understanding of the Earth in the solar system along with its origin, age, and its internal structure; various physical processes; concepts of plate tectonics; concepts of minerals, fossils, and rocks and its different types.

Course Learning Outcomes:

After successful completion of the course, the students are expected to:

1. Acquire the fundamental understanding of the Earth and its components, thorough an understanding of materials such as minerals, fossils and rocks and processes of the earth surface such as earthquake and volcanoes, and apply the knowledge of earth science to address societal issues.

Course Content:

Unit 1:

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:

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:

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

- Rocks: types with examples

- Minerals: Definition and Classification.
- Fossils: mode of preservation and uses

Unit 4:

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.

Unit 5:

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.

GEOLOGY PRACTICAL- MN 1 LAB:

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

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

PRACTICALS: 60 Lectures

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 **MINOR ELECTIVE-2** **1 Paper**

I. MINOR ELECTIVE (MN 2)) (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (SIE + ESE) = 30**

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 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.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks)

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.*

EARTH RESOURCES

Theory: 60 Lectures

Course Objectives:

1. 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.

Course Learning Outcomes:

1. 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 Content:

Unit 1:
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:
Definition of Energy: Primary and Secondary Energy. Renewable and Non-Renewable Sources of Energy. Environmental Dimension of Energy.

Unit 3:

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:
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:
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.

GEOLOGY PRACTICAL- MN 2 LAB:

Marks : Pr (ESE: 3Hrs) =25	**Pass Marks: Pr (ESE) = 10**

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

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

PRACTICALS: **60 Lectures**

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 VI **MINOR ELECTIVE-3** **1 Paper**

I. MINOR ELECTIVE (MN 3)) (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (SIE + ESE) = 30**

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 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.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks)

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.*

FOSSILS & THEIR APPLICATIONS

Theory: 60 Lectures

Course Objectives:

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

Course Outcomes:

After the completion of the course, the student will be able to:

1. Understanding 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 indicatior etc.

Course Content:

Unit 1:
Introduction to fossils: Definition of fossil, fossilization processes, modes of fossil preservation and uses.

Unit 2:
Species concept: Definition of species, methods of description and naming of fossils.

Unit 3:
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:

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

Unit 5:

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 H. Colbert, Michael Morales, Eli C. Minkoff, John Wiley & Sons, 1991.

GEOLOGY PRACTICAL- MN 3 LAB:

Marks : Pr (ESE: 3Hrs) =25	**Pass Marks: Pr (ESE) = 10**

Instruction to Question Setter for

End Semester Examination (ESE):

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

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

PRACTICALS: **60 Lectures**

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.

FORMAT OF QUESTION PAPER FOR SEMESTER INTERNAL EXAMINATION

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.

Question format for **20 Marks**:

Subject/ Code

F.M. =20 **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. .....
2. ..... [5]

Group B

3. ..... [10]
4. ..... [10]

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

FORMAT OF QUESTION PAPER FOR END SEMESTER UNIVERSITY EXAMINATION

Question format for **50 Marks**:

Subject/ Code

F.M. =50 **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. .....

Group B

2. ..... [15]
3. ..... [15]
4. ..... [15]
5. ..... [15]
6. ..... [15]

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

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.

Question format for **100 Marks**:

Subject/ Code

F.M. = 100 **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. [10x1=10]
   i. ..... vi. .....
   ii. ..... vii. .....
   iii. ..... viii. .....
   iv. ..... ix. .....
   v. ..... x .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [20]
5. ..... [20]
6. ..... [20]
7. ..... [20]
8. ..... [20]
9. ..... [20]

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