# FAROOK COLLEGE (AUTONOMOUS)

**FAROOK COLLEGE P.O, KOZHIKODE-673632**

**Regulations, Scheme of Evaluation and Syllabus for**

## Integrated M.Sc. Programme

***in***

## Geology (Core Course)

***with***

## Chemistry and Physics (Allied Core Course)

**(2023 Admission onwards)**

**For Postgraduate (Integrated 5 years programme) Curriculum 2023**

**(FCCBCSS INT-PG-2023)**

**Board of Studies in Geology**
**Farook College (Autonomous), Kozhikode**

# CERTIFICATE

I hereby certify that the documents attached are the bona fide copies of the Scheme and Syllabus of Integrated M.Sc. Geology Programme to be effective from the academic year 2023-24 onwards.

FAROOK COLLEGE (AUTONOMOUS) P.O. FAROOK COLLEGE CALICUT 673 632

**PRINCIPAL**

Principal
FAROOK COLLEGE
(AUTONOMOUS)
Farook College.P.O.(Calicut)

Date:

Place: Farook College (Autonomous), Kozhikode

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## 1. TITLE

These regulations shall be called Farook College (Autonomous), Kozhikode Regulations for Integrated M.Sc. Geology programme under the Choice Based Credit and Semester System, 2023 (FCCBCSS INT-PG-2023) admission onwards.

## 2. INTRODUCTION / PREFACE

The educational system in Kerala has undergone significant transformation over the decades. The introduction of integrated programmes in higher education is one of them. The integrated programme is a degree programme that merges two degrees and a single degree is awarded as a whole after the completion of the programme. Several programmes under liberal arts, humanities and social sciences are offered as stand-alone disciplines in our states. The scope and relevance of the interdisciplinary approach is yet to be explored in the higher education sector of Kerala in an adequate manner to address the changing needs of the society. Integrated Programmes combining two academic disciplines is a potential area of knowledge in the present day context. Interdisciplinary programmes draw from two or more academic disciplines that work together to create a powerful learning experience and emphasize integrative learning, critical thinking, and creative problem solving. The need to create a new generation of students who combine a rigorous disciplinary depth with the ability to reach out to other disciplines and work in interdisciplinary teams is more urgent in the emerging world scenario. Because these skills cut across traditional disciplinary boundaries, interdisciplinary programmes can address identifiable long-term problems in the economy, society, and government more effectively than the academically defined disciplinary paradigms. Interdisciplinary approach in research and education are central to future competitiveness, because knowledge creation and innovation frequently occur at the interface of disciplines.

Curriculum of integrated programme aims to equip students with knowledge, skills, values, attitudes, leadership readiness/qualities and lifelong learning. The students on completion of this programme will attain various 21$^{st}$ century skills like critical thinking, problem solving, analytic reasoning, cognitive skills, self-directed learning etc. The curriculum focuses on pragmatist approach whereby application of theoretical concepts is taught with substantial coverage of practical and field works.

## 3. MEMBERS OF BOARD OF STUDIES

**Chairman**

1. **Dr. Babeesh C**
   Assistant Professor (c)
   Department of Geology, Farook College (Autonomous), Kozhikode

Contact: 9566143252, E-mail: bbshivakripa@gmail.com, babeeshc@farookcollege.ac.in

**Members**

1. **Dr. Kavitha A P**
   Assistant Professor& HoD i/c, Department of Geology, Farook College (Autonomous), Kozhikode
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2. **Dr. Anto Francis**
   Department of Civil Engineering and Geology, Govt. Engineering College (Kerala Technical University), Thrissur-680009

3. **Dr. J K Tomson**
   Scientist E & Group Head, Solid Earth Research Group (SERG), National Centre for Earth Science Studies(NCESS), Ministry of Earth Sciences (MoES), Akkulam, Thiruvananthapuram, Kerala

4. **Dr. P R Arun**
   Senior Scientist, Hydrology and Climatology Division, Centre for Water Resources Development and Management (CWRDM), Kunnamangalam, Kozhikode, 695011

**Special Invitees**

1. **Dr. C Sreejith**
   Assistant Professor, Dept. of P.G. Studies and Research in Geology, M.E.S. Ponnani College, Ponnani South Post, Malappuram-67 9586

2. **Dr. A N Manoharan**
   Assistant Professor, Dept. of Geology, Govt. College, Kasaragod, Vidyanagar-671123, Kasaragod

3. **Dr. Linto Alappat**
   Assistant Professor, Dept. of Geology, Christ College, lrinjalakuda, Irinjalakuda North P.O. Thrissur-6801 25

4. **Dr. M Nithya**
   Assistant Professor, Dept. of P.G.Studies and Research in Geology, M.E.S. Ponnani College, Ponnani South Post, Malappuram-67 9586

## 4. PROGRAMME GENERAL OBJECTIVES

- Dissemination and Advancement of knowledge by providing instructional and research opportunities in various branches of knowledge.
- Promoting innovativeness in teaching –learning methods and inter disciplinary training and research.
- Discover the value of integrating the study of various academic disciplines suited to their lifelong interests.
- Become inter-disciplinary thinkers who analytically and creatively embrace new ideas.
- Develop collaboration skills while working with others who have different perspectives.
- Improving social and Economic conditions and welfare of of people especially pertaining to intellectual, academic and social development.

## 5. SCOPE, COVERAGE & COMMENCEMENT

The regulations provided herein shall apply to Integrated M.Sc. course in Geology at Farook College (Autonomous) under Faculty of Science conducted by the Farook College (Autonomous) for the admissions commencing from 2023, with effect from the academic year 2023-2024. The programme conducted under the Choice Based Credit and Semester System in the College shall be monitored by the College Council.

## 6. DEFINITIONS

**6.1.** 'Programme' means the entire course of study and examinations for the award of a degree.

**6.2.** 'Integrated Programme' contains 'Foundation Programme' and 'Advanced Programme'.

**6.2.1.** 'Foundation Programme' means the course of study from first to sixth semester of Integrated Programme.

**6.2.2.** 'Advanced Programme' means the course of study from seventh to tenth semester of Integrated Programme.

**6.3.** 'Duration of programme' means the time period required for the conduct of the programme. The duration of an Integrated Pprogramme shall be ten semesters distributed in a period of 5 years.

**6.4.** 'Academic Week' is a unit of five working days in which distribution of work is organized from day one to day five, with five contact hours of one hour duration on each day. A sequence of 18 such academic weeks constitutes a semester.

**6.5.** 'Semester' means a term consisting of 18 weeks (16 instructional weeks and two weeks for examination).

**6.6.** 'Course' means a segment of subject matter to be covered in a semester.

**6.7.** 'Common course' means a course that comes under the category of courses, including compulsory English and additional language courses and a set of general courses, the selection of which is compulsory for all students undergoing Integrated Programmes.

**6.8.** 'Core course' means a compulsory course in a subject related to a particular degree programme.

**6.9.** 'Open course' means a course which can be opted by a student at his/her choice.

**6.10.** 'Allied Core Course' means a course which is generally related to the core course.

**6.11.** 'Improvement course' is a course registered by a student for improving his/her performance in that particular course.

**6.12.** 'Audit Course/Ability Enhancement course/Professional Competency Course' is a course which is mandatory as per the directions from the Regulatory authorities like UGC, Supreme Court etc.

**6.13.** 'Department' means any Teaching Department in a college offering a course of study approved by the University as per the Statutes and Act of the University.

**6.14.**'Department Co-ordinator' is a teacher nominated by a Dept. Council to co-ordinate all the works related to Integrated Programme undertaken in that department including continuous evaluation.

**6.15.** 'Department Council' means the body of all teachers of a department in a college.

**6.16.** 'Parent Department' means the Department which offers a particular degree programme.

**6.17.**'College Co-ordinator' is a teacher nominated by the college council to co-ordinate the effective running of the process of FCCBCSS INT-PG-2020 including internal evaluation undertaken by various departments within the college. She/he shall be the convenor for the College level monitoring committee.

**6.18.** College level monitoring committee. A monitoring Committee is to be constituted for FCCBCSS INT-PG-2020 at the college level with Principal as Chairperson, college co-ordinator as convenor and department co-ordinators as members. The elected College union chairperson shall be a member of this committee.

**6.19.**'Faculty Adviser' means a teacher from the parent department nominated by the Department Council, who will advise the student in the academic matters and in the choice of open courses.

**6.20.**'Credit'(C) is a unit of academic input measured in terms of weekly contact hours/course contents assigned to a course.

**6.21.** 'Extra Credit' is the additional credit awarded to a student over and above the minimum credits required in a programme, for achievements in co-curricular activities and social activities conducted outside the regular class hours, as decided by the Farook College. For calculating CGPA, extra credits will not be considered.

**6.22**. 'Letter Grade' or simply 'Grade' in a course is a letter symbol (O, A+, A, B+, B, C, P, F, I and Ab). Grade shall mean the prescribed alphabetical grade awarded to a student based on his/her performance in various examinations. The Letter grade that corresponds to a range of CGPA is given in Annexure I.

**6.23.** Each letter grade is assigned a 'Grade point' (G) which is an integer indicating the numerical equivalent of the broad level of performance of a student in a course. Grade Point means point given to a letter grade on 10 point scale.

**6.24.**'Semester Grade Point Average' (SGPA) is the value obtained by dividing the sum of credit points obtained by a student in the various courses taken in a semester by the total number of credits in that semester. SGPA shall be rounded off to three decimal places. SGPA determines the overall performance of a student at the end of a semester.

**6.25.** 'Credit Point' (P) of a course is the value obtained by multiplying the grade point (G) by the credit (C) of the course: P=G x C

**6.26.**'Cumulative Grade Point Average' (CGPA) is the value obtained by dividing the sum of credit points in all the semesters taken by the student for the entire programme by the total number of credits in the entire programme and shall be rounded off to three decimal places.

**6.27.** Grade Card means the printed record of students' performance, awarded to him/her.

**6.28.** Course teacher: A teacher nominated by the Head of the Department shall be in charge of a particular course.

**6.29.** 'Strike off the roll' A student who is continuously absent for 14 days without sufficient reason and proper intimation to the Principal of the college shall be removed from the roll.

**6.30.** Words and expressions used and not defined in this regulation, but defined in the Calicut University Act and Statutes shall have the meaning assigned to them in the Act and Statutes.

## 7. COURSE DURATION

The Integrated Programme is a five-year (10 semesters) programme with an exit option after the completion of VI Semester. Students who have successfully completed according to the minimum mark/grade required for pass and apply for exit option will be awarded Degree in areas concerned. The degree awarded as per the exit options is as equivalent as the degrees of any non-integrated programme. Students, who continue the programme and successfully complete X semester will be awarded Integrated Master's Degree in the area concerned. Duration of the programme shall be ten semesters distributed in a period of five years. Each semester consists of a minimum of 18 weeks, (16 instructional weeks and two weeks for

examination). The odd (1, 3, 5, 7, 9) semesters shall be from June to October and even (2, 4, 6, 8, 10) semesters shall be from November to March.

## 8. ELIGIBILITY FOR ADMISSION

Eligibility for admissions and reservation of seats for First Semester of the Programme shall be according to the rules framed by the Farook College from time to time. The eligibility of admission to the integrated programme is exactly corresponding to the eligibility criteria of a non-integrated programme in the relevant area as decided by the relevant board of studies *(Minimum qualification for the admission is a pass in higher secondary degree (10+2 Science scheme/ equivalent) or qualifications announced by the College).*

Index Mark for Admission shall be the sum total of Marks for the Higher Secondary or equivalent and the subject marks secured for concerned subjects decided by the relevant Board of Studies.

Admission taken at the first semester shall be admission to "Five Year Integrated programme" and students will not be required to take re-admission at any stage of the programme unless the student discontinues the programme after VI semester. The programme framework provides additional entry point as, the student, who has discontinued his/her studies on obtaining corresponding degree from integrated programme, can join at a later date for the programme to complete Masters Degree, if vacancy available and is subject to the decision of the College.

If any vacancy arises due to discontinuation or exit option after VI Semester, fresh admission shall be allowed subjected to Farook College Admission regulations.

The maximum number of students to be admitted to the Programme shall be limited to 30 students. Student transfer from one college to another college following integrated programme to 3$^{rd}$ and 5$^{th}$ Semester of Foundation Programme and 9$^{th}$ semester of Advanced Programme will be according to the existing rules and procedures of the Farook College (Autonomous).

*The applicants for Integrated M.Sc. Course will be ranked as follows:*

Total marks obtained for Part III Optional at the Higher Secondary or equivalent level plus highest marks scored for any one of the subsidiaries among Physics/ Chemistry/Computer Science/Mathematics/Geology/Biology. In the case of a tie, preference shall be given as per the following order:

1) Candidates with Geology as optional subject
2) Marks for Geology
3) Marks for Chemistry
4) Marks for Physics
5) Marks for Mathematics
6) Marks for Computer Science
7) Alphabetical Order of the applicants

(U.O No. G&AIVJ4852/2021/Admn Dated 26-04-2021)

## 9. OUTCOME BASED EDUCATION

Outcome Based Education (OBE) was introduced by William Spady in the early 1990s for the American school system and eventually adapted by higher education systems. OBE is an approach to teaching and learning that focuses on what students should be able to do at the end of a particular learning experience or program. The emphasis is on measuring and assessing the outcomes or achievements of students, rather than just their attendance, participation or memorization of facts. In OBE, the learning goals and objectives are clearly defined and communicated to both students and teachers. Teachers design their lesson plans, activities, and assessments around these learning goals, ensuring that students have the necessary skills and knowledge to achieve the desired outcomes.

Assessment in OBE is also focused on measuring the degree to which students have achieved the desired learning outcomes. This may involve a range of assessment methods, including performance-based assessments, portfolios, and standardized tests. The benefits of OBE include a focus on student achievement, improved learning outcomes, and greater accountability for both students and teachers. The revised Bloom's Taxonomy provides a useful structure for defining and assessing learning outcomes, and OBE focuses on designing instruction and assessment that support the achievement of these outcomes. The revised Bloom's Taxonomy categorizes educational objectives into six levels of cognitive complexity, ranging from lower-order thinking skills such as remembering and understanding, to higher-order thinking skills such as analyzing, evaluating, and creating. The six levels are:

1. *Remembering*: The ability to recall previously learned information.
2. *Understanding*: The ability to comprehend the meaning of what has been learned.
3. *Applying*: The ability to use knowledge and skills in new situations.
4. *Analyzing*: The ability to break down information into parts and understand the relationships between them.
5. *Evaluating*: The ability to make judgments about the value or quality of information based on criteria.
6. *Creating*: The ability to use knowledge and skills to produce something new.

This taxonomy is widely used in education to help educators design instruction and assessment that align with specific learning outcomes. The revised Bloom's Taxonomy is an updated version of the original Bloom's Taxonomy, which was developed by Benjamin Bloom in the 1950s. The revised version was developed in the 1990s by a group of educators led by Lorin Anderson, and it reflects changes in the way that education is understood and practiced today.

## 10. PROGRAMME OUTCOME

Upon completion of the Integrated Programme in Geology at Farook College (Autonomous), the students will be able to develop:

**PO1. Competency in Disciplinary Knowledge**

Graduates acquire comprehensive knowledge in Earth Science, its fundamental principles and concepts including the study of the Earth's structure, composition, and geological processes.

**PO2. Critical Thinking and Problem Solving**

Encourage students to develop critical thinking skills by analyzing different perspectives on Geoscience-related issues, evaluating evidence and arguments, and forming independent opinions based on scientific principles and ethical considerations.

**PO3. Scientific Temper and Open Mindedness**

Graduates are able to develop scientific temper and open mindedness as processes of thinking, behaving and connecting with others based on scientific notions that contribute to the development of a society and lead to innovations to tackle complex issues and challenges

**PO4. Leadership Skills and Professionalism**

Graduates are able to develop leadership skills, such as organizing field trips, presenting research findings, or mentoring younger students. Encourage them to take initiative, collaborate with peers, and engage in meaningful community service projects.

**PO5. Moral and Ethical Awareness**

Graduates are able to embrace moral and ethical values specific to the society and culture and uphold them consistently as responsible members of the society.

**PO6. Social Responsibility and Citizenship Skills**

Encourage students to engage with local communities to understand their concerns and needs related to geology. This could involve organizing field trips to geological sites, hosting guest speakers from community organizations, or facilitating group discussions with local stakeholders.

**PO7. Global Competence and Sustainability**

Graduates are able to examine local, global and intercultural issues, understand and appreciate different perspectives and world views, interact successfully and respectfully with others, and take responsible action toward sustainability and collective well-being.

**PO8. Employability and Entrepreneurship**

Graduates are able to achieve professional skills required to be employed in their career globally and the potential to formulate innovative ideas and to start up new enterprises and will be ability to apply their knowledge and skills to real-world problems and to practice their profession in an ethical and responsible manner.

**PO9. Research and Inquiry**

Graduates will be able to conduct independent research, using appropriate methods and tools, and will be able to analyze and interpret geological data to develop evidence-based conclusions.

**PO10. Lifelong Learning**

Graduates will demonstrate a commitment to lifelong learning and professional development, staying current with advances in their field and continuously improving their skills and knowledge.

## 11. PROGRAMME SPECIFIC OUTCOMES (PSO)

### Integrated M.Sc. Geology

Integrated M.Sc. Geology is a 5-year long-course focused on Earth Science. The program is aimed at providing training in Geosciences of the highest academic quality in a challenging and supportive learning environment. The program will demonstrate, help to solve and understand major concepts of various disciplines of Geology. Since field trips are a key aspect of our course, we have been offering fieldtrips every year including one-week long field works outside the state. The students will be trained to conduct geologic field mapping, statistical analyses of data collected through field studies/ experimentally generated, use of computer techniques and software, petrological microscopy, fossil identification, study groundwater resources and environmental issues of Earth. The students will get an intense learning experience enabling them to identify and differentiate different minerals, rocks and other geological structures in their natural environment.

After successful completion of the Five-year Integrated M.Sc. program in Geology a student should be able to:

**PSO1.** ***Remember*** the basic concepts of geological time scale and important events; geomorphological features; micro and mega geological structures; formation of economic deposits; identification of fossils, minerals and rocks, basic concepts of hydrogeology; remote sensing, GIS, Engineering geology and global and local natural hazards.

**PSO2.** ***Understand*** the concepts of plate tectonic process and explaining its relationship to earth processes, features and landforms. Also understand the basic concept of geophysical methods that are used for exploration activities.

**PSO3.** ***Understand*** spatial and temporal relationships between Earth processes, landforms and products, and the development and evolution of various spheres and life in Earth including the Lithosphere, Hydrosphere, Atmosphere, and Biosphere including stratigraphy. Also understand the atmospheric and ocean circulation in detailed. Concept of biodiversity

**PSO4.** ***Understand*** the concept of identifying and dating of geological materials; the ages and field relations of rocks and distribution of elements in continents and ocean helps to

construct geological maps and databases. Understand the basic and advanced concept of different types of rocks, minerals and their features present.

**PSO5.** ***Apply*** Earth Observation Science with the help of Remote sensing techniques and its visualization and interpretation using Geographic Information System tools and software. It is useful in many fields, from exploration for resources to geological mapping of the Earth or other planets or monitoring geological hazards. Apply the naming techniques in the various geological fields. Apply the geophysical techniques and other geological techniques for mineral exploration and in the various field of geology. Apply the geological techniques in various field of petrology and hydrogeology.

**PSO6.** ***Analyse*** the geological aspects of construction of buildings and dams, slope stability, mine and quarry design, tunnelling, roads, railways, coastal defences and many other aspects of the built environment.

**PSO7.** ***Analyse*** the causes and effects of global climate change; understand proxies to reconstruct past climate. Also Analyse the hydrogeological parameters that affect all type of water bodies. Analyze the remote sensing data for various geological activities.

**PSO8.** ***Analyze*** geological structures (folds, faults, joints and unconformity), geomorphological features, microfossils and their significance in petroleum and mineral exploration, construction of structures etc. and to utilize petrological microscope.

**PSO9.** ***Analyze*** the management, mitigation measures and importance of forecasting, resilience and minimisation of damage caused by natural hazards (e.g., floods, landslides etc.) through the field based studies in the affected areas.

**PSO10.** ***Evaluate*** systematically and independently and draw a logical conclusion about Geological processes and their applications from mega structures to meso-scale minerals and crystals to microscopic features.

**PSO11.** ***Creat***e Construct and interpret geologic cross sections from geological and topographic maps for the various purposes, for example, mineral exploration.

**PSO12.** ***Create*** critical thinking and scientific knowledge in solving geological issues by carrying out field studies, recording field and remote sensed observations, designing and use of laboratory analyses, interpreting results and preparing scientific/ technical reports and their presentation.

**PSO13.** ***Create*** and develop knowledge of the current opportunities and advances in diverse field of geology through attending national and international level seminars and conferences organizing by the Department.

**PSO14.** ***Create*** collaboration with the scientific organizations and industries through the internships and short-term visits.

**PSO15.** ***Create*** team leadership and raise awareness about the importance of Geoscience in the environment and society, as well as the significance of conserving and sustaining its natural resources. Emphasize the concepts and applications of Intellectual Property Rights (IPR).

## 12. STRUCTURE OF THE PROGRAMME

Students shall be admitted to Integrated Programme under Faculty of Science constituted by Farook College (Autonomous) from time to time.

| Semester I | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course** | **Course Code** | **Course Title** | **Credit** | **Hours** | **IN** | **EX** | **Total** |
| Core 1 | GLO1IB01 | Earth and Environment | 3 | 3 | 15 | 60 | 75 |
| All. Core | | Chemistry I | 2 | 2 | 15 | 60 | 75 |
| | | Physics I | 2 | 2 | 15 | 60 | 75 |
| Common | | Common English Course I | 3 | 4 | 15 | 60 | 75 |
| | | Common English Course II | 3 | 5 | 15 | 60 | 75 |
| | | Additional Language Course I | 4 | 5 | 20 | 80 | 100 |
| Practical* | | Chemistry Practical | 0 | 2 | - | - | - |
| | | Physics Practical | 0 | 2 | - | - | - |
| **Total** | | | **17** | **25** | **95** | **380** | **475** |

| Semester II | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course** | **Course Code** | **Course Title** | **Credit** | **Hours** | **IN** | **EX** | **Total** |
| Core 2 | GLO2IB02 | Geomorphology | 3 | 3 | 15 | 60 | 75 |
| All. Core | | Chemistry II | 2 | 2 | 15 | 60 | 75 |
| | | Physics II | 2 | 2 | 15 | 60 | 75 |
| Common | | Common English Course III | 4 | 4 | 20 | 80 | 100 |
| | | Common English Course IV | 4 | 5 | 20 | 80 | 100 |
| | | Additional Language Course II | 4 | 5 | 20 | 80 | 100 |
| Practical* | | Chemistry Practical | 0 | 2 | - | - | - |
| | | Physics Practical | 0 | 2 | - | - | - |
| **Total** | | | **19** | **25** | **105** | **420** | **525** |

| Semester III | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course** | **Course Code** | **Course Title** | **Credit** | **Hours** | **IN** | **EX** | **Total** |
| Core 3 | GLO3IB03 | Crystallography and Mineralogy | 3 | 4 | 15 | 60 | 75 |
| All. Core | | Chemistry III | 2 | 3 | 15 | 60 | 75 |
| | | Physics III | 2 | 3 | 15 | 60 | 75 |
| General | GLO3A11 | Biodiversity-Scope and Relevance | 4 | 4 | 20 | 80 | 100 |
| | GLO3A12 | Research Methodology | 4 | 4 | 20 | 80 | 100 |
| Practical* | GLO3IH01(P) | Crystallography | 0 | 3 | - | - | - |
| | | Chemistry Practical | 0 | 2 | - | - | - |
| | | Physics Practical | 0 | 2 | - | - | - |
| **Total** | | | **15** | **25** | **85** | **340** | **425** |

| Semester IV | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course** | **Course Code** | **Course Title** | **Credit** | **Hours** | **IN** | **EX** | **Total** |
| Core 4 | GLO4IB04 | Optical and Descriptive Mineralogy | 3 | 4 | 15 | 60 | 75 |
| All. Core | | Chemistry IV | 2 | 3 | 15 | 60 | 75 |
| | | Physics IV | 2 | 3 | 15 | 60 | 75 |
| General | GLO4A13 | Natural Resource Management | 4 | 4 | 20 | 80 | 100 |
| | GLO4A14 | Intellectual Property Rights | 4 | 4 | 20 | 80 | 100 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Practical* | GLO4IH02(P) | Crystallography, Mineralogy | 3 | 3 | 15 | 60 | 75 |
| | | Chemistry Practical | 4 | 2 | 20 | 80 | 100 |
| | | Physics Practical | 4 | 2 | 20 | 80 | 100 |
| **Total** | | | **26** | **25** | **140** | **560** | **700** |

| **Semester V** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course** | **Course Code** | **Course Title** | **Credit** | **Hours** | **IN** | **EX** | **Total** |
| Core 5 | GLO5IB05 | Igneous Petrology | 3 | 4 | 15 | 60 | 75 |
| Core 6 | GLO5IB06 | Metamorphic Petrology | 3 | 3 | 15 | 60 | 75 |
| Core 7 | GLO5IB07 | Sedimentary Petrology | 3 | 3 | 15 | 60 | 75 |
| Core 8 | GLO5IB08 | Structural Geology and Geotectonics | 3 | 4 | 15 | 60 | 75 |
| Open | GLO5ID01 | Geoscience and Environment | 3 | 3 | 15 | 60 | 75 |
| Practical* | GLO5IH03(P) | Petrology | 4 | 4 | 20 | 80 | 100 |
| | GLO5IH04(P) | Structural Geology | 4 | 4 | 20 | 80 | 100 |
| **Total** | | | **23** | **25** | **115** | **460** | **575** |

| **Semester VI** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course** | **Course Code** | **Course Title** | **Credit** | **Hours** | **IN** | **EX** | **Total** |
| Core 9 | GLO6IB09 | Economic Geology | 3 | 4 | 15 | 60 | 75 |
| Core 10 | GLO6IB10 | Palaeontology | 3 | 4 | 15 | 60 | 75 |
| Core 11 | GLO6IB11 | Stratigraphy and Indian Geology | 3 | 4 | 15 | 60 | 75 |
| Elective 1[#] | GLO6IE01(E01a) | Remote Sensing and Geographic Information System | 3 | 3 | 15 | 60 | 75 |
| | GLO6IE01(E01b) | Environmental Geology | | | | | |
| | GLO6IE01(E01c) | Engineering Geology and Hydrogeology | | | | | |
| Practical* | GLO6IH05(P) | Economic Geology and Palaeontology | 3 | 4 | 15 | 60 | 75 |
| Field Trip | GLO6IG01(FT) | Geological Field work | 2 | 3 | 15 | 60 | 75 |
| Project | GLO6IF01 | Project Viva Voice | 3 | 3 | 15 | 60 | 75 |
| **Total** | | | **20** | **25** | **105** | **420** | **525** |

| **Semester VII** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course** | **Course Code** | **Course Title** | **Credit** | **Hours** | **IN** | **EX** | **Total** |
| Core 12 | GLO7IB12 | Advanced Crystallography and Mineralogy | 4 | 5 | 20 | 80 | 100 |
| Core 13 | GLO7IB13 | Advanced Geomorphology | 4 | 4 | 20 | 80 | 100 |
| Core 14 | GLO7IB14 | Advanced Igneous and Metamorphic Petrology | 4 | 5 | 20 | 80 | 100 |
| Core 15 | GLO7IB15 | Advanced Stratigraphy | 4 | 5 | 20 | 80 | 100 |
| Practical | GLO7IH06(P) | Mineralogy, Crystallography, Geomorphology, Igneous and Metamorphic Petrology | 3 | 4 | 15 | 60 | 75 |
| Field Trip | GLO7IG02(FT) | Field Studies | - | 2 | - | - | - |
| **Total** | | | **19** | **25** | **95** | **380** | **475** |

| **Semester VIII** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course** | **Course Code** | **Course Title** | **Credit** | **Hours** | **IN** | **EX** | **Total** |
| Core 16 | GLO8IB16 | Advanced Structural Geology | 4 | 6 | 20 | 80 | 100 |
| Core 17 | GLO8IB17 | Exploration Geophysics and Field Techniques | 4 | 6 | 20 | 80 | 100 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Core 18 | GLO8IB18 | Advanced Economic Geology | 4 | 6 | 20 | 80 | 100 |
| Practical | GLO8IH07(P) | Structural Geology, Geophysics and Economic Geology | 3 | 5 | 15 | 60 | 75 |
| Field Trip | GLO8IG03(FT) | Field Studies | 2 | 2 | 15 | 60 | 75 |
| Internship | GLO8IG04(IN) | Professional Training/Internship[$] | 0 | 0 | - | - | - |
| **Total** | | | **17** | **25** | **90** | **360** | **450** |

| **Semester IX** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course** | **Course Code** | **Course Title** | **Credit** | **Hours** | **IN** | **EX** | **Total** |
| Core 19 | GLO9IB19 | Applied Sedimentology | 4 | 5 | 20 | 80 | 100 |
| Core 20 | GLO9IB20 | Hydrogeology | 4 | 5 | 20 | 80 | 100 |
| Core 21 | GLO9IB21 | Advanced Remote Sensing and Geographic Information System | 4 | 4 | 20 | 80 | 100 |
| Elective 2[#] | GLO9IE02(E02a) | Advanced Environmental Geology | 3 | 3 | 15 | 60 | 75 |
| | GLO9IE02(E02b) | Precambrian Crustal Evolution | | | | | |
| | GLO9IE02(E02c) | Quaternary Geology and Paleoclimate | | | | | |
| Elective 3[#] | GLO9IE03(E03a) | Marine Geology and Oceanography | 3 | 3 | 15 | 60 | 75 |
| | GLO9IE03(E03b) | Disaster Management | | | | | |
| | GLO9IE03(E03c) | Applied River Science | | | | | |
| Practical | GLO9IH08(P) | Sedimentology, Hydrogeology, Remote sensing and Geographic Information System | 3 | 5 | 15 | 60 | 75 |
| Field Trip | GLO9IG05(FT) | Field Training and Mapping | - | 10-15 days | - | - | - |
| **Total** | | | **21** | **25** | **105** | **420** | **525** |

| **Semester X** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course** | **Course Code** | **Course Title** | **Credit** | **Hours** | **IN** | **EX** | **Total** |
| Core 22 | GLO10IB22 | Advanced Palaeontology | 4 | 5 | 20 | 80 | 100 |
| Core 23 | GLO10IB23 | Geochemistry and Isotope Geology | 4 | 5 | 20 | 80 | 100 |
| Elective 4[#] | GLO10IE04(E04a) | Geotechnical Engineering | 3 | 3 | 15 | 60 | 75 |
| | GLO10IE04(E04b) | Tectonic Geomorphology | | | | | |
| | GLO10IE04(E04c) | Coal and Petroleum Geology | | | | | |
| Elective 5[#] | GLO10IE05(E05a) | Advanced Mapping Techniques and Exploration Geology | 3 | 3 | 15 | 60 | 75 |
| | GLO10IE05(E05b) | Elements of Mining and Ore Dressing | | | | | |
| | GLO10IE05(E05c) | Climatology | | | | | |
| Practical | GLO10IH09(P) | Advanced Palaeontology and Geochemistry | 3 | 3 | 15 | 60 | 75 |
| Field Trip | GLO10IG06(FT) | Advanced Field Training and Mapping | 2 | 2 | 15 | 60 | 75 |
| Project | GLO10IF02 | Project | 4 | 4 | 20 | 80 | 100 |
| **Total** | | | **23** | **25** | **120** | **480** | **600** |

[*] Study tour, Study project and practical evaluation will be held at the end of even semester.

[#] An Institution can offer any one among these courses.

$ Report evaluation of the Internship may be done at the end of X[th] Semester

**12.1. Courses**: The Integrated programme shall include nine types of courses, viz; Common Courses (Code IA), Core courses (Code IB), Allied Core courses (Code IC), Open Course

(Code ID), Elective Courses (Code IE), Project (Code IF), Comprehensive Viva (Code IG), Practical/Lab (IH) and Audit courses (Code II).

**12.2. Course code**: Each course shall have a unique alphanumeric code number, which includes abbreviation of the subject in three letters, the semester number (1 to 10) in which the course is offered, the type of the course (IA to II) and the serial number of the course (01,02 .....). For example: GLO2IB04 represents a core course of serial number 04 offered in the second semester of the integrated programme in Geology.

**12.3. Common Courses**

All Integrated Programmes should follow the Common courses in I to IV semesters listed for LRP Programmes in CBCSS UG Regulations, Farook College. The Courses are distributed as per the following table. Changes made in the syllabus of the Common courses by the respective boards will be applicable to Integrated Programmes also.

| No. | Semester | Course Code | Corresponding Course and code in CBCSS UG Regulations |
|---|---|---|---|
| 1 | 1 | ENG1IA01 | ENG1A01 *(Common English Course **1**)* |
| 2 | 1 | ENG1IA02 | ENG1A02 *(Common English Course **2**)* |
| 3 | 1 | MAL1IA07(3) or<br>ARB1IA07(3) or<br>HIN1IA07(3) | MAL1A07(3) or<br>ARB1A07(3) or<br>HIN1A07(3)<br>*(Additional language Course **1**)* |
| 4 | 2 | ENG2IA03 | ENG2A03 *(Common English Course 3)* |
| 5 | 2 | ENG2IA04 | ENG2A04 *(Common English Course **4**)* |
| 6 | 2 | MAL2IA08(3) or<br>ARB2IA08(3) or<br>HIN2IA08(3) | MAL2A08(3) or<br>ARB2A08(3) or<br>HIN2A08(3)<br>*(Additional language Course **2**)* |

In addition to English and Additional Language, the following General Courses are also included in the category of Common Courses:

- GLO3A11. General Course I – Third Semester
- GLO3A12. General Course II – Third Semester
- GLO4A13. General Course III - Fourth Semester
- GLO4A14. General Course IV - Fourth Semester

Common courses A01-A04 shall be taught by English teachers and A07-A08 by teachers of Additional languages respectively. General courses GLO3A11- GLO4A14 shall be offered by Teachers of departments offering core courses concerned.

General courses I, II, III and IV shall be designed by the group of boards concerned.

The subjects under Language Reduced Pattern (LRP) (Alternative Pattern) are grouped into five and General Courses I, II, III & IV shall be the same for each group.

1. BBA, B.Com. Fashion Technology, Hotel Management.

2. Industrial Chemistry, Polymer Chemistry, Food Science and Technology.
3. Computer Science, Electronics, Instrumentation, Printing Technology, Computer Application, Applied Physics
4. Biotechnology, Biochemistry, Aquaculture, Plant Science, Environmental Science & Water Management, Genetics, Microbiology, Geology
5. B.A Multimedia, B.A Visual Communication, B.A Film and Television, BA Graphic Design and Animation programme.
6. English, Malayalam, Sociology, Politics

| **Common Courses in various programme** | **Sem1** | **Sem2** | **Sem3** | **Sem4** |
|---|---|---|---|---|
| Foundation | A01, A02, A07(3) | A03, A04, A08(3) | A11, A12 | A13, A14 |

### 12.4. Core Courses

Core courses are the courses in the major (core) subject of the degree programme chosen by the student. Core courses are offered by the parent department. There shall be a Project Work in the Foundation Programme with 3 credits and for Advanced Programme, with a maximum of 8 credits including Comprehensive Viva-voce. Project Work / Dissertation in the advanced programme shall be treated as Core Courses. Project Work is mandatory for all programmes and Comprehensive Viva-voce is optional and to be done in the end semester of the Advanced Programme.

### 12.5. Allied Core Courses

Two Allied core courses that are related to the core subject and are distributed in the first four semesters. There shall be two Allied core courses in a semester for Integrated M.Sc. Programme. The college can choose any Allied Core courses under Type 1& Type 2 for a programme. Once they choose the Allied Core courses that should be intimated to the University. If a college wants to change the Allied core course pattern (Type 1& Type 2) prior sanction has to be obtained.

| **Semester** | **Course Code** | **Allied Core Course Title** |
|---|---|---|
| 1 | CHE1IC01 | General Chemistry |
| | BPH2C01 | Properties of matter & Thermodynamics |
| 2 | CHE2IC02 | Physical Chemistry |
| | BPH2C02 | Optics, Laser & Electronics |
| 3 | CHE3IC03 | Organic Chemistry |
| | BPH3C03 | Mechanics, Relativity, Waves & Oscillations |
| 4 | CHE4IC04 | Physical and Applied Chemistry |
| | BPH4C04 | Electricity, Magnetism and Nuclear physics |
| | CHE4IH01 | Chemistry Practical |
| | BPH4C05L | Physics Practical |

### 12.6. Open Courses

There shall be one open course in core subjects in the fifth semester. The open course shall be open to all the students in the institution except the students in the parent department. The students can opt that course from any other department in the institution. Each department can decide the open course from a pool of three courses offered by the College. Total credit alloted for open course is 3 and the hours alloted is 3. If there is only one programme in a college, they can choose either language courses or physical education as open course.

### 12.7. Elective courses in Advanced Programme

Elective Course means a course, which can be substituted, by equivalent course from the same subject and a minimum number of courses are required to complete the programme. Elective courses shall be spread over either in the $9^{th}$ & $10^{th}$ Semesters combined or in any one of these Semesters (IX / X) only subject to the stipulations of the Board of Studies concerned.

- Comprehensive Field work/Study Tour, Mapping Camp, Viva-voce, and Project Work / Dissertation shall be treated as Core Courses.
- Common Courses (6 theory) with 22 credits (14 for common English courses + 8 for common languages other than English)
- General Courses (4 theory) with 16 credits
- Core courses (23 Theory, 11 Practical, 5 Elective theory, and 2 Projects and 2 Field Training and a field mapping camp) with a total credit of 135.
- Allied Core courses, Chemistry and Physics as compulsory course (4 theory courses and 2 practical's) with a total of 24 credits.
- Open Course (one from other department) with 3 credits; and
- Altogether, there shall be a total of 200 credits for Common, Core, Allied core, General and Open courses.

### 12.8. Audit Courses/Ability Enhancement Courses/Professional Competency Courses

These are courses which are mandatory for a programme but not counted for the calculation of SGPA or CGPA.

**12.8.1.** There shall be one Audit course each in the first four semesters of the Foundation Programme. These courses are not meant for class room study. The foundation Programmes should follow the Audit courses from I to IV semesters as per the CBCSS UG Regulations, Farook College. Changes made in the syllabus of the Audit courses by the respective boards will be applicable to Integrated Programmes also. The students can attain only pass (Grade P) for these courses. At the end of each semester there shall be examination conducted by the college from a pool of questions (Question Bank) set by the College. The students can also attain these credits through online courses like SWAYAM, MOOC etc (optional). The list of passed students must be sent to the University from the colleges at least before the fifth semester examination. The list of courses in each semester with credits is given below.

| Course | Credit | Semester |
|---|---|---|
| Environment Studies | 4 | 1 |
| Disaster Management | 4 | 2 |
| *Human Rights/ Intellectual Property Rights/ Consumer Protection | 4 | 3 |
| *Gender Studies/Gerontology | 4 | 4 |

*Colleges can opt any one of the courses.

**12.8.2.** There will be two Audit Courses (Ability Enhancement Course & Professional Competency Course) with 4 credits each in the Advanced Programme. These have to be done one each in the seventh and eighth semesters. The credits will not be counted for evaluating the overall SGPA & CGPA. The colleges shall conduct examination for these courses and have to intimate / upload the results of the same to the University on the stipulated date during the IX Semester. Students have to obtain only minimum pass requirements in the Audit Courses. The details of Audit courses are given below:

| Semester | Course Title | Suggested Area | Details |
|---|---|---|---|
| VII | Ability Enhancement Course (AEC) | Internship / Seminar presentation / Publications / Case study analysis / Industrial or Practical Training /Community linkage programme / Book reviews etc. | Board of Studies concerned can design appropriate AEC & PCC and evaluation criteria by considering the relevant aspects in the core area of the faculty under study. |
| VIII | Professional Competency Course (PCC) | To test the skill level of students like testing the application level of different software's such as SPSS/R/ Econometrics/ Pythan/Any software relevant to the programme of study / Translations | |

**Ability Enhancement Course (AEC) GEL 1A 01**

**Scheme and Evaluation**

1. Preparation of a research proposal. Identification. Detailed methodology. Time frame. National and International status of the research problem. Literature survey report. Evaluation: Relevance - 20%, Novelty - 20% Document - 35%, Presentation / Viva - 25%.
2. Developing e-content for any one module of any course of the student's choice. It might include reading material, questions with answers, glossary, PowerPoint and videos. Evaluation: Classroom presentation - 50% Developed contents - 40% Originality - 10%
3. Synthesis of any one geological problem using research literature. Evaluation: Presentation - 25%, Discussion - 25% Methodology - 25%, Result - 25%

**Professional Competency Course (PCC) GEL 2A 02**

1. Statistical data analysis and representation of the results using any one software. Evaluation: Four practical tests of 25% marks each.
2. Developing a new methodology / software / App, for problem solving in geological sciences, significant to the societal needs. Evaluation: The software / app by direct testing. Methodology - by discussion among the panel of teachers.
3. Writing a research paper following the guidelines of any standard research journal, using open-source data. Evaluation: Separate review by at least two teachers from the panel.

### 12.9. Extra Credit Activities

Extra credits are mandatory for the programme. Extra credits will be awarded to students who participate in activities like NCC, NSS and Swatch Bharath. Those students who could not join in any of the above activities have to undergo Farook College Social Service Programme (FCSSP). For calculating SGPA and/or CGPA, extra credits will not be considered.

### 12.10. Projects

Every student of a Foundation Programme shall have to work on a project (minor) of 3 credits under the supervision of a faculty member. There shall be a 'Project work' (Major) with dissertation and 'Comprehensive Viva-voce' as separate courses relating to the Core area under study in the end semester of Advanced Programme and included in the Core Courses. Project Work is mandatory for all programmes and Comprehensive Viva-voce is optional and these shall be done in the end semester. Project work relate Viva voce shall be one of the criteria for Project work evaluation.

## 13. CREDIT PATTERN

Each course shall have certain credits. The total minimum credit for integrated Programme shall be 200 for 10 semesters in which 120 credits for Foundation level (first six semesters) and 80 credits for Advanced level (last four semesters) programmes. These credits shall be spread across core courses, electives, open courses, practicals, seminars and minor/major project/dissertation. However there shall be flexibility in the requirement of

minimum/maximum credits for core and elective courses per semester as well as for whole programme. A student is required to acquire a minimum of 140 credits for the completion of the foundation programme, of which 120 credits are to be acquired from class room study and shall only be counted for SGPA and CGPA. Out of the 120 credits, 38 (14 for common (English) courses + 8 for common languages other than English + 16 for General Courses) credits shall be from common courses, 3 credits for project and 3 credits for the open course.

However the credits to be set apart for the Core and Allied Core courses shall be decided by the faculty concerned. The maximum credits for a course shall not exceed 5.

Total credit for the advanced programme shall be 80 (eighty), this describes the weightage of the course concerned and the pattern of distribution is as detailed below:

i) Total Credit for Core Courses shall not be less than 60 (sixty) and not more than 68 (sixty eight).

ii) Total Credit for Elective Course shall not be less than 12 (twelve) and not more than 20 (Twenty).

**13.1. Distribution of Credits:**

| Sl. No. | Course | | Credits |
|---|---|---|---|
| 1. | Common | English | 14 |
| 2. | Common | Additional Language | 8 |
| 3. | General Courses | | 16 |
| 3. | Core | Geology | 135 |
| 4. | Allied Core Course I | Chemistry | 12 |
| 5. | Allied Core Course II | Physics | 12 |
| 6. | Open Course | One theory course offered by any other department | 3 |
| 7. | Audit Courses (Extra Credits) | each in the first four semesters of the Foundation Programme two Audit Courses | 16 |
| | | (AEC&PEC) with 4 credits each in the Advanced Programme | 8 |
| | | **Total** | **224** |

**14. ATTENDANCE**

A student shall be permitted to appear for the semester examination, only if he/she secures not less than 75% attendance in each semester. Attendance shall be maintained by the Department concerned. Condonation of shortage of attendance to a maximum of 10% in the case of single condonation and 20% in the case of double condonation in a semester shall be granted by University remitting the required fee. Benefits of attendance may be granted to

students who attend the approved activities of the college/university with the prior Concurrence of the Head of the institution. Participation in such activities may be treated as presence in lieu of their absence on production of participation/attendance certificate (within two weeks) in curricular/extracurricular activities (maximum 9 days in a semester).

Students can avail of condonation of shortage of attendance in a maximum of four semesters during the foundation programme (Either four single condonations or one double condonation and two single condonations during the foundation programme and two single condonation or one double condonation during the advanced programme) . If a student fails to get required attendance, he/she can move to the next semester only if he/she acquires 50% attendance. In that case, a Provisional registration is needed. Such students can appear for supplementary examination for such semesters after the completion of the foundation/advanced programme. Less than 50% attendance requires Readmission. Readmission is permitted only once during the entire programme.

**14.1. Re-admission Rules**: There shall be provision for Readmission of students in Integrated Programme. The Principal can grant readmission to the student and inform the matter of readmission to the Controller of Examinations within one month of such readmission. This readmission is not to be treated as college transfer. There should be a gap of at least one semester for readmission. The candidate seeking readmission to a particular semester should have registered for the previous semester examination. Readmission shall be taken within two weeks from the date of commencement of the semester concerned.

## 15. GRACE MARKS:

Grace Marks may be awarded to a student for meritorious achievements in co-curricular activities (in Sports/Arts/NSS/NCC/Student Entrepreneurship) carried out besides the regular hours. Such a benefit is applicable and limited to a maximum of 8 courses in an academic year spreading over two semesters in the Foundation Programme. In addition, maximum of 6 marks per semester can be awarded to the students of Integrated Programmes, for participating in the College Fitness Education Programme (COFE).

## 16. BOARD OF STUDIES & COURSES

The UG Boards of Studies concerned shall design all the courses offered in the Foundation Programmes offered in the first six semesters and PG Board of studies concerned shall design all the courses offered in the last 4 semesters of integrated programme. The Boards shall design and introduce new courses, modify or re-design existing courses and replace any existing courses with new/modified/re-designed courses to facilitate better exposure and training for the students. In due course University may think of establishing separate Board of Studies for the integrated programme of different discipline.

## 17. REGISTRATION

Each student shall make an online registration for the courses he/she proposes to take, in Consultation with the Faculty Adviser within two weeks from the commencement of each Semester. The college shall send a list of students registered for each programme in each

semester giving the details of courses registered, including repeat courses, to the University in the prescribed form within 45 days from the commencement of the semester.

It is mandatory that the students who got admission under CBCSS integrated Programme. A student shall be normally permitted to register for the examination if he/she has required minimum attendance. If the student fails to acquire the required attendance in a semester, the student shall be permitted to move to the next semester (if the attendance is more than 50% - Provisional registration) and can write the examination for the entire courses of the semester in which shortage of attendance occurs, as supplementary examination only after the completion of the foundation/advanced programme. In such cases, a request from the student may be forwarded through the Principal of the college to the Controller of Examinations within two weeks of the commencement of the semester. If the attendance is less than 50%, the student is ineligible to continue the programme and has to seek re-admission. There will not be any Repeat semester in CBCSS Integrated Programmes.

## 18. EXAMINATION

**18.1.** There shall be semester examinations at the end of each semester.

**18.2.** Practical examinations shall be conducted by the College as prescribed by the Board of Studies.

**18.3.** External viva-voce, if any, shall be conducted along with the practical examination/project evaluation.

**18.4.** The model of question papers may be prepared by the Board of Studies concerned. Each question should aim at – (1) assessment of the knowledge acquired (2) standard application of knowledge (3) application of knowledge in new situations.

**18.5.** Different types of questions shall possess different marks to quantify their range.

**18.6.** Project evaluation shall be conducted at the end of sixth semester for foundation programme and $10^{th}$ semester for advanced programme.

**18.7.** Audit course for Foundation Programme: The students can attain only pass (Grade P) for these courses. At the end of each semester, there shall be examination conducted by the college from a pool of questions set by the college. The students can also attain the credits through online courses like SWAYAM, MOOC etc., with the prior permission from the Board of Studies concerned. The College shall send the list of passed students to the University at least before the commencement of fifth semester examination.

**18.8. Improvement course**: Improvement of a particular semester can be done only once. The student shall avail of the improvement chance in the succeeding year after the successful completion of the semester concerned. The students can improve a maximum of two courses in a particular semester. The internal marks already obtained will be carried forward to determine the new grade/mark in the improvement examination. If the candidate fails to appear for the improvement examination after registration, or if there is no change in the

results of the improved examination, the mark/grade obtained in the first appearance will be retained. Improvement and supplementary examinations cannot be done simultaneously.

**18.9. Moderation**: Moderation is eligible as per the existing rules of the Academic Council.

## 19. ASSESSMENT & EVALUATION

**19.1.** Mark system is followed instead of direct grading for each question. For each course in the semester letter grade and grade point are introduced in 10-point indirect grading system as per guidelines given in Annexure-1.

**19.2.** Course Evaluation-The evaluation scheme for each course shall contain two parts 1) Internal assessment 2) External Evaluation

20% weight shall be given to the internal assessment. The remaining 80% weight shall be for the external evaluation, except for project. For project evaluation, existing criteria in the UG/PG Regulations (CBCSS UG 2019) will be made applicable to the foundation and advanced programmes respectively, in the Integrated Programmes.

### 19.2.1. Internal Assessment

20% of the total marks in each course are for internal examinations. The marks secured for internal assessment only need to be sent to University by the colleges concerned. The internal assessment shall be based on a predetermined transparent system involving written tests, Class room participation based on attendance in respect of theory courses and lab involvement/records attendance in respect of Practical Courses. Internal assessment of the project will be based on its content, method of presentation, final conclusion and orientation to research aptitude.

Components with percentage of marks of Internal Evaluation of Theory Courses are-Test paper 40%, Assignment 20%, Seminar 20% and Class room participation based on attendance 20%. For practical courses - Record 60% and lab involvement 40% as far as internal is concerned (if a fraction appears in internal marks, nearest whole number is to be taken). Marks awarded for the record of practical works shall be purely based on the number of practical works carried out/specimens studied by the candidate. For the test paper marks, at least one test paper should be conducted. If more test papers are conducted, the mark of the best one should be taken. To ensure transparency of the evaluation process, the internal assessment marks awarded to the students in each course in a semester shall be notified on the notice board at least one week before the commencement of external examination. There shall not be any chance for improvement for internal marks. The course teacher(s) shall maintain the academic record of each student registered for the course, which shall be forwarded to the University by the college Principal after obtaining the signature of both course teacher and Head of the Department. The Split up of marks for Test paper and Class Room Participation (CRP) for internal evaluation of Integrated Programmes (for both foundation and advanced) are as follows.

***(a) Split up of marks for Theory Test Paper***

| Range of Marks in Test paper | Out of 8 (Max. internal mark is 20) | Out of 6 (Max. internal mark is 15) |
|---|---|---|
| Less than 35% | 1 | 1 |
| 35% – 45% | 2 | 2 |
| 45% – 55% | 3 | 3 |
| 55% – 65% | 4 | 4 |
| 65% – 85% | 6 | 5 |
| 85% – 100% | 8 | 6 |

***(b) Split up of marks for Class room participation (CRP)***

| Range of CRP | Out of 4 (Max. internal mark is 20) | Out of 3 (Max. internal mark is 15) |
|---|---|---|
| 50% ≤ CRP < 75% | 1 | 1 |
| 75% ≤ CRP < 85% | 2 | 2 |
| 85% and above | 4 | 3 |

**19.2.3. External Evaluation**

For Foundation Programme, External evaluation carries 80% of marks. All question papers shall be set by the College. The external question papers may be of uniform pattern with 80/60 marks. The courses with 2/3 credits will have an external examination of 2 hours duration with 60 marks and courses with 4/5 credits will have an external examination of 2.5 hours duration with 80 marks.

For Advanced Programme, External evaluation carries 80% of marks. All question papers shall be set by the University. The external question papers may be of uniform pattern with 80 marks having duration of 3 hours.

The external examination in theory courses is to be conducted by the College with question papers set by external experts/Question bank prepared by the Board of Studies. The evaluation of the answer scripts shall be done by examiners based on a well-defined scheme of valuation and answer keys shall be provided by the College. The external examination in practical courses shall be conducted by two examiners – one internal and an external, the latter appointed by the College. The project evaluation with viva can be conducted either internal or external which may be decided by the Board of Studies concerned. After the external evaluation only marks are to be entered in the answer scripts. All other calculations including grading are done by the College.

Regarding the internal/external proportion of advanced programme, the existing pattern of respective discipline framed by the respective Board of Studies is applicable. The different criteria set for the internal evaluation of advanced programme (from 7th semester to 10 semesters) are same as that of a non-integrated PG programme.

### 19.2.3.1. Scheme of examination - Theory

**Question paper type 1**:

The External QP with 80 marks and Internal Examination is of 20 marks. Duration of each External Examination is 2.5 Hrs. The pattern of External Examination is as given in Annexure II. The students can answer all the questions in Sections A and B. But there shall be Ceiling in each section.

**Question paper type 2**:

The External QP with 60 marks and Internal Examination is of 15 marks. Duration of each External Examination is 2 Hrs. The pattern of External Examination is as given in Annexure II. The students can answer all the questions in Sections A and B. But there shall be Ceiling in each section.

### 19.2.3.2. Scheme of examination - Practical

The External examination in practical courses shall be conducted by two Examiners – one Internal and an External, the latter appointed by the College. Only candidates with records of more than 75% of practical works prescribed in the syllabus and duly attested by the Head of the Department shall be allowed to appear for Practical Examination.

### 19.2.3.3. Core Course Project Work

Evaluation of the Project Report shall be done under Mark System. The evaluation of the project will be done at two stages:

a. Internal Assessment (supervising teachers will assess the project and award internal Marks)
b. External evaluation (external examiner appointed by the College)
c. Grade for the project will be awarded to candidates, combining the internal and external marks.

The internal to external components is to be taken in the ratio 1:4. Assessment of different components may be taken as below:

| **Components** | | **Percentage of Marks** |
|---|---|---|
| **Internal** | **External** | |
| Originality | Relevance of the Topic; Statement of Objectives | 20 |
| Methodology | Reference/Bibliography; Presentation; Quality of Analysis/Use of Statistical Tools. | 20 |
| Scheme/Organisation of Report | Findings and recommendations | 30 |

| | | |
|---|---|---|
| Viva–Voce | Viva–Voce | 30 |

### 19.2.4. Study Tour/Field Work/Field Training and Mapping: Evaluation Scheme

Study tours for geological field work, including collection of minerals, rocks, and fossil specimens, training on the measurement and recording of structural attributes and geological information, are integral and mandatory component of the program. These study tours are to be scheduled as follows:

1. Field work expanding for 8 to 12 days shall be conducted in the first four semesters with emphasis on Physical Geology, Geomorphology, Mineralogy, and Mineral Deposits within southern India. The field work in the first four semesters may be carried out either in a single stretch in any of the semesters or as two stretches initially at first or second semester and later one at the third or fourth semester.
2. Extensive field work with emphasis on Stratigraphy, Structural Geology, Economic Geology, Palaeontology, and Petrology for 12 to 15 days in different parts of India shall be conducted in fifth/sixth and seventh/eighth semester of the programme.
3. Mapping camp, extending for 10 to 15 days in a particular location, anywhere in India with emphasis on structural and lithological mapping shall be carried out during ninth semester of the programme
4. Industrial Training, extending for two - to four- Weeks in any industry/institute anywhere in India/outside India with emphasis on geology or earth science as a domain

The study tour should be organized in such a way that a major portion of the entire tour period is exclusively allocated for field-based studies, including visit to quarries, mines and locations of geological interest, and limited time slots may be reserved to visit Academic/Research institutions. During the field-based studies and training, the students shall be grouped with a maximum strength of 15 numbers in a group supervised by one faculty member for each group.

A detailed and collective report of these field works/field training and mapping, certified by the teacher(s)-in-charge of the study tour(s) and also by the Head of the Department should be submitted in the Sixth/Eighth/Tenth Semesters, and specimens collected during the field works should be displayed at the time of practical examination in Sixth Semester. The study tour report is compulsory for each student appearing for $6^{th}$ and $8^{th}$ Semester practical examination.

***(a) Internal Assessment***

| Sl. No. | Criteria | Marks |
|---|---|---|
| 1. | Punctuality & Field Note | 4 |
| 2. | Field work/Skill | 4 |

| | | |
|---|---|---|
| 3. | Specimen collection | 6 |
| 4. | Viva-Voce | 6 |
| | **Total** | **20** |

***(b) External Evaluation***

| Sl. No. | Criteria | Marks |
|---|---|---|
| 1. | Study Tour Report | 20 |
| 2. | Specimen Display | 20 |
| 3. | Presentation/Viva-Voce | 40 |
| | **Total** | **80** |

**19.2.5. Revaluation**: In the new system of grading, revaluation is permissible. The prevailing rules of revaluation are applicable to FCCBCSS-PG2020.

Students can apply for photocopies of answer scripts of external examinations. Applications for photocopies/scrutiny/revaluation should be submitted within 10 days of publication of results. The fee for this shall be as decided by the College.

## 20. GRADING SYSTEM

**20.1.** Indirect grading System based on a 10-point scale is used to evaluate the performance of students.

**20.2.** Each course is evaluated by assigning marks with a letter grade (O, A+, A, B+, B, C, P, F, I or Ab) to that course by the method of indirect grading (Annexure I).

**20.3.** An aggregate of P grade (after external and internal put together) is required in each course for a pass and also for awarding a degree. However, a minimum of 30% marks on external evaluation is needed for a pass in a course of Integrated Programme. But no separate pass minimum is needed for internal evaluation. No separate grade/mark for internal and external will be displayed in the grade card; only an aggregate grade will be displayed. Also the aggregate mark of internal and external is not displayed in the grade card.

**20.4.** A student who fails to secure a minimum grade for a pass in a course is permitted to write the examination along with the next batch.

**20.5.** After the successful completion of a semester, Semester Grade Point Average (SGPA) of a student in that semester is calculated using the formula given below. For the successful completion of a semester, a student should pass all courses. However, a student is permitted to move to the next semester irrespective of SGPA obtained.

SGPA of the student in that semester is calculated using the formula

$$\text{SGPA} = \frac{\text{Sum of the credit points of all courses in a semester}}{\text{Total credits in that semester}}$$

**20.6.** The Cumulative Grade Point Average (CGPA) of the student is calculated at the end of a programme. The CGPA of a student determines the overall academic level of the student in a programme and is the criterion for ranking the students. CGPA can be calculated by the following formula.

**CGPA for Integrated Programme**:

$$\text{CGPA} = \frac{\text{Total credit points obtained in one to six semesters}}{\text{Total credits acquired (200)}}$$

**CGPA for the students who exit after the completion of Foundation Programme**

$$\text{CGPA} = \frac{\text{Total credit points obtained in seven to ten semesters}}{\text{Total credits acquired (120)}}$$

**CGPA for the students who take admission to Advanced Programme**

$$\text{CGPA} = \frac{\text{Total credit points obtained in ten semesters}}{\text{Total credits acquired (80)}}$$

**20.7.** SGPA and CGPA shall be rounded off to three decimal places. CGPA determines the broad academic level of the student in a programme and is the index for ranking students (in terms of grade points). An overall letter grade (cumulative grade) for the entire programme shall be awarded to a student depending on her/his CGPA (Annexure-I)

## 21. GRADE CARD

**21.1.** The University shall issue to the students grade/marks card (by online) on completion of each semester, which shall contain the following information:

1. Name of University
2. Name of College
3. Title of Programme
4. Semester concerned

5. Name and Register Number of student
6. Code number, Title and Credits of each Course opted in the semester
7. Letter grade in each course in the semester
8. The total credits, total credit points and SGPA in the Semester (corrected to three decimal places)

**21.2.** The final Grade card issued at the end of the final semester shall contain the details of all courses taken during the entire programme including those taken over and above the prescribed minimum credits for obtaining the degree. The final grade card shall show CGPA (corrected to three decimal places), percentage of marks (corrected to two decimal places) and the overall letter grade of a student for the entire programme. The final grade card shall also include the CGPA and percentage of marks of common courses, core courses, elective courses, allied core courses and open courses separately. This is to be done in a 10- point indirect scale. The final Grade card also contains the list of Audit courses passed and the details of Extra credits.

**21.3. Evaluation of Audit courses for Foundation Programme**: The examination shall be conducted by the college itself from the Question Bank prepared. The Question paper shall be of 100 marks of 3 hour duration.

**21.4. Evaluation of Audit Courses for Advanced Programme**: Evaluation of Audit course is 100% Internal and it shall be done by the Institutions/Board of Studies/Department Council concerned. Some of the Board of Studies prepared the guidelines of Audit Courses, otherwise, the institution shall decide the same. The examination and evaluation shall be conducted by the college itself either in the normal structure or MCQ model from the Question Bank and other guidelines provided by the Board of Studies. The Question paper shall be for minimum 20 weightage and a minimum of 2 hour duration for the examination. The result has to be intimated /uploaded to the University during the Third Semester as per the notification of the University.

## 22. AWARD OF DEGREE

The successful completion of all the courses (common, core, elective, allied core and open courses) prescribed for the degree programme with 'P' grade shall be the minimum requirement for the award of degree.

## 23. TRANSITORY PROVISIONS

Notwithstanding anything contained in these Regulations, the Vice-Chancellor shall, for a period of three years from the date of coming into force of these Regulations, have the power to provide by order that these regulations shall be applied to any programme with such modifications as may be necessary.

## 24. GRIEVANCE REDRESSAL COMMITTEE

**24.1.** Department level: The College shall form a Grievance Redressal Committee in each department comprising of course teacher, one senior teacher and elected representative of students (Association Secretary) as members and the Head of the Department as Chairman. This committee shall address all grievances relating to the internal assessment grades of the students.

**24.2.** College level: There shall be a college level grievance Redressal committee comprising of student adviser, two senior teachers, two staff council members (one shall be elected member) and elected representative of students (College Union Chairperson) as members and Principal as Chairman.

**24.3.** University level: The University shall form a Grievance Redressal Committee as per the existing norms.

## 25. STEERING COMMITTEE

A Steering Committee consisting of two Governing Council members of whom one shall be a teacher, the Principal, Controller of Examinations, seven teachers from different disciplines (preferably one from each faculty) and two Chairpersons of Board of Studies (one UG and 1 PG), shall be formed to resolve the issues, arising out of the implementation of FCCBCSS-UG 2020. The Governing Council member who is also a teacher shall be the Convener of the committee. The quorum of the committee shall be six and meeting of the committee shall be held at least thrice in an academic year. The resolutions of the committee will be implemented by the Principal in exigency and this may be ratified by the Academic Council.

## 26. REPEAL

The regulations now in force in so far as they are applicable to programmes offered by the College and to the extent they are inconsistent with these regulations are hereby repealed. In the case of any inconsistency between the existing Regulations and these Regulations relating the Choice-Based Credit Semester System in their application to any course offered in the College, the latter shall prevail.

## ANNEXURE-I

### Method of Indirect Grading

Evaluation (both internal and external) is carried out using Mark system .The Grade on the basis of total internal and external marks will be indicated for each course, for each semester and for the entire programme.

Indirect Grading System in 10 - point scale is as below:

### Ten Point Indirect Grading System

| Percentage of Marks (Both Internal &External put together) | Grade | Interpretation | Grade point Average (G) | Range of grade points | Class |
|---|---|---|---|---|---|
| 95 and above | O | Outstanding | 10 | 9.5 - 10 | First Class with Distinction |
| 85 to below 95 | A+ | Excellent | 9 | 8.5 - 9.49 | |
| 75 to below 85 | A | Very good | 8 | 7.5 - 8.49 | |
| 65 to below 75 | B+ | Good | 7 | 6.5 - 7.49 | First Class |
| 55 to below 65 | B | Satisfactory | 6 | 5.5 - 6.49 | |
| 45 to below 55 | C | Average | 5 | 4.5 - 5.49 | Second Class |
| 35 to below 45 | P | Pass | 4 | 3.5 - 4.49 | Third Class |
| Below 35 | F | Failure | 0 | 0 | Fail |
| Incomplete | I | Incomplete | 0 | 0 | Fail |
| Absent | Ab | Absent | 0 | 0 | Fail |

***Conversion Formula**: Percentage of Marks = Grade point x 10*

## ANNEXURE-II

**Question paper type 1 (Foundation Level)**

**Scheme of Examinations:**

The external QP with 80 marks and internal examination is of 20 marks. Duration of each external examination is 2.5 Hrs. The pattern of External Examination is as given below. The students can answer all the questions in Sections A&B. But there shall be Ceiling in each section.

**Section A**

Short answer type carries 2 marks each -15questions Ceiling -25

**Section B**

Paragraph/ Problem type carries 5 marks each -8questions Ceiling -35

**Section C**

Essay type carries 10 marks (2 outof4) 2X10=20

**Question paper type 2**

**Scheme of Examination:**

The external QP with 60 marks and internal examination is of 15 marks. Duration of each external examination is 2 Hrs. The pattern of External Examination is as given below. The students can answer all the questions in Sections A & B. But there shall be Ceiling in each section.

**Section A**

Short answer type carries 2 marks each -12 questions Ceiling -20

**Section B**

Paragraph/ Problem type carries 5 marks each -7 questions Ceiling -30

**Section C**

Essay type carries 10 marks (1 out of 2) 1X10=10

**Question paper type 1 (Advanced Level)**

**Scheme of Examinations:**

The external QP with 80 marks and internal examination is of 20 marks. Duration of each external examination is 2.5 Hrs. The pattern of External Examination is as given below.

**Section A**

Short answer type carries 2 marks each -12questions (10 out of 12) 10X2=20

**Section B**

Paragraph/ Problem type carries 8 marks each -7questions (5 out of 7) 5X8=40

**Section C**

Essay type carries 10 marks (2 outof4) 2X10=20

**Question paper type 2**

**Scheme of Examination:**

The external QP with 60 marks and internal examination is of 15 marks. Duration of each external examination is 2 Hrs. The pattern of External Examination is as given below.

**Section A**

Short answer type carries 2 marks each -12questions (9 out of 11) 9X2=18

**Section B**

Paragraph/ Problem type carries 8 marks each -6questions (4 out of 6) 4X8=32

**Section C**

Essay type carries 10 marks (1 out of 2) 1X10=10

## COURSE STRUCTURE - OPEN COURSE

**(For students other than Integrated M.Sc. Geology) Total Credits: 3**

**(Internal 20%; External 80%)**

| *Semester* | *Code No* | *Course Title* | *Hrs/ Week* | *Total Hrs* | *Marks* |
|---|---|---|---|---|---|
| V | GLO5ID01 | Open Course 1: Geoscience and Environment | 3 | 48 | 75 |
| | GLO5ID02 | Open Course 2: Disaster Management | | | |
| | GLO5ID03 | Open Course 3: Ground water exploration and Management | | | |

### OPEN COURSE EVALUATION AND GRADING

**Open Course: Evaluation Scheme**

The evaluation scheme contains two parts: *viz.*, internal evaluation and external evaluation.

### 1. INTERNAL EVALUATION

20% of the total marks in each course are for internal evaluation. The internal assessment shall be based on a predetermined transparent system involving written test, class room participation, assignment and seminar/viva in respect of theory courses.

**Table 1: Components of Evaluation**

| Sl. No. | Components | Mark |
|---|---|---|
| 1 | Class room participation (20%) | 3 |
| 2 | Test papers I (40%) | 6 |
| 3 | Assignment (20%) | 3 |
| 4 | Seminar (20%) | 3 |
| | **Total Marks** | **15** |

**Test Paper**

**Table 2: Pattern of Test Papers**

| *Duration* | *Pattern* | *Total number of questions* | *Number of questions to be answered* | *Marks for each question* | *Ceiling of Marks* |
|---|---|---|---|---|---|
| 1 Hour | Short answer | 6 | Up to 6 | 2 | 10 |
| | Paragraph | 4 | Up to 4 | 5 | 15 |
| | Essay | 2 | 1 | 10 | 10 |
| | | | | *Total Marks** | 35 |

*85% and above = 6, 65 to below 85% = 5, 55 to below 65% = 4, 45 to below 55% = 3, 35 to 45% = 2, below 35% = 1, Absent = 0 mark.

## 2. EXTERNAL EVALUATION

External evaluation carries 80% marks (60 marks). Examinations will be conducted at the end of each semester. Duration of each external examination is 2 Hours.

**Table 1: Pattern of Question Paper**

| *Duration* | *Pattern* | *Total number of questions* | *Number of questions to be answered* | *Marks for each question* | *Ceiling of Marks* |
|---|---|---|---|---|---|
| 2 Hours | Short answer | 12 | Up to 12 | 2 | 20 |
| | Paragraph | 7 | Up to 7 | 5 | 30 |
| | Essay | 2 | 1 | 10 | 10 |
| ***Total Marks*** | | | | | **60** |

# CORE COURSE: GEOLOGY
## (THEORY)

| SEMESTER I<br>Core Course 1<br>GLO1IB01 – EARTH AND ENVIRONMENT | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 4 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Memorize*** various concepts of geology and planet earth | Remember | PSO1 |
| CO2 | ***Define*** various concepts of minerals and Rocks | Remember | PSO1 |
| CO3 | ***Identify*** structural features | Analyze | PSO8 |
| CO4 | ***Discuss*** the concepts; ***classify*** causes and mitigation of natural hazards | Understand<br>Analyze | PSO2<br>PSO9 |
| CO5 | ***Make use of*** concepts and theories in in the context of current natural hazards like earthquake, volcanic eruption etc. | Apply | PSO5 |

**COURSE CONTENT**

| **Unit 1.** | **14 Hours** |
|---|---|
| 1.1. Geology and its perspective<br>1.2. Origin of Planets- Nebular hypothesis, Planetesimal hypothesis, Gaseous-Tidal Hypothesis; Binary star Hypothesis<br>1.3. Earth in relation to solar system, size, shape, mass, density and its development.<br>1.4. Age of the Earth – Determination of Earth's age, - Radioactive methods and non-radioactive methods.<br>1.5. Plate Tectonics: The Discovery of Plate Tectonics, The Mosaic of Plates, Rates and History of Plate Motions, The Engine of Plate Tectonics.<br>1.6. Geological Time scale: Eons; Eras; Periods; and Epochs | |
| **Unit 2.** | **10 Hours** |

| | |
|---|---|
| 2.1. Minerals: A brief introduction to minerals, The Atomic Structure of Minerals. Rock-Forming Minerals, Properties of Minerals.<br>2.2. Rocks: Types of rocks - brief introduction to Igneous, sedimentary and metamorphic rocks; Concept of rock cycle, Rock and Fossil Record. | |
| **Unit 3.** | **10 Hours** |
| 3.1. Brief Introduction about Folds, Faults, and other Records of Rock Deformation, Evolution of the Continents<br>3.2. Elementary ideas about outcrops, dip, strike, outlier, inlier and overlap | |
| **Unit 4.** | **15 Hours** |
| 4.1. Natural Hazards: Volcanism, Earthquakes, Tsunamis, Landslide<br>4.2. Issues relating to prediction, protection and mitigation.<br>4.3. Landscape - Tectonic and Climate Interaction | |
| **Unit 5.** | **15 Hours** |
| 5.1. Volcanoes – Classification based on Lava types; styles of eruptions – Landforms, Products - Global Distribution; Causes; Effects; Prediction<br>5.2. Mountains and Classification, Isostasy – Airy Theory, Pratt Theory, Heiskanen's Theory<br>5.3. Earthquakes – Properties of seismic waves; Magnitude and Intensity – Ritcher and Mercalli's Scales; Seismogram and Seismograph. Origin, distribution and prediction of earthquakes.<br>5.4. Tsunami – Origin and effects. | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents. |

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| **Short answer** | 12 | Up to 12 | 2 | **20** |
| **Paragraph** | 7 | Up to 7 | 5 | **30** |
| **Essay** | 2 | 1 | 10 | **10** |
| **Total** | | | | **60** |

**UNITS WISE MARK DISTRIBUTION**

| **Unit** | **Mark** |
|---|---|
| Unit 1. | 10 |
| Unit 2. | 10 |
| Unit 3. | 10 |
| Unit 4. | 15 |
| Unit 5. | 15 |

**REFERENCES:**


1. Frank Press Raymond Siever: Understanding Earth (3rd ed). W.H. Freeman and Company. New York. 2000
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4. Cox A. & Hart R.B.: Plate Tectonics How it works. Blackwell Scientific Publ. Co. Boston. 1986.
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6. Murck B.W., Skinner B.J & Porter S.C.: Dangerous Earth – An Introduction to Geologic Hazards John Wiley & Sons New York. 1996
7. Condie, K.C.: Earth as an Evolving Planetary System, 3rd Edition, Academic Press, USA. 2015
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9. Tarbuck, E.J. and Lutgens, F.K.: Earth: An Introduction to Physical Geology. 9th Edition, Pearson Education, Inc., New Jersey, USA. 2008
10. Wicander, R. and Monroe, J.: Essentials of Geology. 4th Edition, Thomson Learning Inc., USA. 2006

| SEMESTER II<br>Core Course 2<br>GLO2IB02– GEOMORPHOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 4 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Recognize*** different weathering processes. | Remember | PSO1 |
| CO2 | ***Predict*** geological action of different geological agents | Understand | PSO2 |
| CO3 | ***Integrate*** field methodologies | Create | PSO11 |

**COURSE CONTENT**

| **Unit 1.** | **15 Hours** |
|---|---|

1.1. Introduction: Fundamental concepts; Cycle of erosion; Base level.

1.2. Weathering: Factors influencing weathering Types - Physical: Expansion, crystal growth, thermal expansion, organic activity, colloidal plucking. Chemical: Hydration, hydrolysis, oxidation, carbonation and solution.

1.3. Products of Weathering, Soil and Soil Profile

1.4. Mass wasting: Conditions favoring mass wasting: lithology, stratigraphy, structure, topography, climate, organism etc. Slow flowage: creep, solifluction Rapid flowage: Earthflow, Mudflow, Debris avalanche Landslides: slump, slide, fall.

| **Unit 2.** | **14 Hours** |
|---|---|

2.1. Running water as a geological agent: Development of a typical stream-Drainage system consequent and subsequent streams - Drainage basin- Drainage Pattern- Geological work of stream, erosional and depositional fluvial landforms, Concept of base level, Peneplanation, Monadnocks, Stream terrace, Rejuvenation, Knick Point, Entrenched meanders.

2.2. Geological work of wind. Erosional and depositional landforms. Loess, types of dunes, Pedi planation, playas and inselbergs. Formation of deserts.

| **Unit 3.** | **14 Hours** |
|---|---|
| 3.1. Glaciers- Formation of glaciers- Types- Movements-Erosional and depositional landforms, Glacier landforms, glacial ages.<br>3.2. Underground water: occurrence, zone of aeration and saturation, Water table, Perched water table, porosity, permeability, Aquifers- confined and unconfined, aquicludes, aquitard and aquifuge. Artesian wells, Geyser and springs.<br>3.3. Erosional and depositional landscapes produced by action of ground water Origin of limestone caverns-Stalactite and stalagmites. Karst topography: Terra rosa, lapies, sinkholes, blind valley, natural bridge, tunnel. | |
| **Unit 4.** | **13 Hours** |
| 4.1. Oceans and Seas: Waves, tides and currents. Geological work of oceans. Classification of shore line and Coast, Shore line types<br>4.2. Description of continental margins, Continental Shelf-Continental slope submarine canyons- sea mount – Guyots, midocean ridges, trenches.<br>4.3. Coral reefs – types and origin.<br>4.4. Lakes and its types | |
| **Unit 5.** | **8 Hours** |
| 5.1. Field methodologies in Geology– Topographic Maps and its uses – Instruments – Clinometer, Brunton compass, Map Symbols, Toposheets,<br>5.2. GPS, Aerial Photographs, Satellite imageries | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br><br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br><br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.<br><br>**E content Delivery**: Videos of geomorphological features and their formation will help students to understand the concept more easily |

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| **Short answer** | 12 | Up to 12 | 2 | **20** |
| **Paragraph** | 7 | Up to 7 | 5 | **30** |
| **Essay** | 2 | 1 | 10 | **10** |
| **Total** | | | | **60** |

**UNITS WISE MARK DISTRIBUTION**

| **Units** | **Mark** |
|---|---|
| Unit 1. | 15 |
| Unit 2. | 12 |
| Unit 3. | 15 |
| Unit 4. | 10 |
| Unit 5. | 8 |

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1. Thornbury W.D. 1984, Principles of Geomorphology, First Willey Eastern Reprint, New Delhi.
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3. Avery T. E and Berlin G. L, 1992, Fundamentals of remote sensing and Air photo interpretation. McMillion Publishing Co., New York.
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8. Wicander, R. and Monroe, J., 2006. Essentials of Geology. 4th Edition, Thomson Learning Inc., USA.

| SEMESTER III<br>Core Course 3<br>GLO3IB03 – CRYSTALLOGRAPHY AND MINERALOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 4 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Memorize*** various concepts of mineralogy and crystallography | Remember | PSO1 |
| CO2 | ***Recognize*** face, form, Axis, symmetry and laws of crystallography. | Remember | PSO1 |
| CO3 | ***Recognize*** and ***determine*** Miller indices of crystallographic planes & directions. | Remember<br>Evaluate | PSO1<br>PSO10 |
| CO4 | ***Determine*** different symmetry class and morphological forms present in particular symmetry class. | Evaluate | PSO10 |
| CO5 | ***Distinguish*** mineral and describe physical properties and optical properties of given minerals. | Understand | PSO4 |
| CO6 | ***Memorize*** concepts of Polymorphism, pseudomorphism, isomorphism and solid solution | Remember | PSO1 |

**COURSE CONTENT**

| **Unit 1.** | **13 Hours** |
|---|---|
| 1.1. Crystallography – A brief introduction to scope and its applications.<br>1.2. Nature of crystals; crystalline and amorphous materials; polycrystalline materials; a brief introduction to Crystal systems.<br>1.3. Morphological characters of crystal – faces, forms, edges solid angles Interfacial angle<br>1.4. Symmetry elements – crystallographic axes, crystal notation, parameter system of | |

Weiss and Miller indices, axial ratio.

1.5. Laws of crystallography – law of constancy of symmetry, law of constancy of interfacial angles, law of rational indices.

1.6. Classification of crystals into systems and classes – Holohedral, Hemihedral, Hemimorphic and Enantiomorphic forms in crystals.

| **Unit 2.** | **14 Hours** |
|---|---|

2.1. Study of the symmetry elements and forms of the Normal, pyritohedral, tetrahedral and plagiohedral classes of cubic system with special reference to well-developed crystals of Galena, Spinel, Garnet, Flourite, Diamond, Pyrite, Tetrahedrite, Boracite and cuprite.

2.2. Study of symmetry elements and forms of Normal, Hemimorphic, Tripyramidal, Sphenoidal and Trapezphedral classes of Tetragonal system.

2.3. Study of the symmetry elements and forms of Normal, Hemimorphic, Tripyramidal, Trapezohedral, Rhombohedral, Rhombohedral Hemimorphic and Trapezohedral classes of Hexagonal system.

| **Unit 3.** | **13 Hours** |
|---|---|

3.1. Study of the symmetry elements and forms of the Normal and Sphenoidal classes of the Orthorhombic system.

3.2. Study of the symmetry elements and forms of the Normal classes of the Monoclinic and Triclinic systems.

3.3. Twin crystals – Definitions – Effects of Twinning – laws of twinning – composition plane, twinning plane and twinning axis, indices of twins – simple and repeated (polysynthetic twins), contact and penetration twins: secondary twins.

| **Unit 4.** | **10 Hours** |
|---|---|

4.1. Definition of Mineral and Mineraloid – Scope and aim of Mineralogy.

4.2. Crystal Coordination - the making of minerals

4.3. Classification and structural diversity of silicate minerals

| **Unit 5.** | **14 Hours** |
|---|---|

5.1. Compositional variation and coupled ionic substitution, Isomorphism, Polymorphism, Pseudomorphism, solid solution and ex- solution in minerals.

5.2. Physical properties of minerals Form, colour, streak, luster, Hardness, Cleavage, Fracture, Specific Gravity, Tenacity, transparency, Electrical and Magnetic properties- pyro and piezo electricity, Ferri-, Para-, and Diamagnetism.

| MODE OF TRANSACTION |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br><br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br><br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.<br><br>**E content Delivery**: Videos of 3D representation of crystals or minerals will help students to understand the concept more easily |

| MODE OF ASSESSMENT |
|---|
| **Internal Assessment (15 Marks)**<br><br>a. Classroom participation (20%): 3 Mark<br>b. Test papers I (40%): 6 Mark<br>c. Assignment (20%): 3 Mark<br>d. Seminar/ Viva (20%): 3 Mark |
| **External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21* |
| **PATTERN OF QUESTION PAPER** |

| Pattern | Total No. of questions | No. of questions to be answered | Marks for each question | Ceiling of Marks |
|---|---|---|---|---|
| **Short answer** | 12 | Up to 12 | 2 | **20** |
| **Paragraph** | 7 | Up to 7 | 5 | **30** |
| **Essay** | 2 | 1 | 10 | **10** |
| **Total** | | | | **60** |

| UNITS WISE MARK DISTRIBUTION | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 10 |
| Unit 2. | 15 |

| | |
|---|---|
| Unit 3. | 15 |
| Unit 4. | 10 |
| Unit 5. | 10 |

**REFERENCES:**


1. Borchardt-Ott, W: Crystallography– An Introduction. Springer Heidelberg, 355p, 2011
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3. Klen C., Hurlbut C.S.: Manual of Minerology, John Wiley & Sons, 1985.
4. Perkins D.:Mineralogy. Pearson Education (3Ed), 568 p,2015

| SEMESTER IV<br>Core Course 4<br>GLO4IB04 – OPTICAL AND DESCRIPTIVE MINERALOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 4 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Read*** physics of how light interacts with minerals. | Remember | PSO1 |
| CO2 | ***Demonstrate*** petrological microscope and classify isotropic and anisotropic minerals | Understand | PSO4 |
| CO3 | ***Identify*** uniaxial and biaxial indicatrices; | Analyze | PSO8 |
| CO4 | ***Differentiate*** minerals based on their optical properties in relation to indicatrices, absorption, pleochroism, extinction, birefringence; Interference figures | Analyze | PSO8 |

**COURSE CONTENT**

| **Unit 1.** | **13 Hours** |
|---|---|
| 1.1. Nature of light – Ordinary and polarized light; Refraction and reflection; Refractive index, Critical angle and Total internal reflection.<br>1.2. Double refraction – Plane Polarization by Reflection; Plane polarization by Refraction; Nicol Prism; Plane polarization by absorption.<br>1.3. Petrological microscope and its parts<br>1.4. Isotropic and anisotropic minerals - Optical properties. | |
| **Unit 2.** | **15 Hours** |
| 2.1. Characters of Uniaxial and biaxial minerals – Optic axis and optic axial angle; Acute and Obtuse Bisectrix; Optic sign of Uniaxial and Biaxial minerals; Uniaxial and Biaxial Indicatrix; Sign of elongation.<br>2.2. Extinction – Types, angles, determination, and applications in mineral identification. | |

| | |
|---|---|
| 2.3. Optical accessories and uses – Quartz wedge (Determination of order of Interference Colour), Gypsum plate and Mica plate (Determination of Fast and Slow vibration directions). | |
| **Unit 3.** | **12 Hours** |
| 3.1. Structure, Chemistry, Optical and Physical properties, Modes of occurrence and uses of the following groups of minerals: Olivine, Garnet, Epidote, Aluminium silicates, Pyroxene, and Amphibole. | |
| **Unit 4.** | **12 Hours** |
| 4.1. Structure, Chemistry, Optical and Physical properties, Modes of occurrence and uses of the following groups of minerals: Mica, Chlorite, Polymorph and varieties of Quartz, Feldspars, Feldspathoids and Spinel. | |
| **Unit 5.** | **12 Hours** |
| 5.1. Chemistry, Optical and Physical properties, Modes of occurrences and industrial uses of the following minerals: Scapolite, Cordierite, Talc, Serpentine, Steatite, Calcite, Dolomite, Topaz, Staurolite, Beryl, Tourmaline, Fluorite, Apatite, Zircon, Rutile, Sphene, Zeolites and Corundum. | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br><br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br><br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.<br><br>**E content Delivery**: Natural occurrence of minerals through videos and photos help students to relate the concept that learnt from the class to the real scenario |

| **MODE OF ASSESSMENT** |
|---|
| **Internal Assessment (15 Marks)**<br><br>a. Classroom participation (20%): 3 Mark |

| | |
|---|---|
| b. Test papers I (40%): | 6 Mark |
| c. Assignment (20%): | 3 Mark |
| d. Seminar/ Viva (20%): | 3 Mark |

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| Pattern | Total No. of questions | No. of questions to be answered | Marks for each question | Ceiling of Marks |
|---|---|---|---|---|
| **Short answer** | 12 | Up to 12 | 2 | **20** |
| **Paragraph** | 7 | Up to 7 | 5 | **30** |
| **Essay** | 2 | 1 | 10 | **10** |
| **Total** | | | | **60** |

**UNITS WISE MARK DISTRIBUTION**

| Units | Mark |
|---|---|
| Unit 1. | 13 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 13 |
| Unit 5. | 10 |

**REFERENCES:**


1. Dyar M.D., Gunter, M.E.:Mineralogy and Optical Mineralogy. Min. Soc. America, 705p, 2007.
2. Nesse W.D.: Introduction to Optical Mineralogy. Oxford University Press; 4 edition, 384p, 2012.
3. Pichler H., Riegraf C.S.: Rock-forming Minerals in Thin Section. Springer, 220 p, 2011.
4. Deer W.A., Howie R.A., Zussman J.: Introduction to the Rock-forming Minerals. Mineralogical Society of Great Britain & Ireland,510p, 2013

| SEMESTER V<br>Core Course 5<br>GLO5IB05 – IGNEOUS PETROLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 4 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Identify*** important structures and textures of igneous rocks. | Remember | PSO1 |
| CO2 | ***Classify*** igneous rocks | Understand | PSO4 |
| CO3 | ***Discuss*** the reasons for diversity in igneous rocks. | Understand | PSO4 |
| CO4 | ***Understand*** the crystallization behaviour and petrogenetic significance of magmas. | Understand | PSO4 |
| CO5 | ***Compare*** different rock types, their mineralogy, classification and occurrence | Evaluate | PSO10 |

**COURSE CONTENT**

| **Unit 1.** | **12 Hours** |
|---|---|
| 1.1. Composition and constitution of magmas – Primary and Parental Magmas.<br>1.2. Forms of Intrusive igneous rocks: Concordant forms - Sill, Laccolith, Lopolith and Phacolith, Discordant forms - Dykes, Cone Sheets, Volcanic neck, Ring dyke, Batholiths, Stocks, Bosses and bysmaliths.<br>1.3. Forms of Extrusive igneous rocks: Lava flows, Pyroclastic deposits - Agglomerate, Lapilli, volcanic ash and volcanic froth. | |
| **Unit 2.** | **13 Hours** |
| 2.1. Structures: vesicular and Amygdaloidal structures – block lava – Ropy lava – pillow structure – flow structure – sheet joints- mural jointing – columnar jointing – rift and grain.<br>2.2. Minor structures – Micro Structures– Reaction rims – orbicular structure – | |

| | |
|---|---|
| Spherulitic structure – Perlitic structures¬– Xenolithic structure<br>2.3. Textures: Definition and description - crystallinity: crystallites and microlites – Devitrification – Granularity – shapes of crystals, mutual relations – Equigranular textures: allotriomorphic, hypidiomorphic, Panidiomorphic. inequigranular Textures: porphyritic and Intergrowth texture – Trachytic texture – Intergrowth texture -Directive textures, Overgrowth textures, Reaction textures | |
| **Unit 3.** | **13 Hours** |
| 3.1. Classification: bases of classification – Genetic classification – classification based on colour index – based on the proportion of Alkali to plagioclase feldspars-based on silica saturation – based on alumina saturation<br>3.2. A short account of CIPW classification, Normative minerals, salic and femic groups – Merits and defects of CIPW classification<br>3.3. Tyrrel's tabular classification- IUGS classification. | |
| **Unit 4.** | **13 Hours** |
| 4.1. Reaction principle and Bowen's reaction series - Causes for the diversity of Igneous rocks<br>4.2. Magmatic Differentiation: Fractional Crystallization, Liquid immiscibility, Assimilation<br>4.3. Crystallization of Unicomponent magma<br>4.4. Crystallization and petrogenetic significance of Binary magmas: Diopside – Anorthite Eutectic system, Albite – Anorthite Solid-Solution system, Forsterite – Silica incongruent melting system and Ab- Or system. | |
| **Unit 5.** | **13 Hours** |
| 5.1. Study of Texture, Mineralogy, Classification, and Modes of occurrence of Granite, Granodiorite, Syenite, Diorite, Gabbro with their hypabyssal and volcanic equivalents.<br>5.2. Petrographic characters and origin of Pegmatites, Lamprophyres, Alkaline rocks, Dunite, Peridotite and Anorthosites | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the |

course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| **Short answer** | 12 | Up to 12 | 2 | **20** |
| **Paragraph** | 7 | Up to 7 | 5 | **30** |
| **Essay** | 2 | 1 | 10 | **10** |
| **Total** | | | | **60** |

**UNITS WISE MARK DISTRIBUTION**

| **Units** | **Mark** |
|---|---|
| Unit 1. | 12 |
| Unit 2. | 14 |
| Unit 3. | 12 |
| Unit 4. | 14 |
| Unit 5. | 08 |

**REFERENCES:**

1. Frost, B.R., Frost, C.D., 2014. Essentials of Igneous and Metamorphic Petrology. Cambridge University Pres. 318 p.

2. Raymond, L.A., 2002. Petrology: The Study of Igneous, Sedimentary and Metamorphic Rocks, 720p.
3. Winter, J.D., 2009. Principles of Igneous and Metamorphic Petrology. Pearson, 720 p.

| SEMESTER V<br>Core Course 6<br>GLO5IB06 – METAMORPHIC PETROLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Identify*** and define basic concept, factors and types of metamorphism | Remember | PSO1 |
| CO2 | ***Classify*** different structures and textures of metamorphic rocks | Understand | PSO4 |
| CO3 | ***Discuss*** different metamorphic grades and facies | Understand | PSO4 |
| CO4 | ***Understand*** petrography and origin of various metamorphic rocks | Understand | PSO4 |

**COURSE CONTENT**

| **Unit 1.** | **12 Hours** |
|---|---|
| 1.1. Metamorphism – Definition; limits of metamorphism (low and high T/P limits and influence of water and bulk compositions on metamorphic limits).<br>1.2. Variables of metamorphism – temperature, lithostatic pressure, deviatoric stress, fluids.<br>1.3. Types of metamorphism – classification based on the principal agents (thermal, dynamic, dynamo-thermal, hydrothermal); based on geological setting – contact, shock, high-strain, regional (burial, ocean-ridge, orogenic); based on plate tectonic setting – metamorphism at convergent, divergent, and transform plate margins.<br>1.4. Fault-zone and impact metamorphism | |
| **Unit 2.** | **12 Hours** |
| 2.1. Classification of metamorphic rocks: foliated and lineated; non-foliated and non-lineated; specific rock groups (Quartzite, Greenstone, Amphibolite, Serpentinite, Calc- silicate, Skarn) | |

| | |
|---|---|
| 2.2. Metamorphic structures – fabric, layer, foliation, schistosity, cleavage, gneissosity, lineations.<br>2.3. Metamorphic textures – augen, cataclastic, corona, decussate, epitaxial, flaser, granoblastic, lepidoblastic, megacrystic, nematoblastic, poikiloblastic, porphyroblastic, strain shadow, symplectite, and relict textures.<br>2.4. Equilibrium mineral assemblages; Introduction to chemographic diagrams: ACF, AKF Diagrams | |
| **Unit 3.** | **8 Hours** |
| 3.1. Metamorphic grades and isograds; mineral zones and Barrowian sequence;<br>3.2. Metamorphic facies – zeolite, prehnite-pumpellyite, greenschist, epidote-amphibolite, amphibolite, granulite, blueschist, eclogite, and contact metamorphic facies<br>3.3. Facies series and plate tectonics – paired metamorphic belts. | |
| **Unit 4.** | **8 Hours** |
| 4.1. Metamorphic effects on – argillaceous (medium P-T Barrovian); calcareous (contact metamorphism); basic igneous (regional metamorphism) rocks<br>4.2. Petrography and origin of slate, phyllite, chlorite schist, kyanite schist, biotite schist, biotite gneiss, hornblende gneiss, amphibolite, marble, charnockite, eclogite, and mylonite | |
| **Unit 5.** | **8 Hours** |
| 5.1. Prograde and retrograde metamorphism<br>5.2. Nature of metamorphic fluids and metasomatism<br>5.3. Anatexis and migmatites; metamorphic differentiation. | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br><br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br><br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents. |

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| Short answer | 12 | Up to 12 | 2 | 20 |
| Paragraph | 7 | Up to 7 | 5 | 30 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

**UNITS WISE MARK DISTRIBUTION**

| **Units** | **Mark** |
|---|---|
| Unit 1. | 12 |
| Unit 2. | 14 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 10 |

**REFERENCES:**


1. Barker, A.J., 1990. Introduction to Metamorphic Textures and Microstructures. Blackie, 162p.
2. Bucher, K. and Grapes, R., 2011. Petrogenesis of Metamorphic Rocks. Springer-Verlag, Berlin-Heidelberg, 428p.

3. Frost, C.D., Frost, B.R, 2013. Essentials of Igneous and Metamorphic Petrology, Cambridge University Press, 336p.
4. Kretz, R., 1994. Metamorphic Crystallization. John Wiley & Sons, 507p.
5. Miyashiro, A., 1978. Metamorphism and Metamorphic Belts. 3rd Edition. George Allen & Unwin, London, 492p.
6. Vernon, R.H. and Clarke, G.L., 2008. Principles of Metamorphic Petrology. Cambridge University Press, 446p.
7. Winter, J.D., 2011. Principles of Igneous and Metamorphic Petrology, Prentice-Hall, 728p.

| SEMESTER V<br>Core Course 7<br>GLO5IB07 – SEDIMENTARY PETROLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Identify*** broad classification of sedimentary rocks. | Remember | PSO1 |
| CO2 | ***Classify*** different sedimentary structures | Understand | PSO4 |
| CO3 | ***Discuss*** different rock types, their Mineralogy, classification and origin | Understand | PSO4 |

**COURSE CONTENT**

| **Unit 1.** | **10 Hours** |
|---|---|
| 1.1. Origin of sediments<br>1.2. Weathering and sedimentary flux: Physical and chemical weathering,<br>1.3. Soils and paleosols. | |
| **Unit 2.** | **8 Hours** |
| 2.1. Sediment granulometry, Grain size scale, particle size distribution, Environmental connotation; particle shape and fabric | |
| **Unit 3.** | **12 Hours** |
| 3.1. Sedimentary textures, structures and environment;sediment transport and sedimentary structures:<br>3.2. Fluid flow-Types of fluids, Laminar vs. turbulent flow, Particle entrainment, transport and deposition.<br>3.3. Paleocurrent analysis- Paleocurrents for different sedimentary environments Sedimentary structure- Primary and syn-sedimentary structures | |

| **Unit 4.** | **10 Hours** |
|---|---|
| 4.1. Varieties of sedimentary rocks<br>4.2. Siliciclastic rocks: Conglomerates, Sandstones and its classification, Mudrocks.<br>4.3. Carbonate rocks: controls of carbonate deposition, components and classification of limestone, dolomite and dolomitisation | |
| **Unit 5.** | **8 Hours** |
| 5.1. Diagenesis: concepts of diagenesis, stages of diagenesis, compaction and cementation. | |

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| Short answer | 12 | Up to 12 | 2 | 20 |
| Paragraph | 7 | Up to 7 | 5 | 30 |

| | | | | |
|---|---|---|---|---|
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 10 |
| Unit 2. | 10 |
| Unit 3. | 13 |
| Unit 4. | 15 |
| Unit 5. | 12 |

**REFERENCES:**


1. Prothero, D. R., & Schwab, F. 2004. Sedimentary geology. Macmillan.
2. Tucker, M. E. 2006 Sedimenary 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

| SEMESTER V<br>Core Course 8<br>GLO5IB08 – STRUCTURAL GEOLOGY AND GEOTECTONICS | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 4 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Discuss*** different types of rock deformation, associated pressure temperature conditions, stages of deformation. | Understand | PSO4 |
| CO2 | ***Explain*** geometric and genetic classification of different structures and associated deformation mechanism. | Understand | PSO4 |
| CO3 | ***Distinguish*** different tectonic deformation structures in Earth surface | Analyze | PSO8 |

**COURSE CONTENT**

| **Unit 1.** | **12 Hours** |
|---|---|
| 1.1. Concept of force and stress. Normal stress and shear Stress. Stress components. Hydrostatic and deviatoric stresses.<br>1.2. Concept of strain. Nature of strain. Pure shear and simple shear. Concept of strain ellipsoid. Behaviour of materials under stress.<br>1.3. Concept of deformation. Elastic and plastic behaviour of rocks. Brittle and ductile deformation. | |
| **Unit 2.** | **14 Hours** |
| 2.1. Folds: Basic fold geometry, nomenclature and definitions.<br>2.2. Classification of folds. Describing folds. Interference and superposition of folds. Folds and ductile deformation.<br>2.3. Unconformity: Concept of unconformity, types of unconformity, criteria of recognition, significance of unconformity | |
| **Unit 3.** | **14 Hours** |

3.1. Faults: Fault geometry, nomenclature and definitions,
3.2. Classification of faults, Features associated with fault plane, criteria for recognizing fault in field. Faulting and earthquakes.
3.3. Concept of Shear zone.

| **Unit 4.** | **12 Hours** |
|---|---|

4.1. Joints: Nomenclature and definitions related to joints and the structures related to joints. Classification of joints.
4.2. Linear structures: Lineations, cleavages and foliations. Morphology and description of lineations and cleavages, cleavages on different scales.
4.3. Significance of linear structures.

| **Unit 5.** | **12 Hours** |
|---|---|

5.1. Introduction to plate-tectonics, Historical development of the concept of plate-tectonics
5.2. Continental drift, Sea-floor spreading; Concept of lithosphere and lithospheric plates. Nature of plate boundaries. Hot-spots and mantle plumes.
5.3. Geological structures associated with different plate boundaries, Continents and Oceans, Mountain ranges, Oceanic ridges and trenches, Stable and unstable tectonic zones.
5.4. Tectonics of Indian plate. Brief study of origin of Himalayas.

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark

| | | | | |
|---|---|---|---|---|
| c. Assignment (20%): 3 Mark<br>d. Seminar/ Viva (20%): 3 Mark | | | | |
| **External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21* | | | | |
| **PATTERN OF QUESTION PAPER** | | | | |
| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
| Short answer | 12 | Up to 12 | 2 | 20 |
| Paragraph | 7 | Up to 7 | 5 | 30 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 10 |
| Unit 2. | 15 |
| Unit 3. | 15 |
| Unit 4. | 10 |
| Unit 5. | 10 |

**REFERENCES:**


1. Billings M P, Structural Geology, Pearson Education, 624pp
2. Davis, G.H., Reynolds, S.J., 1996, Structural geology of rocks and regions, 2nd Edition, John Wiley & sons.
3. Hamblin, W.K., Christiansen, E.H. 2003, Earth Dynamic Systems, 10th Edition, Prentice Hall.
4. Turcotte, D.L., & Schubert, G., 2001, Geodynamics 2nd Edition, Cambridge University Press
5. Pollard, D.D. & Fletcher, R.C. 2005, Fundamentals of Structural Geology, CambridgeUniversity Press

6. Park, R. G., 1983, Foundations of structural Geology, Blackie Academic and Professional
7. Ramsay, J.G. & Huber, M.I. 1984, The Techniques of Modern Structural Geology, Vol 1: Strain Analysis, Academic Press
8. Ramsay, J.G. & Huber, M.I. 1987, The Techniques of Modern Structural Geology, Vol 2: Folds and Fractures, Academic Press.
9. Moores, E.M., Twiss, R.J. 1995, Tectonics,W.H. Freeman
10. Ragan, D. M. (2009) Structural Geology: an introduction to geometrical techniques ($4^{th}$ Ed). Cambridge University Press (For Practical).

| SEMESTER VI<br>Core Course 9<br>GLO6IB09 – ECONOMIC GEOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 4 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Classify*** different mineral deposits in earth. | Understand | PSO4 |
| CO2 | ***Outline*** how prevailing geological features controls ore deposition and also serve as tools to find hidden treasure | Apply | PSO6 |
| CO3 | ***Reconstruct*** the formation of mineral deposits. | Create | PSO8 |
| CO4 | ***Survey*** the mineral deposits of India | Analyze | PSO5 |
| CO5 | ***Discover*** the formation and different aspects related to Coal, crude oil and natural gas | Apply | PSO6 |

**COURSE CONTENT**

| **Unit 1.** | **12 Hours** |
|---|---|
| 1.1. Historical development of economic Geology.<br>1.2. Geochemical distribution of elements.<br>1.3. Materials of mineral deposits – ore minerals, gangue minerals, tenor and grade of ores, ore shoots and bonanzas.<br>1.4. Classification of mineral deposits. Outline of Lindgren's and Bateman's classification-Syngenetic and epigenetic deposits.<br>1.5. Controls of ore localization – structural, stratigraphic, physical and chemical.<br>1.6. Brief study of metallogenic epochs and provinces – geologic thermometers. | |
| **Unit 2.** | **14 Hours** |

2.1. Magmatic processes. – mode of formation – Early magmatic processes and deposits, disseminations, segregations and injections – Late magmatic processes and deposits – Residual liquid segregation and injection – immiscible liquid segregation and injection – sublimation.

2.2. Contact Metasomatic processes – the process and effects – resulting mineral deposits.

2.3. Hydrothermal processes – principles – Factors affecting deposition – wall rock alteration – minerals sequence – cavity filling deposits Fissure veins, shear – zone, stock-work, saddle reef, ladder vein, fold cracks, breccia filling, solution cavities, pore space and vesicular filling – replacement deposits- process and deposits – criteria of replacement.

| **Unit 3.** | **14 Hours** |
|---|---|

3.1. Sedimentary processes and cycles – principles involved in sedimentation – cycles of Iron and manganese

3.2. Weathering processes – principles- Residual concentration process and deposits – mechanical concentration principles – eluvial, alluvial, beach and eolian placers.

3.3. Oxidation and supergene sulphide enrichment – solution and deposition in the zone of oxidation – secondary sulphide enrichments – Gossans and capping.

3.4. Metamorphic processes – Formation of Graphite, Asbestos, Talc, Soapstone and Sillimanite group of minerals.

| **Unit 4.** | **14 Hours** |
|---|---|

4.1. Diagnostic physical properties, chemical composition, uses, modes of occurrence and distribution in India of the following:

4.2. Economic Minerals- Gold, Silver, Copper, Lead, Zinc, Iron, Manganese, Chromium, Tin, Aluminium

4.3. Radioactive metals - Thorium, Uranium, Titanium.

4.4. Industrial Minerals- Asbestos, Barite, Graphite, Gypsum and Mica.

4.5. Abrasives- Diamond, Corundum, Emery garnet, Abrasive sand, Tripoli, Pumice, Sand feldspar, Limestone, Clay, Talc etc.

4.6. Refractories- fireclay, graphite, Dolomite and sillimanite group of minerals, diaspore, pyrophillite, zircon etc

4.7. Ceramic minerals- Clay, Feldspar, Wollastonite,

4.8. Gemstones.

| **Unit 5.** | **10 Hours** |
|---|---|

5.1. Fossil fuels – coal and lignite – uses, classification, constitution, origin and distribution in India.

5.2. Petroleum- composition, uses, theories of origin, oil traps, and important oil fields of India.

5.3. A brief account of mineral deposits in Kerala.
5.4. Significance of minerals in the National Economy. Strategic, critical and essential minerals.

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| Short answer | 12 | Up to 12 | 2 | 20 |
| Paragraph | 7 | Up to 7 | 5 | 30 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

**UNITS WISE MARK DISTRIBUTION**

| **Units** | **Mark** |
|---|---|

| | |
|---|---|
| Unit 1. | 10 |
| Unit 2. | 13 |
| Unit 3. | 13 |
| Unit 4. | 14 |
| Unit 5. | 10 |

**REFERENCES:**


1. Gokhale and Rao. 1973. Ore deposits of India. Thomson Press (India), Publication Division, Delhi
2. Mead. L.Jensen and Alan M.Bateman. 1981. Economic Mineral Deposits. John Wiley and Sons, New York
3. Krishnaswamy, S. 1972. Indian Mineral Resources.Oxford & IBH Pub. Co. New Delhi
4. Park C. F and Macdiarmid. 1964. Ore deposits. W.H. Freeman and CO
5. Umeshwar Prasad. 2006. Economic geology. CBS Publishers, New Delhi.

| SEMESTER VI<br>Core Course 10<br>GLO6IB10 – PALAEONTOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 4 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Describe*** different methods of fossil preservation and uses of fossils | Remember | PSO1 |
| CO2 | ***Explain*** morphology, classification and importance of foraminifera | Understand | PSO3 |
| CO3 | ***Distinguish*** morphology, classification of different Phylum – Coelenterate, Hemichordata, Mollusca, Gastropoda, Cephalopoda, Brachiopoda, Echinodermta and Arthropoda | Understand | PSO3 |
| CO4 | ***Survey*** different plant fossils in India. | Analyze | PSO7 |

**COURSE CONTENT**

| **Unit 1.** | **10 Hours** |
|---|---|
| 1.1. An outline of life through ages, its evolution and distribution<br>1.2. Definition of Palaeontology – organic world – classificationof animals– Habitats and habits of animals - Flora and Fauna – vertebrates and invertebrates<br>1.3. Definition of fossils – nature and modes of preservation of fossils: Unaltered hard parts: Altered hard parts : Petrifaction, permineralisation, carbonisation, recrystallisation, silicification , mould, casts, tracks , trails, borings,<br>1.4. Uses of fossils – stratigraphic indicators – climatic indicators- indicators of palaeogeography – indicators of evolution and migration of life forms – indicators of new deposits of coal and petroleum. | |
| **Unit 2.** | **14 Hours** |

2.1. Phylum protozoa – Order: Foraminifera: General morphology – chitinous test – septa, arrangement of chambers, suture, aperture, dimorphism – classification, geological history and stratigraphic importance.

2.2. Phylum coelenterata – class Anthozoa – zoological features – General morphology: corallum, corallite , theca , chambers, septa, fossula, columella, septal developments, classification – tabulate corals – Rugose corals evolution geological distribution – stratigraphic importance.

2.3. Sub phylum Hemichordata – class Graptozoa: order Dendroidea and Graptoloidea – general morphology , rhabdosome, stipe, theca , common canal , nema , virgula , sicula, angle of divergence, central disc, uniserial, biserial, classification, geological distribution and stratigraphic importance.

| **Unit 3.** | **14 Hours** |
|---|---|

3.1. Phylum mollusca: Class Pelecypoda:- General characters – umbo, Hinge line – ligament – lunule and escutcheon – adductor impressions, pallial line, pallial sinus, dental patterns, ornamentation, classification, geological history

3.2. Class Gastropoda:- General morphology, shell forms, whorl, spire, spiral angle, suture, aperture, columella, umbilicus , peristome , aperture , (Holostomatus and siphonostomatus ) – types of coiling – Dextral and sinistral – ornamentation , classification and geological history

3.3. Class Cephalopoda:- General morphology , siphuncle, septa, septal necks, connecting ringes, chambers, suture lines, (Nautilitic , Goniotitic , Ceratitic and Ammonitic) – shell forms – ornamentation – classification, geological history- morphology of a Belemnite shell.

| **Unit 4.** | **14 Hours** |
|---|---|

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

4.2. Phylum Echinodermata: - Class Echinoidea:- General morphology, periproct, apical system (Anus, ocular plates, Genetal plates, madriporic plates), corona (Ambulacra , inter ambulacra) – peristome – Regular and irregular echinoids – classification – geologicial history.

4.3. Class Crinoidea:- General morphology , calyx , dorsal cup, (Radicals , basals, intrabasals), arms, stem, classification, geological history. Class Blastoidea: - General morphology – calyx, dorsal cup (Basals, radials, deltoids, ambulacra). Brachioles, cicatrix, geological history

| **Unit 5.** | **12 Hours** |
|---|---|

5.1. Phylum Arthropoda: - Class – Trilobita- General morphology: Cephalon: glabella, facial suture, free cheek, fixed cheek, genal angle, genal spine, cranadium; thorax – pygidium – classification – geological history.

5.2. Brief account of Siwalik vertebrate fossils

5.3. General classification of plant kingdom – plant fossils from India – A brief account of the following plant fossils:- Glossopteris , Gangamopteris , Ptilophyllum , Calamites, Lepididendron and Sigillaria.

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| Short answer | 12 | Up to 12 | 2 | 20 |
| Paragraph | 7 | Up to 7 | 5 | 30 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

| UNITS WISE MARK DISTRIBUTION | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 10 |
| Unit 2. | 13 |
| Unit 3. | 14 |
| Unit 4. | 13 |
| Unit 5. | 10 |

**REFERENCES:**


1. Henry woods: Invertebrate palaeontolgy – Cambridge.
2. Romer, A.S.: Vertebrate palaeontology, Chicago press.
3. Arnold, C.A., An introduction to Palaeobotany., MC-Graw Hill.
4. B.U. Haq and A. Boersma (1978) Introduction to marine Micropalaeontology. Elsevier, Netherlands
5. Raup, D.M. and Stanely, M.S.: Principles of Palaeontology, CBS Publishers.
6. Moore, R.C., Laliker , C.G.& Fishcher, A.G.: Invertebrate Fossils , Harper brothers
7. Shrock. R.R. and Twenhofel , W.H – 1953 : Principles of invertebrate Palaeontology, Amold publication

| SEMESTER VI<br>Core Course 11<br>GLO6IB11 – STRATIGRAPHY AND INDIAN GEOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 4 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Describe*** various stratigraphic laws & physical and biological criteria of correlation | Remember | PSO1 |
| CO2 | ***Interrelate*** the stratigraphic distribution of India | Understand | PSO3 |
| CO3 | ***Discuss*** stratigraphy and geology of Kerala | Understand | PSO3 |

**COURSE CONTENT**

| **Unit 1.** | **12 Hours** |
|---|---|
| 1.1. Scope of the subject, its relationship with other disciplines.<br>1.2. Principles of stratigraphy.<br>1.3. Indian Time Scale<br>1.4. Correlation, facies and unconformities. | |
| **Unit 2.** | **14 Hours** |
| 2.1. Facies and facial changes-litho and bio facies- break in stratigraphic records - diastems.<br>2.2. Stratigraphic classification. Walters law<br>2.3. BiostratigraphIc classification- Biozones, biohorizon, index fossil.<br>2.4. Range zone- Taxon range zone concurrent range zone, interval zone, assemblage zone, Acme zone.<br>2.5. Lithostratigraphic classification Group, Formation, Member, Bed.<br>2.6. Chronostratigraphic classification- Eonothem, erathem, system, series, stage. | |
| **Unit 3.** | **13 Hours** |
| 3.1. Early Precambrian Stratigraphy: concept of craton, mobile belt, shield area, Sargur supracrustals; Tectonic frame work of south India; Dharwar Supergroup; Aravalli | |

| | |
|---|---|
| Supergroup<br>3.2. Late Precambrian Stratigraphy: Delhi Supergroup, Cudappah Supergroup, Vindhyan Super group. Brief study of Singhbhum craton, Sausar and Sakoli group | |
| **Unit 4.** | **13 Hours** |
| 4.1. Cambrain of Salt Range and Paleozoic rocks of Kashmir Valley, Spiti Valley and Pensinsular India<br>4.2. Gondwana Supergroup – their classification, lithology, fossils and distribution in India.<br>4.3. Brief knowledge on distribution, lithology, fossil content and classification of Triassic of Spiti, Jurassic of Kutch and Cretaceous of Tiruchirappali. | |
| **Unit 5.** | **12 Hours** |
| 5.1. Deccan Traps – Intra and Inter trapeans – Origin, composition, distribution.<br>5.2. Stratigraphy of Siwalik system, fauna and flora of Siwaliks<br>5.3. Tertiary rocks of Assam, Karewa formation<br>5.4. Tertiary rocks of Tamil Nadu<br>5.5. Stratigraphy and Geology of Kerala | |

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

| **External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21* | | | | |
|---|---|---|---|---|
| **PATTERN OF QUESTION PAPER** | | | | |
| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
| Short answer | 12 | Up to 12 | 2 | 20 |
| Paragraph | 7 | Up to 7 | 5 | 30 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 10 |
| Unit 2. | 12 |
| Unit 3. | 13 |
| Unit 4. | 13 |
| Unit 5. | 12 |

**REFERENCES:**


1. Lemon, R.R .1990. Principles of stratigraphy.. Merrill Publ. New York
2. Boggs, S.1987. Principles of Sedimentology and Stratigraphy, Merrill, New York.
3. Krishnan, M.S. 1982. Geology of India and Burma. CBS publishers, New Delhi
4. Vaidyanathan R and Ramakrishnan M. 2008. Geology of India, GSI Publications.
5. Soman, K.(1997): Geology of Kerala, Geological society of India publications

| SEMESTER VII<br>Core Course 12<br>GLO7IB12 – ADVANCED CRYSTALLOGRAPHY AND MINERALOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 4 | 5 | 20 | 80 | 100 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Memorize*** the mineralogical composition of Crust and Mantle | Remember | PSO1 |
| CO2 | ***Use*** of Crystal notations (Schoenflies notation, Herman Maugin) | Apply | PSO5 |
| CO3 | ***Utilize*** petrological microsope for conoscopic observation of minerals | Analyze | PSO8 |
| CO4 | ***Derive*** 32 crystal classes and stereographic projections | Create | PSO12 |

**COURSE CONTENT**

| **Unit 1.** | **16 Hours** |
|---|---|
| 1.1. Crystallography: Derivation and determination of point groups.<br>1.2. Concept of space group. Crystalline state-Repetition theory. Translation periodicity of crystals. Basic rotational symmetries and possibility of simultaneous rotational symmetries in different directions of crystals-symmetrical plane and symmetrical lattices.<br>1.3. Derivation of 32 crystal classes. Stereographic projection of crystals. Crystal notation- Schoenflies notation. Herman Mauguin symbols-comparison between Schoenflies and International notations. Calculation of crystal elements to test the knowledge of the application of tangent relation, anharmonic ratios, Napier;s theorem and equation of the normal. | |
| **Unit 2.** | **16 Hours** |
| 2.1. Conoscopic observations of minerals under petrological microscope:<br>2.2. Formation of interference figures; Uniaxial and biaxial interference figures | |

| | |
|---|---|
| 2.3. Determination of the Optic sign of uniaxial and biaxial minerals, Optical indicatrix of uniaxial and biaxial minerals.<br>2.4. Vibration directions and sign of elongation in minerals. Extinction and extinction angle. Determination of Optic axial angle (2V). | |
| **Unit 3.** | **16 Hours** |
| 3.1. Mineralogical expression of radioactivity – metamictization, fracturing, discoloration, pleochroic haloes and fission tracks<br>3.2. Chemical classification of minerals. XRD, ICPMS, Electron probe micro analysis (EPMA), Scanning and transmission electron microscopy. | |
| **Unit 4.** | **16 Hours** |
| 4.1. Rock and Ore forming minerals: Structure, chemistry, P-T stabilities, paragenesis and mode of alteration of silicates, oxides, carbonates, phosphates, sulphates and halides. | |
| **Unit 5.** | **16 Hours** |
| 5.1. Earth mineralogy: Average mineralogical composition of crust and mantle.<br>5.2. Mineral transformations in the mantle with depth. | |

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (20 Marks)**

a. Classroom participation (20%): 4 Mark
b. Test papers I (40%): 8 Mark
c. Assignment (20%): 4 Mark

| |
|---|
| d. Seminar/ Viva (20%): 4 Mark |
| **External Assessment (80 Marks)** *Duration 2.5 Hours, No of Questions: 27* |
| **PATTERN OF QUESTION PAPER** |

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| Short answer | 15 | Up to 15 | 2 | 25 |
| Paragraph | 8 | Up to 8 | 5 | 35 |
| Essay | 4 | 2 | 10 | 20 |
| **Total** | | | | **80** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 16 |
| Unit 2. | 15 |
| Unit 3. | 15 |
| Unit 4. | 17 |
| Unit 5. | 17 |

**REFERENCES:**


1. Deer, W.A., Howie, R.A. & Zussman, J. 1962. Rock forming minerals. Vol. 1 to 5, Longmans, London.
2. Blackburn, W.H. & Dennen, W.H. 1988. Principles of mineralogy. WCM Publishers, Iowa.
3. Kerr, P.F. 1959. Optical mineralogy.3rd edition. McGraw Hill, New York.
4. Winchell, A.N. & Winchell, H. 1951. Elements of optical mineralogy. Part II. 4th edition. Wiley, New York.

| SEMESTER VII<br>Core Course 13<br>GLO7IB13 – ADVANCED GEOMORPHOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 4 | 4 | 20 | 80 | 100 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Explain*** Various geomorphological principles and processes | Understand | PSO3 |
| CO2 | ***Summarize*** Tectonic geomorphology | Understand | PSO2 |
| CO3 | ***Classify*** Geomorphic features of India and Kerala | Understand | PSO2 |
| CO4 | ***Identify*** Practical Applications of geomorphological studies in various fields | Analyze | PSO2 |

**COURSE CONTENT**

| **Unit 1.** | **12 Hours** |
|---|---|
| 1.1. Introduction: geomorphic principles and processes.<br>1.2. Theory of uniformitarianism, Control of geomorphological features by geological structures, lithology, diastrophism, climate and time.<br>1.3. Anthropogenic effects on geomorphic processes<br>1.4. Ocean Basin Shape: Heat Conduction; Ocean Basin Shape<br>1.5. Contraction and Isostasy | |
| **Unit 2.** | **13 Hours** |
| 2.1. Tectonic Geomorphology: Crustal Change and Faulting - Crustal Thickening, Erosion, and Mantle Response; Fault-Scale Tectonic Deformation<br>2.2. Deformation and Flexure - Paleo seismology; Geomorphic Evidence of Long-term Deformation; Flexure of the Lithosphere | |
| **Unit 3.** | **13 Hours** |

| | |
|---|---|
| 3.1. Hillslopes: forms relation to lithology and structural weakness in rock, environmental control and mass movement, modification by overland flow of hillslopes.<br>3.2. Applied Geomorphology: Application of Geomorphology in Civil Engineering, Hydrogeology, and Environmental Studies | |
| **Unit 4.** | **13 Hours** |
| 4.1. Wetlands Geological significance, classification and mode of formation. The Indian scenario conservation and management in India. Backwaters (Kayals) of Kerala.<br>4.2. Soils formation, classification, soil profile, soils of Kerala.<br>4.3. Geomorphology of Kerala classification, relief features, geological Significance, rivers of Kerala. | |
| **Unit 5.** | **13 Hours** |
| 5.1. Geomorphic features of India: Extra-Peninsular region, Indo-Gangetic plain and Peninsula - their geomorphic evolution.<br>5.2. Environmental geomorphology: elementary concept. | |

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (20 Marks)**

a. Classroom participation (20%): 4 Mark
b. Test papers I (40%): 8 Mark
c. Assignment (20%): 4 Mark
d. Seminar/ Viva (20%): 4 Mark

| **External Assessment (80 Marks)** *Duration 2.5 Hours, No of Questions: 27* | | | | |
|---|---|---|---|---|
| **PATTERN OF QUESTION PAPER** | | | | |
| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
| Short answer | 15 | Up to 15 | 2 | 25 |
| Paragraph | 8 | Up to 8 | 5 | 35 |
| Essay | 4 | 2 | 10 | 20 |
| **Total** | | | | **80** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 16 |
| Unit 2. | 16 |
| Unit 3. | 16 |
| Unit 4. | 17 |
| Unit 5. | 15 |

**REFERENCES:**


1. W.D. Thornbury (1969) Principles of Geomorphology. Wiley Eastern Ltd. New Delhi.
2. H.S. Sharma (1990) Indian Geomorphology.Concept Pub. Co., New Delhi.
3. L.B.Leopold (1976) FluviaL processes in geomorphology. E.P.H.Publishing House, New Delhi.
4. Duff, P.Mc L. D. (Ed) (1992) Holmes principles of physical geology. 4th edition, Chapman & Hall, London.
5. Anderson, R.S. & S.P. Anderson, 2010, Mechanics and Chemistry of Landscapes, Cambridge University Press.
6. Anderson, R.S., The Little Book of Geomorphology - available as a ~15MB download from:http://instaar.colorado.edu/~andersrs/The_little_book_010708_print.pdf

| SEMESTER VII<br>Core Course 14<br>GLO7IB14 – ADVANCED IGNEOUS AND METAMORPHIC PETROLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 4 | 5 | 20 | 80 | 100 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Explain*** the significance of texture and structure of igneous rocks | Understand | PSO3 |
| CO2 | ***Illustrate*** Phase rule | Understand | PSO3 |
| CO3 | ***Appraise*** Phase diagram to understand the course of crystallization of various chemical systems | Evaluate | PSO10 |
| CO4 | ***Classify*** the igneous rocks | Apply | PSO5 |
| CO5 | ***Revise*** the metamorphism process in space and time | Create | PSO12 |

**COURSE CONTENT**

| **Unit 1.** | **16 Hours** |
|---|---|
| 1.1. Introduction: Concept of heat and temperature inside the Earth. Melting and crystallization.<br>1.2. Magma and magmatic processes.<br>1.3. Major, minor, trace and rare earth element geochemistry of igneous rocks.<br>1.4. Significance of isotopic studies in the petrogenesis of igneous rocks.<br>1.5. Genetic significance of the textures and structures of the igneous rocks. | |
| **Unit 2.** | **16 Hours** |
| 2.1. Classification of igneous rocks- concept of mode and norm,<br>2.2. Differentiation Index IUGS diagrams, TAS classification of volcanic rocks.<br>2.3. Mineralogical and chemical description and significance of important igneous rocks of continental and oceanic association. | |

| **Unit 3.** | **16 Hours** |
|---|---|
| 3.1. Phase rule and concept of phase diagrams- Unary, Binary, Ternary, Quaternary.<br>3.2. Study of the course of crystallisation of the following ternary systems: Forsterite-Diopside – Silica, Forsterite - Anorthite - Silica, Diopside - Anorthite – Albite, Albite – Anorthite - Orthoclase, MgO - $Al_2O_3$ - $SiO_2$. Quaternary System, Di- An- Ab- Fo. | |
| **Unit 4.** | **16 Hours** |
| 4.1. Concept of metamorphism- Changes in pressure and temperature.<br>4.2. Equilibrium and non-equilibrium reactions.<br>4.3. Agents of metamorphism.<br>4.4. Types of metamorphism, metamorphic grade and facies of metamorphism. | |
| **Unit 5.** | **16 Hours** |
| 5.1. Solid-solid reactions, Genetic significance of textures and structures of metamorphism.<br>5.2. Application of thermodynamics in metamorphic rock formation.<br>5.3. Paired metamorphic Belts and plate tectonics.<br>5.4. Mineral paragenesis- Graphical representation of metamorphic mineral paragenesis, composition plotting ACF, AKF, AFM. Diagrams. | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br><br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br><br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents. |

| **MODE OF ASSESSMENT** |
|---|
| **Internal Assessment (20 Marks)**<br>a. Classroom participation (20%): 4 Mark<br>b. Test papers I (40%): 8 Mark |

| | | | | |
|---|---|---|---|---|
| c. Assignment (20%): 4 Mark<br>d. Seminar/ Viva (20%): 4 Mark | | | | |
| **External Assessment (80 Marks)** *Duration 2.5 Hours, No of Questions: 27* | | | | |
| **PATTERN OF QUESTION PAPER** | | | | |
| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
| Short answer | 15 | Up to 15 | 2 | 25 |
| Paragraph | 8 | Up to 8 | 5 | 35 |
| Essay | 4 | 2 | 10 | 20 |
| **Total** | | | | **80** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 16 |
| Unit 2. | 16 |
| Unit 3. | 16 |
| Unit 4. | 16 |
| Unit 5. | 16 |

**REFERENCES:**


1. Best, M.G., 2002, Igneous and metamorphic petrology, 2nd Edition, Blackwell Publishers
2. Philpots A.R., 1990, Principles of Igneous and metamorphic petrology, Prentice Hall.2.
3. Yardley, B.W., 1989, An introduction to metamorphic petrology, Longman
4. Tyrrell, G.W. 1978 -Principles of petrology – Chapman and Hall Ltd., London.
5. Mihir K.Boss- Igneous Petrology

| SEMESTER VII<br>Core Course 15<br>GLO7IB15 – ADVANCED STRATIGRAPHY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 4 | 5 | 20 | 80 | 100 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Explain*** detailed stratigraphy concepts and processes | Understand | PSO3 |
| CO2 | ***Illustrate*** major extinctions in present Eon | Understand | PSO3 |
| CO3 | ***Explain*** detailed Stratigraphy of India | Understand | PSO2 |
| CO4 | ***Classify*** detailed Geology of India | Apply | PSO5 |

**COURSE CONTENT**

| **Unit 1.** | **16 Hours** |
|---|---|
| 1.1. Development of stratigraphic concepts<br>1.2. Stratigraphic classification & nomenclature, study of stratigraphic elements<br>1.3. Stratification: processes controlling stratification- physical, chemical and biological<br>1.4. Vertical succession, lithological uniformity, heterogeneity, patterned succession, alternations, varve's, cycles (symmetrical and asymmetrical)<br>1.5. Lateral variations and facies concept<br>1.6. Unconformity<br>1.7. Methods of Correlation: Shaw's Graphic Correlation<br>1.8. Brief ideas of Magnetostratigraphy, cyclostratigraphy, pedostratigraphy, chemostratigraphy and sequence stratigraphy<br>1.9. Major Extinction events in Phanerozoic Eon<br>1.10. K-T Boundary extinction and its causes | |
| **Unit 2.** | **16 Hours** |

| | |
|---|---|
| 2.1. Precambrian Stratigraphy; Precambrian geochronology; Archean Geology of India: (i) Dharwar Craton, (ii) Singhbhum Craton; Proterozoic Geology of India: (i) Central Indian Tectonic Zone, (ii) Vindhyan Supergroup, (iii) Cuddapah Supergroup; PrecambrianCambrian boundary. | |
| **Unit 3.** | **16 Hours** |
| 3.1. Paleozoic Stratigraphy; Igneous activities and paleogeography during the Paleozoic Era; Paleozoic of Kashmir; Permian-Triassic Boundary Concept, classification, fauna, flora and age limits of Gondwana Supergroup and related paleogeography, paleoclimate, and depositional characteristics | |
| **Unit 4.** | **16 Hours** |
| 4.1. Mesozoic Stratigraphy; Classification, depositional characteristics, fauna, and flora of: Triassic of Spiti, Jurassic of Kutch, Cretaceous of Trichinapalli; Deccan Volcanic Province; Cretaceous- Tertiary Boundary. | |
| **Unit 5.** | **16 Hours** |
| 5.1. Cenozoic Stratigraphy; Paleogene Systems of India; Neogene Systems of India; Evolution of Himalayas; Siwalik Supergroup; Pleistocene-Holocene Boundary; Concept of Meghalayan.<br>5.2. Detailed Geology of Kerala | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents. |

| **MODE OF ASSESSMENT** |
|---|
| **Internal Assessment (20 Marks)**<br>a. Classroom participation (20%): 4 Mark |

| | |
|---|---|
| b. Test papers I (40%): | 8 Mark |
| c. Assignment (20%): | 4 Mark |
| d. Seminar/ Viva (20%): | 4 Mark |

**External Assessment (80 Marks)** *Duration 2.5 Hours, No of Questions: 27*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| Short answer | 15 | Up to 15 | 2 | 25 |
| Paragraph | 8 | Up to 8 | 5 | 35 |
| Essay | 4 | 2 | 10 | 20 |
| **Total** | | | | **80** |

**UNITS WISE MARK DISTRIBUTION**

| **Units** | **Mark** |
|---|---|
| Unit 1. | 13 |
| Unit 2. | 18 |
| Unit 3. | 16 |
| Unit 4. | 17 |
| Unit 5. | 16 |

**REFERENCES:**


1. Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.
2. Danbar, C.O. and Rodgers, J. (1957): Principles of Stratigraphy, John Wiley and Sons.
3. Doyle, P. and Bennett. M.R. (1996): Unlocking the Stratigraphic Record, John Wiley and Sons.
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5. K. S. Valdiya (2010): The Making of India-Geodynamic Evolution; Macmillan Publishers India Ltd.

6. Krishnan, M.S. (1982): Geology of India and Burma, C.B.S. Publ. and Distributors, Delhi.
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8. M. S. Krishnan (1982), Geology of India and Burma; 6th Ed. CBS Publishers and Distributors (India).
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10. Pascoe, E.H. (1968): A Manual of the Geology of India and Burma (Vols. I-IV), GSI, Govt. of India Press, Delhi.
11. Pomerol, C. (1982): The Cenozoic Era? Tertiary and Quaternary, Ellis Harwood Ltd., Halsted Press. Schoch,
12. Robert, M. (1989): Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York.
13. Roy, R. Lemon (1990): Principles of Stratigraphy; Merrill Publishing Company, Ohio
14. Wadia, D.N. (1984), Geology of India; 4th edition. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

| SEMESTER VIII<br>Core Course 16<br>GLO8IB16 – ADVANCED STRUCTURAL GEOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 4 | 6 | 20 | 80 | 100 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome | Learning Domain | PSO No |
|---|---|---|---|
| | Upon completion of this course, students will be able to; | | |
| CO1 | ***Interpret*** the mathematical expressions of structural features | Understand | PSO2 |
| CO2 | ***Sketch*** linear and planar structures | Apply | PSO5 |
| CO3 | ***Design*** structural features from given data | Create | PSO11 |

**COURSE CONTENT**

| **Unit 1.** | **19 Hours** |
|---|---|
| 1.1. Stress and Strain: Mechanical properties of rocks. Two dimensional stress and strain analyses. Relationships for elastic, plastic and viscous materials; Strain and displacement<br>1.2. Graphical representation of finite strain: Strain ellipsoid; Flinn diagram and Mohrs circle. Types of strain ellipsoids and their geological significance.<br>1.3. Strain analysis of naturally deformed rocks. Rheology.<br>1.4. Geological mapping and map reading; Attitudes of planes and lines and their representation. | |
| **Unit 2.** | **20 Hours** |
| 2.1. Folds: Mechanics of folding; Geometric classification after Ramsay; Genetic classification after Donath and Parker<br>2.2. Minor folds and their uses in determining the major fold structure; Pumpelley's rule. Evidence of buckling. Interference patterns of superposed fold.<br>2.3. Distribution of strains in folds. | |
| **Unit 3.** | **20 Hours** |
| 3.1. Faults: Dynamics of faulting; Displacement, slip and separation | |

| | |
|---|---|
| 3.2. Fault geometry and classification; Characteristics of faults and fault zones.<br>3.3. Causes and dynamics of faulting. Strain significance of faults.Fault-related folding.<br>3.4. Shear zones: Strain variation in shear zones. Shear sense indicators. Brittle and ductile shear zones, geometry and products of shear zones; shear sense indicators; Mylonites and cataclasites, their origin and significance.<br>3.5. Crustal scale faults: Strike-slip, transpression, and transtension. | |
| **Unit 4.** | **18 Hours** |
| 4.1. Joints and fractures: Distinction; Joint formation in response to loading and stress; Fracture development and propagation;<br>4.2. Classification of joints and extension fractures.<br>4.3. Analysis of joints and their tectonic significance.<br>4.4. Unconformity: Importance of unconformity in tectono-stratigraphic correlation. | |
| **Unit 5.** | **19 Hours** |
| 5.1. Tectonites: Fabric elements and classification; L-, L-S and S-tectonic fabrics. Petrofabric analysis.<br>5.2. Structural analysis: Principles and elements of structural analysis.<br>5.3. Geometrical analysis of simple and complex structures on mesoscopic to macroscopic scale. Gravity induced structures.<br>5.4. Stereographic projections: linear and planar features. | |

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (20 Marks)**

a. Classroom participation (20%): 4 Mark
b. Test papers I (40%): 8 Mark

| | | | | |
|---|---|---|---|---|
| c. Assignment (20%): 4 Mark<br>d. Seminar/ Viva (20%): 4 Mark | | | | |
| **External Assessment (80 Marks)** *Duration 2.5 Hours, No of Questions: 27* | | | | |
| **PATTERN OF QUESTION PAPER** | | | | |
| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
| Short answer | 15 | Up to 15 | 2 | 25 |
| Paragraph | 8 | Up to 8 | 5 | 35 |
| Essay | 4 | 2 | 10 | 20 |
| **Total** | | | | **80** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 13 |
| Unit 2. | 18 |
| Unit 3. | 16 |
| Unit 4. | 17 |
| Unit 5. | 16 |

**REFERENCES:**


1. Ramsay, J.G. & Huber, M.I. 1983. The Techniques of modern structural geology.V.1. Strain Analysis.
2. Ramsay, J.G. & Huber, M.I. 1987. The Techniques of modern structural geology.V.2. Folds and Fractures.
3. Park, R.G. Foundations of structural geology.
4. Turner, F.J. & Weiss, L.E. 1963. Structural analysis of metamorphic tectonites.
5. Price, N.J. & Cosgrove, J.W. 1990. Analysis of Geological structures.Cambridge University Press.
6. Davis, G.H. 1984. Structural Geology of Rocks and Regions.

7. Ghosh, S.K. 1993. Structural Geology: Fundamentals and modern developments.
8. Suppe, J. 1985 Principles of structural geology. Printice-Hall.
9. Fossen H. Structural Geology , Cambridge University press
10. Ragan D. M., Structural Geology , Cambridge University press
11. Billings M. P. Structural Geology, 1960, 514 pp

| SEMESTER VIII<br>Core Course 17<br>GLO8IB17 – EXPLORATION GEOPHYSICS AND FIELD TECHNIQUES | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 4 | 6 | 20 | 80 | 100 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Explain*** Gravity methods for exploration | Understand | PSO3 |
| CO2 | ***Extrapolate*** Magnetic data for different correction | Understand | PSO3 |
| CO3 | ***Examine*** Seismic data to find out the different subsurface layers | Apply | PSO5 |
| CO4 | ***Use*** Radiometric data for exploration | Apply | PSO5 |

**COURSE CONTENT**

| **Unit 1.** | **20 Hours** |
|---|---|
| 1.1. Scope of exploration geophysics – physical properties of the earth – Electrical methods – SP, IP, EM and Resistivity - methods of electrode arrangement – field methods – interpretation – application<br>1.2. FIELD TECHNIQUES: - Resistivity surveys – Wenner and Schlumberger methods – electrical sounding and profiling – problems on these methods – methods –calculation of auxiliary point - SP methods - Interpretation of data – curve matching use of standard computer packages in interpretation | |
| **Unit 2.** | **19 Hours** |
| 2.1. Gravity methods - Principle –density and rock types-- regional and local anomalies - field methods – gravimeters – corrections – interpretation of gravity data – determination of shape and depth of ore bodies — corrections & applications – GRACE mission<br>2.2. FIELD TECHNIQUES:- Problems on gravity methods - Preparation of anomaly maps - methods of corrections. | |

| Unit 3. | 20 Hours |
|---|---|
| 3.1. Magnetic methods – principle - field procedure – magnetometers – interpretation of magnetic data – size and shape of bodies – correction of magnetic data - applications - airborne geophysical surveys<br>3.2. FIELD TECHNIQUES:- Problems on magnetic methods – preparation of anomaly maps – methods of corrections | |
| **Unit 4.** | **19 Hours** |
| 4.1. Seismic method: Seismic waves – elastic properties of materials - travel velocity in various geological formations – principles – field operation – refraction and reflection survey – correction of seismic data – methods of interpretation – determination of attitude and depth of formations – various types of shooting<br>4.2. FIELD TECHNIQUES:- Problems on refraction and reflection methods – 3 layer and inclined beds – calculation based on intercept time and cross over distance | |
| **Unit 5.** | **18 Hours** |
| 5.1. Radiometric method: Fundamentals of radioactivity – principle of radioactivity methods – types of counters – field methods and interpretation – Well logging - Self potential – resistivity – radioactivity logging methods – caliper and other miscellaneous logging methods – field procedure and interpretation of data<br>5.2. FIELD TECHNIQUES: - Radioactive methods - problems on well logging – interpretation of data. | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents. |

| **MODE OF ASSESSMENT** |
|---|
| **Internal Assessment (20 Marks)** |

| | |
|---|---|
| a. Classroom participation (20%): | 4 Mark |
| b. Test papers I (40%): | 8 Mark |
| c. Assignment (20%): | 4 Mark |
| d. Seminar/ Viva (20%): | 4 Mark |

**External Assessment (80 Marks)** *Duration 2.5 Hours, No of Questions: 27*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| Short answer | 15 | Up to 15 | 2 | 25 |
| Paragraph | 8 | Up to 8 | 5 | 35 |
| Essay | 4 | 2 | 10 | 20 |
| **Total** | | | | **80** |

**UNITS WISE MARK DISTRIBUTION**

| **Units** | **Mark** |
|---|---|
| Unit 1. | 16 |
| Unit 2. | 16 |
| Unit 3. | 16 |
| Unit 4. | 16 |
| Unit 5. | 16 |

**REFERENCES:**


1. Arnaud Gerkens, J. C. d'.Foundation of exploration geophysics.Amsterdam ; New York : Elsevier ; New York, NY, U.S.A, 1989.
2. Burger, H.R., Exploration Geophysics of the Shallow Subsurface, Prentice Hall, 1992.
3. Dobrin, M.B An introduction to geophysical prospecting, McGraw Hill, New Delhi,1984
4. Ramachandra Rao, M.B. Outline of geophysical prospecting. Wesley press, Mysore, 1975

5. Rama Rao, B.S and Murthy I.B.R Gravity and magnetic methods of prospecting. Arnold Heinmann Pub. New Delhi, 1978
6. Robinson, Edwin S., Cahit Coruh, Basic exploration geophysics. New York : Wiley, 1988.

| SEMESTER VIII<br>Core Course 18<br>GLO8IB18 – ADVANCED ECONOMIC GEOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 4 | 6 | 20 | 80 | 100 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Explain*** the mineral deposits in detail | Understand | PSO2 |
| CO2 | ***Summarize*** the metallogenesis process | Understand | PSO2 |
| CO3 | ***Discuss*** the Uranium and Thorium deposits of India | Understand | PSO2 |

**COURSE CONTENT**

| **Unit 1.** | **20 Hours** |
|---|---|
| 1.1. Mineral deposits – types, morphology and forms of ore bodies.<br>1.2. Source of ore forming material. Physico-chemical environment of ore formation.<br>1.3. Genetic classification of mineral deposits. Magmatic Ore Deposits- Chromite, Magnetite and Platinum Group Element Deposits of the Bushveld Complex.<br>1.4. Hydrothermal Deposits; Volcanogenic Massive Sulfide (VMS), Porphyry, Sedimentary Exhalative (SEDEX), Mississippi Valley Type (MVT) Deposits. Iron-Oxide Copper Gold (IOCG) Deposits | |
| **Unit 2.** | **19 Hours** |
| 2.1. Ore microscope - Polishing and mounting of ores. Mineralogical, trace element and stable isotope geothermometers; fluid inclusion studies.<br>2.2. Physical and optical properties of important ore minerals.<br>2.3. Textures and structures of ore and gangue minerals.<br>2.4. Ore genesis. Paragenetic sequences, zoning. Metallogenic epochs and provinces. Ore forming solutions and their migration. | |
| **Unit 3.** | **18 Hours** |
| 3.1. Global Tectonics and Metallogeny; Patterns in the distribution of mineral deposits, | |

| | |
|---|---|
| 3.2. Crustal evolution and metallogenesis, Metallogeny through time, Plate tectonics and ore deposits.<br>3.3. Strata bound and stratiform ore deposits - distribution, form, setting and origin | |
| **Unit 4.** | **19 Hours** |
| 4.1. Nature and origin of mineral deposits associated with different rocks and their Indian examples: magmatic deposits in ultramafic, mafic and felsic association; Anorthosite - Fe - Titanium oxide distribution, setting, constitution and origin.<br>4.2. Post-magmatic deposits; sedimentary deposits; syn-sedimentary deposits; deposits formed in a near surface environment by residual concentration and mechanical concentration- Placer Deposits, Sedimentary Fe Deposits.<br>4.3. Infiltration and supergene enrichment, Metamorphic and metamorphosed deposits. | |
| **Unit 5.** | **20 Hours** |
| 5.1. Genetic classification of U and Th deposits.<br>5.2. Geology and genesis of U deposits of Jaduguda.Pb - Zn deposits of Rajasthan, Cu deposits of Singhbhum and Malanjkhand, East coast Bauxite, Iron ore deposits of Bailadila and Kundremukh.<br>5.3. Brief introduction to gas hydrates.<br>5.4. Strategic, critical and essential minerals of India; National mineral policy of India | |

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (20 Marks)**

a. Classroom participation (20%): 4 Mark
b. Test papers I (40%): 8 Mark
c. Assignment (20%): 4 Mark

| |
|---|
| d. Seminar/ Viva (20%): 4 Mark |
| **External Assessment (80 Marks)** *Duration 2.5 Hours, No of Questions: 27* |
| **PATTERN OF QUESTION PAPER** |

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| Short answer | 15 | Up to 15 | 2 | 25 |
| Paragraph | 8 | Up to 8 | 5 | 35 |
| Essay | 4 | 2 | 10 | 20 |
| **Total** | | | | **80** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 16 |
| Unit 2. | 16 |
| Unit 3. | 16 |
| Unit 4. | 16 |
| Unit 5. | 16 |

**REFERENCES:**


1. Barnes, H.L. (Ed.). 1997. Geochemistry of hydrothermal ore deposits. John Wiley & Sons.
2. Craig, J.R. & Vaughan, 1994. Ore microscopy and ore petrography.John Wiley & Sons.
3. Evans, A.M. 1992. Ore geology and industrial minerals.Blackwell Science.
4. Jensen, M.L. & Bateman, A.M. 1981. Economic mineral deposits.John Wiley & Sons.
5. Misra, K.C. 1999. Understanding mineral deposits.Kluwer Academic Publishers.
6. Mookherjee, A. 1998. Ore genesis – a holistic approach.Allied Publishers.
7. Stanton, R.L. 1981. Ore Petrology.Mcgraw Hill.

8. Nicholas Arndtand Clement Ganino. 2012. Metals and Society—An Introduction to Economic Geology, Springer Verlag, Berlin Heidelberg. Pp. 160.ISBN 978-3-642-22995-4.
9. Laurence Robb, 2004. Introduction to ore-forming processes. Blackwell science ltd., malden, ma, 373 p.
10. Mihir Deb and Sanjib Chandra Sarkar, 2017. Minerals and Allied Natural Resources and Their Sustainable Development: Principles, Perspectives with Emphasis on the Indian Scenario. Springer, Pp. 550.

| SEMESTER IX<br>Core Course 19<br>GLO9IB19 – APPLIED SEDIMENTOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 4 | 5 | 20 | 80 | 100 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Explain*** the principles in fluid dynamics relevant for transport and deposition of sediments and define geological terms to describe sedimentary structures, textures and processes | Understand | PSO4 |
| CO2 | ***Summarize*** the formation of different sedimentary structures. | Understand | PSO2 |
| CO3 | ***Discuss*** how the sediments are converted into sedimentary rocks. | Understand | PSO2 |
| CO4 | ***Classify*** the siliclasic sediments and carbonate sediments | Apply | PSO5 |
| CO5 | ***Use*** the composition of the rock and sedimentary structures to interpret sedimentary processes. | Apply | PSO5 |

**COURSE CONTENT**

| **Unit 1.** | **16 Hours** |
|---|---|
| 1.1. Sedimentary processes: weathering, sediment transport by fluids. Simple fluid flow concept.<br>1.2. Textures of clastic and non-clastic rocks.<br>1.3. Sedimentary structures: classification, genesis and significance.<br>1.4. Use of structures and textures in basin studies. | |
| **Unit 2.** | **16 Hours** |
| 2.1. Description and classification of siliciclastic rocks; sediment maturity; introduction to stream flow; grain transport and deposition | |

| | |
|---|---|
| 2.2. Sedimentary environment: physical and chemical properties of depositional environment and its classification.<br>2.3. Lithologies, structures and vertical sequences formed in fluvial, deltaic, coastal, deep sea, glacial, aeolian and carbonate depositional environments<br>2.4. Processes that influence the formation of sediments and sedimentary rocks, as well as focusing on the physical, chemical, and biological aspects of sediments and sedimentary rocks. | |
| **Unit 3.** | **16 Hours** |
| 3.1. Provenance: light minerals, heavy minerals and insoluble residue in provenance studies and correlation of sedimentary rocks.<br>3.2. Diagenesis: compaction, cementation, chemical alteration and recrystallisation.<br>3.3. Sedimentation and Tectonics: tectonic control of sedimentation. Geosynclines and their lithological associations.<br>3.4. Plate Tectonics in relation to type and evolution of basins. Sedimentary basins- classifications, introduction to basin analysis. Post-depositional sedimentary processes- clastic and carbonate diagenesis | |
| **Unit 4.** | **16 Hours** |
| 4.1. Clay Minerals: classification, techniques of identification, diagenesis and use in environmental interpretation. | |
| **Unit 5.** | **16 Hours** |
| 5.1. Analytical techniques in sedimentology | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents. |

| **MODE OF ASSESSMENT** |
|---|

**Internal Assessment (20 Marks)**

a. Classroom participation (20%): 4 Mark
b. Test papers I (40%): 8 Mark
c. Assignment (20%): 4 Mark
d. Seminar/ Viva (20%): 4 Mark

**External Assessment (80 Marks)** *Duration 2.5 Hours, No of Questions: 27*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| Short answer | 15 | Up to 15 | 2 | 25 |
| Paragraph | 8 | Up to 8 | 5 | 35 |
| Essay | 4 | 2 | 10 | 20 |
| **Total** | | | | **80** |

**UNITS WISE MARK DISTRIBUTION**

| **Units** | **Mark** |
|---|---|
| Unit 1. | 14 |
| Unit 2. | 14 |
| Unit 3. | 17 |
| Unit 4. | 15 |
| Unit 5. | 20 |

**REFERENCES:**


1. F.J. Pettijohn (1975) Sedimentary rocks. Harper and Row Publ., New Delhi.
2. Blatt, Middleton & Murray (1980) Origin of sedimentary rocks. Printice Hall Inc.
3. J.D. Collins and D.B. Thompson (1982) Sedimentary Structures. George Allen & Unwin, London.
4. M.E. Tucker (1981) Sedimentary Petrology: an introduction. John Willey & Sons, New York.

5. Collinson, J., Mountney, N., Thompson, D., Sedimentary Structures, Terra Publishing, 3rd Edn., 2006
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8. Selley, R.C., Applied sedimentology, 2nd Edn., Academic Press, 2000
9. Tucker, M.E. Sedimentary Petrology, 3rd Edn., Blackwell Science, 2001

| SEMESTER IX<br>Core Course 20<br>GLO9IB20 – HYDROGEOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 4 | 5 | 20 | 80 | 100 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***State*** the relation between Geology and hydrogeology | Remember | PSO1 |
| CO2 | ***Summarize*** the occurrence of Groundwater in different types of rocks | Understand | PSO3 |
| CO3 | ***Compute*** the quality criteria of Groundwater | Apply | PSO5 |
| CO4 | ***Identify*** the methods of ground water recharge | Apply | PSO7 |
| CO5 | ***Determine*** the different methods of ground water prospecting | Evaluate | PSO10 |

**COURSE CONTENT**

| **Unit 1.** | **16 Hours** |
|---|---|
| 1.1. Geology and Hydrogeology and their relationship.<br>1.2. Surface and sub-surface distribution of water, aquifers, aquicludes, aquitard, aquifuge.<br>1.3. Physical properties of reservoir rocks.<br>1.4. Darcy's law and its range validity.<br>1.5. Groundwater flow under steady and unsteady conditions.<br>1.6. Occurrence of groundwater in different rock types. | |
| **Unit 2.** | **16 Hours** |
| 2.1. Fresh and saltwater relationship in coastal areas.<br>2.2. Ghyzen-Herzberg principle. Prevention and control of sea water intrusion.<br>2.3. Overexploitation of groundwater. Groundwater contamination and pollution. | |

| **Unit 3.** | **16 Hours** |
|---|---|
| 3.1. Quality and geochemistry of groundwater.<br>3.2. Groundwater exploration and management.<br>3.3. Natural and artificial recharge of groundwater.<br>3.4. Modelling of aquifer systems. | |
| **Unit 4.** | **16 Hours** |
| 4.1. Critical velocity ratio, Bligh's Creep Theory for Seepage Flow, Measurement of Precipitation, Hydrograph and Runoff, Well Hydraulics | |
| **Unit 5.** | **16 Hours** |
| 5.1. Groundwater prospecting - Gravity, resistivity surveys, Magneto-tellurics; Water divining and other historical methods. Pumping tests and well yield. | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents. |

| **MODE OF ASSESSMENT** |
|---|
| **Internal Assessment (20 Marks)**<br>a. Classroom participation (20%): 4 Mark<br>b. Test papers I (40%): 8 Mark<br>c. Assignment (20%): 4 Mark<br>d. Seminar/ Viva (20%): 4 Mark |
| **External Assessment (80 Marks)** *Duration 2.5 Hours, No of Questions: 27* |
| **PATTERN OF QUESTION PAPER** |

| Pattern | Total No. of questions | No. of questions to be answered | Marks for each question | Ceiling of Marks |
|---|---|---|---|---|
| Short answer | 15 | Up to 15 | 2 | 25 |
| Paragraph | 8 | Up to 8 | 5 | 35 |
| Essay | 4 | 2 | 10 | 20 |
| **Total** | | | | **80** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 14 |
| Unit 2. | 15 |
| Unit 3. | 16 |
| Unit 4. | 17 |
| Unit 5. | 18 |

**REFERENCES:**


1. Todd, D.K. 1988. Groundwater Hydrology.John Willey and Sons.
2. Davis, S.N. & De Wiest, R.J.N. 1966. Hydrogeology. John Wiley & Sons, New York.
3. Raghunath, H.M. 1983. Groundwater. Willey Eastern, Calcutta.

| SEMESTER IX<br>Core Course 21<br>GLO9IB21 – ADVANCED REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 4 | 4 | 20 | 80 | 100 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Explain*** the process of digital Imaging and image classification | Remember | PSO1 |
| CO2 | ***Summarize*** the fundamental interaction of electromagnetic radiation with earth surface objects. | Understand | PSO3 |
| CO3 | ***Categorize*** the different type of remote sensing data products and analysis technique and select the more appropriate to solve a real-world problem. | Analyze | PSO7 |
| CO4 | ***Utilize*** the various kind of data from several sources and analyses using GIS concept and tools | Analyze | PSO7 |
| CO5 | ***Combine*** Quantitative remote-sensing principles and integrate different tools GIS for remote sensing data analysis. | Create | PSO12 |

**COURSE CONTENT**

| **Unit 1.** | **14 Hours** |
|---|---|
| 1.1. Multispectral Remote Sensing,Types of satellite imageries.<br>1.2. Introduction to satellite/digital image processing: concept of digital images, data acquisition, image registration, radiometric and geometric correction of satellite data, Image enhancement techniques, image transformation- Principal Component Analysis (PCA), Intensity Hue Saturation (IHS), Brovey method and Wavelet transformation.<br>1.3. Image classification: Supervised classification and Unsupervised classification, Advantages, Disadvantages and limitations, Accuracy assessment; principles of Remote sensing in geology, Spectral characteristics of rocks and minerals. | |

| Unit 2. | 12 Hours |
|---|---|
| 2.1. Hyperspectral remote sensing, Spectral Signatures and BRDF in the Visible, Near Infrared and Shortwave Infrared regions of EMR, Hyperspectral Issues.<br>2.2. Hyperspectral Data cube. Radiation science basics - Thermal radiation principles, thermal interaction behavior of terrain elements, thermal sensors and specifications; Image characters, spatial and radiometry; interpretation of thermal image; Comparison of Multispectral, Hyperspectral and thermal Image Data. | |
| **Unit 3.** | **12 Hours** |
| 3.1. Introduction to microwave remote sensing – concept and principle; Interactions between radar and surface materials - complex dielectric properties, roughness polarization; Passive & active microwave remote sensing<br>3.2. Application of microwave remote sensing and microwave image interpretation. | |
| **Unit 4.** | **14 Hours** |
| 4.1. Introduction to Geographic Resources Analysis Support System (GRASS)<br>4.2. GIS - Raster data handling – Reclassification, recode - map algebra - Resampling and interpolation of raster data – Overlaying - Spatial analysis Neighborhood analysis and cross-category statistics - Buffering - Cost surfaces - Terrain and watershed analysis – Modeling raster data – Vector data handling - Topological operations – Buffering – Overlay – Dissolve – clip,union intersect – Network analysis – Spatial interpolation – handling lidar point cloud data<br>4.3. Drainage mapping and morphometric analysis<br>4.4. Database design; analysis for urban and regional resource mapping, Urban hazards and risk management through GIS | |
| **Unit 5.** | **12 Hours** |
| 5.1. Concept of Digital Elevation model, Digital elevation model (DEM) in hydrological modelling using GIS, Integration of Remote Sensing and GIS, Water quality monitoring and hydrogeological modelling using GIS.<br>5.2. Integration of Remote Sensing and GIS. Database design & analysis for urban and regional resource mapping, Urban hazards and risk management through GIS. | |

| MODE OF TRANSACTION |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students. |

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (20 Marks)**

a. Classroom participation (20%): 4 Mark
b. Test papers I (40%): 8 Mark
c. Assignment (20%): 4 Mark
d. Seminar/ Viva (20%): 4 Mark

**External Assessment (80 Marks)** *Duration 2.5 Hours, No of Questions: 27*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| Short answer | 15 | Up to 15 | 2 | 25 |
| Paragraph | 8 | Up to 8 | 5 | 35 |
| Essay | 4 | 2 | 10 | 20 |
| **Total** | | | | **80** |

**UNITS WISE MARK DISTRIBUTION**

| **Units** | **Mark** |
|---|---|
| Unit 1. | 15 |
| Unit 2. | 16 |
| Unit 3. | 16 |
| Unit 4. | 17 |
| Unit 5. | 16 |

**REFERENCES:**


1. 1.Remote sensing and image interpretation by Lillisand, T. M. and Keifer, R. W., 2007, John
2. Willey and Sons, USA
3. Introduction to environmental remote sensing by Barrett, E. C. and Curtis L. F., 1999,
4. Chapman and Hall Publishers, USA.
5. Fundamentals of remote sensing by Joseph G., 2003, Universities Press, Hyderabad.
6. Introduction to geographic information systems by Chang, Kang-taung, 2002, Tata McGraw-Hill, USA.

| SEMESTER X<br>Core Course 22<br>GL10IB22 – ADVANCED PALAEONTOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 4 | 5 | 20 | 80 | 100 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Describe*** the concept of adaptation and functional morphology | Remember | PSO1 |
| CO2 | ***Summarize*** the evolution of man and vertebrate fossils of India | Understand | PSO3 |
| CO3 | ***Outline*** the application of micropalaeontology and sampling methods | Remember | PSO1 |
| CO4 | ***Utilize*** the identification and uses of important microfossils | Analyze | PSO8 |

**COURSE CONTENT**

| **Unit 1.** | **16 Hours** |
|---|---|
| 1.1. Species concept, Describing Single specimen, Ontogenetic variations, The population as a unit; the species as a unit, Grouping of species into higher categories.<br>1.2. Adaptation and functional morphology | |
| **Unit 2.** | **16 Hours** |
| 2.1. Trace fossils, Evolution of Vertebrates, Siwalik Mammals<br>2.2. Evolution of Man, Cretaceous Vertebrates,<br>2.3. Important Gondwana, Intertrappean and Tertiaries flora of India. | |
| **Unit 3.** | **16 Hours** |
| 3.1. Subsurface and surface sampling methods, processing of samples.<br>3.2. Paleoenvironmental interpretation using microfossils, Role of Micropaleontology | |

| | |
|---|---|
| in Hydrocarbon exploration. | |
| **Unit 4.** | **16 Hours** |
| 4.1. Morphology, Classification and evolution of Foraminifera; Stratigraphy of foraminifera with special reference to India, Stable isotopic study of foraminifera and interpretation of paleo ecology, spores and pollens. | |
| **Unit 5.** | **16 Hours** |
| 5.1. Morphology and geological distribution of Ostracoda, Radiolaria, Calcareous algae, calcareous nannofossils, Diatoms, Dinoflagellate. deep sea records | |

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (20 Marks)**

a. Classroom participation (20%): 4 Mark
b. Test papers I (40%): 8 Mark
c. Assignment (20%): 4 Mark
d. Seminar/ Viva (20%): 4 Mark

**External Assessment (80 Marks)** *Duration 2.5 Hours, No of Questions: 27*

**PATTERN OF QUESTION PAPER**

| Pattern | Total No. of questions | No. of questions to be answered | Marks for each question | Ceiling of Marks |
|---|---|---|---|---|
| Short answer | 15 | Up to 15 | 2 | 25 |
| Paragraph | 8 | Up to 8 | 5 | 35 |

| | | | | |
|---|---|---|---|---|
| Essay | 4 | 2 | 10 | 20 |
| **Total** | | | | **80** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 15 |
| Unit 2. | 16 |
| Unit 3. | 15 |
| Unit 4. | 17 |
| Unit 5. | 17 |

**REFERENCES:**


1. G.H.B von Koenigswald, J.D. Ernies W.L Buning C. W. Wange (Editors), Evolutionary Trends in Foraminifera, Elsevier, 1963
2. Ager, D.V., Principles of Palaeontology, McGraw Hill, 1963
3. Arkell, W. J., Jurassic Geology of the World, Oliver and Boyd, 1960
4. Brouwer A., General Palaeontology. Olier and Boyd, 1967
5. Colebert H. Edwin, Evolution of the vertebrates, John Wiley and Sons, 1961
6. Cushman A. Joseph, Foraminifera, Harvvard University Press, 1959
7. Woods Henry, Invertebrate Palaeontology, Cambridge University Press, 1961
8. Zittel Karl A. Von, Text Book of Palaeontology, Parts I and II, McMillan, 1964.
9. Noa Version, Stratigraphic Principles of Palaeontology, Oxford University Press, 1952
10. John J. Daniel, Introduction to Microfossils, Harper and Brothers, 1956
11. Moore R.C., Lalicker C.G., Fisher A.G., Invertebrate Fossils, McGraw Hill, 1952

| SEMESTER X<br>Core Course 23<br>GL10IB23 – GEOCHEMISTRY AND ISOTOPE GEOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 4 | 5 | 20 | 80 | 100 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Describe*** the origin of solar system and geochemical elements in earth | Remember | PSO1 |
| CO2 | ***Summarize*** the thermodynamic control over the distribution of elements | Understand | PSO4 |
| CO3 | ***Outline*** the chemical parameters of water and its calculations | Analyse | PSO7 |
| CO4 | ***Explain*** the radioactive decay and dating methods | Understand | PSO4 |
| CO5 | ***Assess*** the stable isotope geochemistry and their applications | Evaluate | PSO10 |

**COURSE CONTENT**

| **Unit 1.** | **16 Hours** |
|---|---|
| 1.1. Different processes of nucleosynthesis Meteorites, Chondrites and chondritic ratios.<br>1.2. Origin of the solar system and distribution of elements with respect to distance from the Sun. Geochemical and Cosmo chemical classification of elements | |
| **Unit 2.** | **16 Hours** |
| 2.1. Thermodynamics and thermodynamic control on distribution of chemical species (between coexisting phases).<br>2.2. Thermodynamics of mixing and solutions. Kinetics and metastability. Clapeyron equation. Simple thermodynamic calculations involving phase changes and equilibrium reactions. | |

| **Unit 3.** | **16 Hours** |
|---|---|
| 3.1. Aqueous geochemistry: Molarity and molality, solubility product and solubility, acids and bases, dissociation constant, pH, hydrolysis, ionic concentration. $CO_2$-$H_2O$ interaction to form carbonic acid, dissolution of calcite, weathering reactions. | |
| **Unit 4.** | **16 Hours** |
| 4.1. Discovery of radioactivity, stable and radiogenic isotopes Nuclear structure and energies.<br>4.2. Stability of nuclides. Radioactive decay schemes. Decay constant, half-life, parent-daughter relations.<br>4.3. Methods of dating: Isochron method, model/mineral ages, Fission track, $^{40}Ar$-$^{39}Ar$, U and Th disequilibrium, choncordia method, $^{14}C$, Be and Al.<br>4.4. Interpretation and geological significance of ages.<br>4.5. Isotope systematics of K-Ar, Rb-Sr, Sm-Nd, U-Th-Pb in igneous, metamorphic and sedimentary rocks and in evolution of ocean, crust and mantle. Short-lived isotopes. | |
| **Unit 5.** | **16 Hours** |
| 5.1. Stable isotopes: Isotopes of oxygen and hydrogen, carbon, nitrogen and sulphur.<br>5.2. Processes of isotope fractionation, fractionation factor. O isotopes: fractionation in the hydrologic cycle, paleoclimatology.<br>5.3. C and N isotopes fractionation in biological processes.<br>5.4. Use of S isotopes in ore geology. Stable isotope geothermometry and geobarometry.<br>5.5. Isotopes in mineral exploration, petroleum exploration, paleo-climate evaluation, health and environmental aspects. | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br><br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br><br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents. |

**MODE OF ASSESSMENT**

**Internal Assessment (20 Marks)**

a. Classroom participation (20%): 4 Mark
b. Test papers I (40%): 8 Mark
c. Assignment (20%): 4 Mark
d. Seminar/ Viva (20%): 4 Mark

**External Assessment (80 Marks)** *Duration 2.5 Hours, No of Questions: 27*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| Short answer | 15 | Up to 15 | 2 | 25 |
| Paragraph | 8 | Up to 8 | 5 | 35 |
| Essay | 4 | 2 | 10 | 20 |
| **Total** | | | | **80** |

**UNITS WISE MARK DISTRIBUTION**

| **Units** | **Mark** |
|---|---|
| Unit 1. | 15 |
| Unit 2. | 16 |
| Unit 3. | 15 |
| Unit 4. | 17 |
| Unit 5. | 17 |

**REFERENCES:**


1. Faure, G. (1986). Principles of Isotope Geology.John Wiley, 589p.
2. Doe, B.R. (1970) Lead isotopes. Springer Verlag, 137p.
3. Faure, G. and Powell, J.L. (1972) Strontium Isotope Geology. Springer Verlag, 188p.

# CORE COURSE: GEOLOGY

## (PRACTICALS)

| SEMESTER III<br>Core Course Practical 01<br>GLO3IH01(P) – CRYSTALLOGRAPHY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 0 | 3 | - | - | - |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Read*** the axial disposition, axial relationship and axial analysis of crystal systems | Remember | PSO1 |
| CO2 | ***Identify*** and describe crystal models in normal class. | Remember | PSO4 |
| CO3 | ***Measure*** simple twin models | Evaluate | PSO11 |

**COURSE CONTENT**

| **Exercises** | **32 Hours** |
|---|---|

1. Study of axial disposition, axial relationship and axial analysis of crystal systems.
2. Classification of normal classes of all systems by studying the symmetry elements.
3. Identification and description of the following crystal models in normal classes only.
4. Isometric system: Galena, garnet, Fluorite, Magnetite.
5. Tetragonal System: Zircon, Cassiterite, Rutile, Octahedrite, Apophyllite.
6. Hexagonal: Beryl, Calcite.
7. Orthorhombic: Olivine, Topaz, Barite.
8. Monoclinic: Gypsum, Orthoclase, Augite, Amphibole.
9. Triclinic: Axinite, Albite, Kyanite.
10. Study of simple twin models.
11. Galena-Flourite-Pyrite-rutile-calcite-quartz-staurolite-Gypsum-augite-orthoclase-albite-Calamine
12. Study of axial disposition, axial relationship and axial analysis of crystal systems.

| MODE OF TRANSACTION |
| --- |
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br><br>**Demonstrations**: Helps to illustrate and consolidate theoretical principles outlined in the course.<br><br>**Observation**: It involves understanding the axial disposition, axial relationship, and axial analysis of crystal systems. By doing so, one can identify and describe the crystal models in their normal class. |

***Practical examination will be conducted at the end of semester IV.**

| SEMESTER IV<br>Core Course Practical 02<br>GLO4IH02(P) – CRYSTALLOGRAPHY AND MINERALOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Identify*** megascopic minerals | Remember | PSO1 |
| CO2 | ***Identify*** thin section of minerals | Remember | PSO1 |

**COURSE CONTENT**

| **Experiments** | **48 Hours** |
|---|---|
| **PART A** (Megascopic identification) | |
| 1. **Megascopic identification and description of the following**: Quartz, smoky quartz, milky Quartz, Rosy quartz, Amethyst, Chalcedony, Agate, Flint, Jasper, Chert, Opal, Orthoclase, Microcline, Albite, Oligoclase, Labradorite, Nepheline, Leucite, Sodalite, Enstatite, Bronzite, Hypersthene, Diopside, Augite, Spodumene, Acmite, Rhodonite, Wollastonite, Anthophyllite, Tremolite, Actinolite, Hornblende, Olivine, Serpentine, Muscovite, Biotite, Vermiculite, Phlogpite, Chlorite, Epidote, Garnet, Natrolite, Stilbite, Apophyllite, Talc, Steatite, Andalusite, Kyanite, Sillimanite, Staurolite, Cordierite, Apatite, Beryl, Topaz, Calcite, Dolomite, Tourmaline, Zircon, Fluorite. | |
| PART-B **(Microscopic identification)** | |
| 1. **Microscopic identification and description of the following**: Quartz, smoky quartz, milky Quartz, Rosy quartz, Amethyst, Chalcedony, Agate, Flint, Jasper, Chert, Opal, Orthoclase, Microcline, Albite, Oligoclase, Labradorite, Nepheline, Leucite, Sodalite, Enstatite, Bronzite, Hypersthene, Diopside, Augite, Spodumene, Acmite, Rhodonite, Wollastonite, Anthophyllite, Tremolite, Actinolite, Hornblende, Olivine, Serpentine, Muscovite, Biotite, Vermiculite, Phlogpite, Chlorite, Epidote, Garnet, Natrolite, Stilbite, Apophyllite, Talc, Steatite, Andalusite, Kyanite, Sillimanite, Staurolite, Cordierite, Apatite, Beryl, Topaz, Calcite, Dolomite, Tourmaline, Zircon, Fluorite. | |

## MODE OF TRANSACTION

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Demonstrations:** Helps to illustrate and consolidate theoretical principles outlined in the course. It also provides students to visually and experientially engage with the principles, techniques, and properties of crystals.

**Virtual or online simulations**: In situations where access to physical crystals or laboratory facilities is limited, virtual or online simulations can be used to simulate crystallography practicals. These simulations can provide a realistic and interactive experience, allowing participants to manipulate virtual crystals, perform measurements, and analyze crystal structures.

**Observation:** It involves observing the megascopic and microscopic properties of a mineral with the help of a petrological microscope and also through hand specimens.

## MODE OF ASSESSMENT

**Internal Assessment (15 Marks)**

| | | |
|---|---|---|
| a. | Submission of Record* | 9 Marks |
| b. | Lab involvement | 6 Marks |
| | i. Viva | 3 Marks |
| | ii. Lab skill /performance# | 1.5 Marks |
| | iii. punctuality$ | 1.5 Marks |

**Every student has to submit record of experiments and other lab works which is duly certified by the HoD*

*#Skill and performance in doing experiments and observations*

*$Students involvement in the laboratory will be assessed by the course instructor*

**External Assessment (60 Marks):** *Duration 2 Hours*

| SEMESTER V<br>Core Course Practical 03<br>GLO5IH03(P) – PETROLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 4 | 4 | 20 | 80 | 100 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Identify*** and describe important Igneous rock specimens in hand and thin section. | Remember | PSO1 |
| CO2 | ***Identify*** and describe important Metamorphic rock specimens in hand and thin section. | Remember | PSO1 |
| CO3 | ***Identify*** and describe important Sedimentary rock specimens in hand and thin section. | Remember | PSO1 |
| CO4 | ***Assess*** different structures and textures of igneous rocks | Evaluate | PSO10 |
| CO5 | ***Assess*** different structures and textures of metamorphic rocks | Evaluate | PSO10 |
| CO6 | ***Assess*** different structures and textures of sedimentary rocks | Evaluate | PSO10 |

**COURSE CONTENT**

| **Experiments** | **64 Hours** |
|---|---|
| **PART A** (Megascopic identification) | |
| 1. **Megascopic identification and description of the following rocks:**<br>❖ Granite, Graphic granite, Pegmatite, Aplite, Granite Porphyry, Syenite, Syenite porphyry, Diorite, Gabbro, Anorthosite, Dunite, Pyroxenite, Dolerite, Basalt, Rhyolite, Felsites, Obsidian, Pumice, Scoria. | |

- ❖ Slate, Phyllite, Schists, Gneisses, Quartzite, Marble, Amphibolite, Eclogite, Leptynite, Charnockite, Khondalite, Schorl rock, Banded Magnetite Quartzite

- ❖ Conglomerate, Breccia, Sandstone, Arkose, Shale, Limestone, Laterite, Chert, Grit, Lignite.

**PART-B** (Microscopic identification)

1. **Microscopic identification and description of the following rocks:**

   - ❖ Mica Granite, Hornblende Granite, Graphic Granite, Syenite, Nepheline Syenite, Diorite, Gabbro, Dunite, Peridotite, Granite porphyry, Diorite, Dolerite, Anorthosite, Basalt.

   - ❖ Slate, Chlorite schist, Mica schist, Kyanite schist, Charnockite, Eclogite, Amphibolite, Khondalite, Augen Gneiss, Garnet Biotite Gneiss,

   - ❖ Conglomerate, Breccia, Sandstone, Arkose, Shell limestone.

## MODE OF TRANSACTION

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Demonstrations:** Helps to illustrate and consolidate theoretical principles outlined in the course. It also provides students to visually and experientially engage with the principles, techniques, and properties of a rock.

**Observation:** It involves observing the megascopic and microscopic properties of different types of rocks with the help of a petrological microscope and also through hand specimens.

## MODE OF ASSESSMENT

**Internal Assessment (20 Marks)**

| | | |
|---|---|---|
| a. | Submission of Record* | 12 Marks |
| b. | Lab involvement | 8 Marks |
| | i. Viva | 4 Marks |
| | ii. Lab skill /performance# | 2 Marks |

| |
|---|
| iii. punctuality[$] 2 Marks<br><br>[*]*Every student has to submit record of experiments and other lab works which is duly certified by the HoD*<br><br>[#]*Skill and performance in doing experiments and observations*<br><br>[$]*Students involvement in the laboratory will be assessed by the course instructor* |
| **External Assessment (80 Marks):** *Duration 2.5 Hours* |

| SEMESTER V<br>Core Course Practical 04<br>GLO5IH04(P) – STRUCTURAL GEOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 4 | 4 | 20 | 80 | 100 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Identify*** and explain different types of geological structures in the field, their geometries and types, and relate them to distinct deformation regime. | Remember | PSO1 |
| CO2 | ***Draw***, interpret geological maps and construct geological cross sections, read topographic maps. | Create | PSO11 |
| CO3 | ***Interpret*** the thickness, width of an outcrop, attitude of a formation both by construction and calculation methods. | Understand | PSO4 |
| CO4 | ***Identify*** different types of geological structures in the map (horizontal bed, inclined bed, fold, fault, and unconformity. | Analyse | PSO8 |

**COURSE CONTENT**

| Experiments | 64 Hours |
|---|---|

**1. Illustration with the help of neat diagrams of the following:**

Attitude of beds, true and apparent dip, strike and dip symbols, rules of 'V', types of Folds, Faults, Joints and Unconformities. Maps with suitable sections and geological descriptions

- ❖ Simple horizontal beds – two maps.
- ❖ Study of effect of relief on 'V' of outcrops – four maps.
- ❖ Simple dipping beds – three maps.
- ❖ Simple dipping beds with intrusions – three maps.
- ❖ Tracing the outcrops –with three point problems- Three maps.
- ❖ Problems involving bore hole data, thickness, dip and apparent dip –three

maps.

- ❖ Simple dipping beds with unconformity – five maps.
- ❖ Folded beds – five maps.
- ❖ Maps with different types of faults –five numbers.
- ❖ Combination of intrusions, unconformity, folds and faults –six maps.

**2. Structural problems:**

- ❖ Problems involving true and apparent dip, true vertical thickness and width of outcrops. Three-point problems.

## MODE OF TRANSACTION

**Demonstrations:** Helps to illustrate and consolidate the basic Structural Geology principles outlined in the course.

**Calculation:** This involves learning by doing by applying mathematical expressions to find out the true and apparent dip, true vertical thickness and width of outcrops.

**Drawing:** It involves interpret geological maps and construct geological cross sections, read topographic maps.

## MODE OF ASSESSMENT

**Internal Assessment (20 Marks)**

| | | |
|---|---|---|
| a. | Submission of Record* | 12 Marks |
| b. | Lab involvement | 8 Marks |
| | i. Viva | 4 Marks |
| | ii. Lab skill /performance# | 2 Marks |
| | iii. punctuality$ | 2 Marks |

**Every student has to submit record of experiments and other lab works which is duly certified by the HoD*

*#Skill and performance in doing experiments and observations*

*$Students involvement in the laboratory will be assessed by the course instructor*

**External Assessment (80 Marks):** *Duration 2.5 Hours*

| SEMESTER VI<br>Core Course Practical 05<br>GLO6IH05(P) – ECONOMIC GEOLOGY AND PALEONTOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 4 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome | Learning Domain | PSO No |
|---|---|---|---|
| | Upon completion of this course, students will be able to; | | |
| CO1 | ***Identify*** common economically important minerals in hand specimen | Remember | PSO1 |
| CO2 | ***Identify*** megascopic fossils based on their morphological characters | Understand | PSO1 |

**COURSE CONTENT**

| **Experiments** | **64 Hours** |
|---|---|
| **PART- A** (Economic Geology) | |
| 1. **Megascopic identification and description of Indian occurrences & uses of the following ore and Industrial Minerals:**<br>❖ **Sulphides:** Realgar, Orpiment, Stibnite, Molybdenite, Galena, Sphalerite, Chalcophyrite, Pyrite, Arsenopyrite, Marcasite.<br>❖ **Sulphates:** Barite, Celestite, Gypsum<br>❖ **Oxides:** Cuprite, Corundum, Hematite, Ilmenite, Magnetite, Chromite, Cassiterite, Rutile, Pyrolusite, Psilomelane, Goethite, Limonite, Bauxite<br>❖ **Carbonates:** Calcite, Dolomite, Magnesite, Siderite, Aragonite, Witherite, Strontianite, Cerussite, Azurite, Malachite.<br>❖ **Industrial Minerals:** Halite, Fluorite, Phosphatic Nodule, Monazite, Graphite, Coal and its varities, Asbestos. | |
| **PART-B** (Paleontology) | |
| 2. **Megascopic identification and description of the following fossils with neat diagrams:** | |

- ***Anthozoa***: Calceola, Zaphrentis, Lithostrotion, Favosites, Halysites, Montlivaltia, Isastrea, Thecosmilia;
- ***Brachiopoda***: Sprifer, Productus, Terebratula, Rhynchonella, Athyris, Orthis, Lingula
- ***Echinoderma***: Cidaris, Hemicidaris, Micraster, Holaster, Hemiaster, Pentremites,
- ***Mollusca-Lamellibranchia***: Arca, Cardium, Cardita, Pecten, Trigonia, Megaladon, Spondylus, Gryphaea, Exogyra, Ostrea, Inoceramus, Alectryonia, Hippurities, Venus
- ***Mollusca-Gastropoda***: Natica, Turbo, Trochus, Turritella, Cerithium, Conus, Murex, Fusus, Physa, Bellerophon,
- ***Mollusca-Cepalopoda***: Nautilus, Goniatites, Ceratites, Acanthoceras, Phylloceras, Scaphites, Baculites, Turrilites and Belemnites,
- ***Trilobites***: Paradoxides, Calymene, Phacops, Olenus, Olenellus.
- ***Graptolites***: Phyllograptus, Tetragraptus, Didymograptus, Diplograptus, Monograptus,
- ***Plant fossils***: Glossopteris, Gangamopteris, Ptillophylum, Lepidodendron, Sigillaria, Calamites, Elatocladus, Vertibraria.

## MODE OF TRANSACTION

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Demonstrations:** Helps to illustrate and consolidate geological principles outlined in the course. It also provides students to visually and experientially engage with the principles, techniques, and properties of an economic minerals and megacopic fossils.

**Observation:** It involves observing the megascopic properties of different varieties of Economic minerals and fossil specimens.

## MODE OF ASSESSMENT

**Internal Assessment (15 Marks)**

| | |
|---|---|
| a. Submission of Record* | 9 Marks |
| b. Lab involvement | 6 Marks |
| i. Viva | 3 Marks |

| |
|---|
| ii. Lab skill /performance[#] 1.5 Marks<br>iii. punctuality[$] 1.5 Marks<br><br>[*]*Every student has to submit record of experiments and other lab works which is duly certified by the HoD*<br><br>[#]*Skill and performance in doing experiments and observations*<br><br>[$]*Students involvement in the laboratory will be assessed by the course instructor* |
| **External Assessment (60 Marks):** *Duration 2 Hours* |

| SEMESTER VII<br>Core Course Practical 06<br>GLO7IH06(P) – MINERALOGY, CRYSTALLOGRAPHY, GEOMORPHOLOGY, IGNEOUS AND METAMORPHIC PETROLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 4 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Apply*** the angular relationships between crystal faces – Stereographic projections | Apply | PSO5 |
| CO2 | ***Calculate*** the axial ratios, zone symbols, Napiers's rule, Laws of anharmonic ratios | Apply | PSO5 |
| CO3 | ***Identify*** the Gnomonic projections of the normal class | Analyze | PSO8 |
| CO4 | ***Identify*** mineral specimens based on physical properties and optical properties | Analyze | PSO8 |
| CO5 | ***Prepare*** thin sections of igneous and metamorphic rock samples | Apply | PSO5 |
| CO6 | ***Identify*** the petrography of igneous and metamorphic rocks & metamorphic mineral paragenesis in hand specimens and thin sections and arranging them according to the intensity of metamorphism | Analyze | PSO8 |

**COURSE CONTENT**

| **Experiments** | **64 Hours** |
|---|---|
| **PART- A** (Crystallography) | |
| 1. Spherical projection of Cube, Octahedron and Dodecahedron.<br>2. Stereographic projection of holohedral classes of all the systems, pyritohedral, tetrahedral, plagiohcdral classes of Isometric system and Rhombohedral classes of | |

Hexagonal system.

3. Gnomonic projections of the normal class of Isometric, Tetragonal, Hexagonal and Orthorhombic systems.

4. Calculations of Axial ratios, Zone symbols, Napier's rule, Laws of anharmonic ratio.

**PART-B** (Mineralogy)

1. Megascopic identification and description of the following fossils with neat diagrams: Identification of mineral specimens based on physical properties.

2. Determination of the following optical characters by classical methods:
   - ❖ Order of interference colour
   - ❖ Sign of elongation
   - ❖ Birefringence
   - ❖ Scheme of pleochroism
   - ❖ Optic orientation
   - ❖ Determination of the vibration directions of polariser and analyzer
   - ❖ Extinction and extinction angle determination
   - ❖ Optic sign
   - ❖ Refractive index by Becke line method
   - ❖ Identification of thin sections of important rock forming minerals

3. Recalculation of mineral formula from EPMA analysis – ***Garnet***; ***Pyroxene***; ***Feldspar***; ***Biotite***; ***Hornblende***.

**PART-C** (Geomorphology)

1. Interpretation of toposheets and identification of geomorphic features, fluvial and coastal land forms.

2. Calculation of surface area and slope.

3. Study of drainage pattern and morphometric analysis.

**PART-D** (Igneous and Metamorphic Petrology)

1. Preparation of thin sections of igneous and metamorphic rock samples (2 nos. each)**;** Petrography of igneous and metamorphic rocks**;** Textures and structures of igneous and metamorphic rocks and their genetic significance with neat sketches.

2. Determination of modal composition, Calculation of norm (25 exercises)**;** Niggli

values; Variation diagrams Harker, Larsen, Niggli; Calculation of Differentiation index; Peacock alkali-lime index; Use of triangular diagram in the classification of igneous rocks; Use of triangular diagram in the classification of igneous rocks.

3. Identification of metamorphic mineral paragenesis in hand specimens and thin sections and arranging them according to the intensity of metamorphism; Graphical representation of metamorphic mineral parageneses; ACF and AKF diagrams; AFM diagrams.

4. Construction of phase diagrams based on experimental data of the following systems- Albite-anorthite; Forsterite-fayalite; Diopside- anorthite; Diopside – albite; Forsterite -silica.

## MODE OF TRANSACTION

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Demonstrations:** Helps to illustrate and consolidate theoretical principles outlined in the course. It also provides students to visually and experientially engage with the principles, techniques, and properties of crystals.

**Virtual or online simulations**: In situations where access to physical crystals or laboratory facilities is limited, virtual or online simulations can be used to simulate crystallography practicals. These simulations can provide a realistic and interactive experience, allowing participants to manipulate virtual crystals, perform measurements, and analyze crystal structures.

**Observation:** It involves observing the megascopic and microscopic properties of a mineral and rocks with the help of a petrological microscope and also through hand specimens.

## MODE OF ASSESSMENT

**Internal Assessment (15 Marks)**

a. Submission of Record* 9 Marks
b. Lab involvement 6 Marks
    i. Viva 3 Marks
    ii. Lab skill /performance# 1.5 Marks
    iii. punctuality$ 1.5 Marks

| |
|---|
| [*]*Every student has to submit record of experiments and other lab works which is duly certified by the HoD*<br>[#]*Skill and performance in doing experiments and observations*<br>[$]*Students involvement in the laboratory will be assessed by the course instructor* |
| **External Assessment (60 Marks):** *Duration 2 Hours* |

| SEMESTER VIII<br>Core Course Practical 07<br>GLO8IH07(P) – STRUCTURAL GEOLOGY, GEOPHYSICS AND ECONOMIC GEOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 5 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Interpret*** the geologic maps. | Understand | PSO4 |
| CO2 | ***Apply*** stereographic solutions to problems in structural geology. | Apply | PSO5 |
| CO3 | ***Interpret*** the geometric analysis of planar and linear structures | Understand | PSO2 |
| CO4 | ***Identify*** ore mineral specimens using physical properties & thin sections of important ore forming minerals | Analyze | PSO8 |

**COURSE CONTENT**

| **Experiments** | **64 Hours** |
|---|---|
| **PART- A** (Structural Geology) | |
| 1. Interpretation of geologic maps;<br>2. Trigonometric, graphic and stereographic solutions to problems in structural geology;<br>3. Geometric analysis of planar and linear structures;<br>4. Fabric diagrams, Rose diagrams and histograms | |
| **PART-B** (Geophysics) | |
| 1. Electrical profiling and sounding.<br>2. Gravity measurement at few selected points, study of the drift of gravimeter.<br>3. Measurement of horizontal and vertical components of the earth's magnetic field. | |

4. Simple exercises on seismic exploration.

**PART-C** (Economic Geology)

1. Identification of important ore minerals.
2. Collection and display of data on production, consumption and export of important minerals.
3. Identification of ore minerals under ore microscope.
4. Genetic significance of important ore.

## MODE OF TRANSACTION

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Demonstrations:** Helps to illustrate and consolidate theoretical principles outlined in the course.

**Experimentation:** This involves learning by doing or hands on experience by applying geophysical and geological principles.

**Observation:** It involves noticing or perceiving values or measurements on equipment and acquisition of information from the primary source

## MODE OF ASSESSMENT

**Internal Assessment (15 Marks)**

| | | |
|---|---|---|
| a. | Submission of Record* | 9 Marks |
| b. | Lab involvement | 6 Marks |
| i. | Viva | 3 Marks |
| ii. | Lab skill /performance# | 1.5 Marks |
| iii. | punctuality$ | 1.5 Marks |

**Every student has to submit record of experiments and other lab works which is duly certified by the HoD*

*#Skill and performance in doing experiments and observations*

*$Students involvement in the laboratory will be assessed by the course instructor*

**External Assessment (60 Marks):** *Duration 2 Hours*

| SEMESTER IX<br>Core Course Practical 08<br>GLO9IH08(P) – SEDIMENTOLOGY, HYDROGEOLOGY, REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 5 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Explain*** sieve analysis, plotting and interpreting the data | Apply | PSO5 |
| CO2 | ***Identify*** heavy minerals in thin section | Analyze | PSO8 |
| CO3 | ***Solve*** problems on Porosity, permeability, void ratio and Darcy's Law. Computation of aquifer parameters from pump test data. | Apply | PSO5 |
| CO4 | ***Prepare*** and ***interpret*** water table contour maps | Apply | PSO5 |
| CO5 | ***Interpret*** graphical representation of hydro chemical data | Understand | PSO3 |
| CO6 | ***Use*** GIS software for various geological purposes. | Apply | PSO5 |

**COURSE CONTENT**

| **Experiments** | **64 Hours** |
|---|---|
| **PART- A** (Sedimentology) | |
| 1. Study of clastic and non-clastic rocks in hand specimen.<br>2. Microscopic examination of important rock types.<br>3. Separation of heavy minerals and study of their microscopic charcteristics.<br>4. Grain size analysis by sieving, plotting of size distribution data.<br>5. Determination of roundness and sphericity of grains. | |

**PART-B** (Hydrogeology)

1. Preparation and interpretation of water table contour maps.
2. Problems on Porosity, permeability, void ratio and Darcy's Law. Computation of aquifer parameters from pump test data.
3. Graphical representation of hydro chemical data - Piper trilinear diagram, USSL Diagram, Stiffs polygon.
4. Calculation of various parameters based on chemical data, electrical resistivity survey and interpretation of data.

**PART-C** (Remote Sensing and Geographic Information System)

1. Georeferencing, plotting of points, lines, polygons.
2. Length and area calculation
3. Map making – layout creation
4. Basics of digital image processing
5. Band combinations of satellite data
6. Gathering satellite images from USGS and Bhuvan
7. Extraction of features
8. Classification of features.

## MODE OF TRANSACTION

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Demonstrations:** Helps to illustrate and consolidate theoretical principles outlined in the course.

**Experimentation:** This involves learning by doing or hands on experience by applying sedimentological principles.

**Observation:** It involves noticing or perceiving values or measurements on equipment and acquisition of information from the primary source.

## MODE OF ASSESSMENT

**Internal Assessment (15 Marks)**

| | | |
|---|---|---|
| a. | Submission of Record* | 9 Marks |
| b. | Lab involvement | 6 Marks |
| | i. Viva | 3 Marks |

| | |
|---|---|
| ii. Lab skill /performance[#] | 1.5 Marks |
| iii. punctuality[$] | 1.5 Marks |

[*]*Every student has to submit record of experiments and other lab works which is duly certified by the HoD*

[#]*Skill and performance in doing experiments and observations*

[$]*Students involvement in the laboratory will be assessed by the course instructor*

**External Assessment (60 Marks):** *Duration 2 Hours*

| SEMESTER X<br>Core Course Practical 09<br>GL10IH09(P) – ADVANCED PALAEONTOLOGY AND GEOCHEMISTRY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Identify*** different microfossils in thin section | Analyze | PSO8 |
| CO2 | ***Prepare*** microfossil slides of their own. | Apply | PSO5 |
| CO3 | ***Determine*** different elements and oxides in rock samples/water samples | Evaluate | PSO10 |

**COURSE CONTENT**

| **Experiments** | **64 Hours** |
|---|---|
| **PART- A** (Advanced Palaeontology) | |
| 1. Separation of microfossils and preparation of slides of Ostracoda, Foraminifera and Bryozoa.<br>2. Identification and study of microfossils in slides, at least 10 Nos. | |
| **PART-B** (Geochemistry) | |
| 1. Chemical Analysis of elements and oxides for Rock Sample/Sediments/Water samples using various methods (Titration, AASS, UV Spectrophotometer and Flame Photometer)<br>2. Calculation of isotope proportions in samples.<br>3. Determination of pH of groundwater samples<br>4. Calculation of bulk rock compositions from modal mineralogy and mineral chemistry<br>5. Calculation of δ18O in water reservoirs and ice-cores<br>6. Calculation of palaeo sea-surface temperatures | |

7. Calculation of age of rock samples based on different decay schemes

## MODE OF TRANSACTION

**Demonstrations:** Helps to illustrate and consolidate theoretical principles outlined in the course.

**Experimentation:** This involves learning by doing or hands on experience by applying chemical and palaeontological principles.

**Observation:** It involves noticing or perceiving chemical change or measurements on equipment and acquisition of information from the primary source.

## MODE OF ASSESSMENT

**Internal Assessment (15 Marks)**

| | | |
|---|---|---|
| a. | Submission of Record* | 9 Marks |
| b. | Lab involvement | 6 Marks |
| | i. Viva | 3 Marks |
| | ii. Lab skill /performance# | 1.5 Marks |
| | iii. punctuality$ | 1.5 Marks |

**Every student has to submit record of experiments and other lab works which is duly certified by the HoD*

*#Skill and performance in doing experiments and observations*

*$Students involvement in the laboratory will be assessed by the course instructor*

**External Assessment (60 Marks):** *Duration 2 Hours*

# CORE COURSE: ELECTIVE

## (THEORY)

| SEMESTER VI<br>Core Course: Elective 1#<br>GLO6IE01(E01a) – REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Define*** and ***use*** of Remote Sensing | Remember<br>Apply | PSO1<br>PSO5 |
| CO2 | ***Define*** and ***use*** of Global Positioning System | Understand<br>Apply | PSO3<br>PSO5 |
| CO3 | ***Discuss*** and ***use*** Geographic Information System | Understand<br>Apply | PSO4<br>PSO5 |
| CO4 | ***Discuss*** basics of Geographic Information System database | Understand | PSO4 |

**COURSE CONTENT**

| **Unit 1.** | **9 Hours** |
|---|---|
| 1.1. History and development of Remote Sensing. Basic concepts and principles of Remote Sensing.<br>1.2. Introduction to electromagnetic radiation and electromagnetic spectrum. Interaction of EMR with objects and Atmosphere.<br>1.3. Passive and Active remote sensing. Platforms and Sensors. Different resolutions concepts, pixel size and scale. | |
| **Unit 2.** | **9 Hours** |
| 2.1. Introduction to the basics of aerial photography and photogrammetry<br>2.2. Introduction to GPS, Orbit elements, Types of orbits, Motions of planets and satellites<br>2.3. Satellites and their characteristics, Sun synchronous and geo-synchronous satellites, basics of visual interpretation of satellite images and their keys. | |

| **Unit 3.** | **12 Hours** |
|---|---|
| 3.1. Brief history of GIS; Introduction to GIS – definition, concepts and components of GIS, Geospatial data type<br>3.2. GIS system, GIS science and GIS applications; Definition of map, different types of thematic maps, scale<br>3.3. Geographic coordinate system, Datum; Types of map projections; commonly used map projections; Projected Coordinate System. | |
| **Unit 4.** | **9 Hours** |
| 4.1. Visualization of geographical data, Basic ideas about data visualization, Geo-referencing, Maps and cartographic communication.<br>4.2. Digital representation of geographic data: Data structure, spatial data model, raster and vector models. Comparison of raster and Vector data. | |
| **Unit 5.** | **9 Hours** |
| 5.1. GIS Data Management: GIS File Data Formats-Vector Data File Formats and Raster Data File Formats<br>5.2. Database design - editing and topology creation in GIS, linkage between spatial and non-spatial data<br>5.3. Database Management System, Types of data management system | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents. |

| **MODE OF ASSESSMENT** |
|---|
| **Internal Assessment (15 Marks)**<br>a. Classroom participation (20%): 3 Mark<br>b. Test papers I (40%): 6 Mark |

| | | | | |
|---|---|---|---|---|
| c. Assignment (20%): 3 Mark<br>d. Seminar/ Viva (20%): 3 Mark | | | | |
| **External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21* | | | | |
| **PATTERN OF QUESTION PAPER** | | | | |
| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
| Short answer | 12 | Up to 12 | 2 | 20 |
| Paragraph | 7 | Up to 7 | 5 | 30 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 12 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 12 |

**REFERENCES:**


1. Drury S.A. 1987. Image interpretation in Geology.Chapman and Hall.
2. Gupta R.P. 1991 Remote Sensing Geology. Springer-Verlag.
3. Lillisand, T. M. and Keifer, R. W., 2007 : Remote sensing and image interpretation John Willey and Sons, USA
4. Chang.T.K. 2002: Geographic Information Systems. Tata McGrawHill
5. Heywood.I, Cornelius S and CrverSteve. 2003: An Introduction to Geographical Information Systems. Pearson Education
6. Wise S.2002: GIS Basics. Taylor Publications
7. ESRI Map book: GIS the Language of Geography by ESRI-USA ESRI-2004

| SEMESTER VI<br>Core Course: Elective 1#<br>GLO6IE01(E01b) – ENVIRONMENTAL GEOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Recall*** various biosphere- geosphere interactions | Remember | PSO3 |
| CO2 | ***Explain*** how earth processes create hazards to life and property | Apply | PSO5 |
| CO3 | ***Discuss*** the occurrence and formation of earth resources and significant environmental effects caused by their extraction, processing, and use. | Understand | PSO3 |
| CO4 | ***Classify*** the major sources of water pollution and ***develop*** methods for their management | Understand<br>Create | PSO3<br>PSO15 |
| CO5 | ***Classify*** the methods of solid and radioactive waste management | Understand | PSO3 |
| CO6 | ***Classify*** various aspects of environmental regulations in India | Understand | PSO3 |

**COURSE CONTENT**

| **Unit 1.** | **9 Hours** |
|---|---|
| 1.1. Introduction: Earth, man and environment: Basic environmental problems. Geoscience factors in environmental planning. Environmental Geosciences-fundamental concepts.<br>1.2. The Earth Systems and Biosphere: Conservation of matter in various geospheres - lithosphere, hydrosphere, atmosphere and biosphere. Concepts of ecology / Ecosystems. Biogeographical zonations of earth. The earth's major ecosystems-terrestrial and aquatic. | |
| **Unit 2.** | **9 Hours** |

| | |
|---|---|
| 2.1. Earth's Processes and Geological Hazards Earth's Processes and Geological Hazard: Earth's processes; Concept of residence time and rates of natural cycles.<br>2.2. Catastophic geological hazards. Study of floods, landslides, earthquakes, volcanism and avalanche, with a view to assess the magnitude of the problem, prediction and perception of the hazards. | |
| **Unit 3.** | **10 Hours** |
| 3.1. MINERAL RESOURCES AND ENVIRONMENT: Resource and Reserves. Environmental impact of exploitation, processing and smelting of minerals.<br>3.2. ENERGY RESOURCES AND ENVIRONMENT: Environmental effects associated with each types of energy resource, viz. Petroleum, natural gas, hydropower, nuclear, coal, solar and wind energy. | |
| **Unit 4.** | **10 Hours** |
| 4.1. WATER RESOURCE AND ENVIRONMENT: Global Water Balance. Ice Sheets and fluctuations of sea levels. Origin and composition of sea water. Resources of oceans. Ocean pollution by toxic wastes. Human Use of Surface and Ground Waters. Ground Water Pollution. | |
| **Unit 5.** | **10 Hours** |
| 5.1. WASTE DISPOSAL: Solid waste disposal - geology in planning and siting of land fills. Radioactive waste management.<br>5.2. ENVIRONMENTAL LAW: Environmental legistation in India. | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents. |

| **MODE OF ASSESSMENT** |
|---|

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| Short answer | 12 | Up to 12 | 2 | 20 |
| Paragraph | 7 | Up to 7 | 5 | 30 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

**UNITS WISE MARK DISTRIBUTION**

| **Units** | **Mark** |
|---|---|
| Unit 1. | 12 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 12 |

**REFERENCES:**


1. Keller, E.A.: Environmental Geology: CBS Publisher, New Delhi.
2. Valdiya, K.S. : Environmental Geology-Indian Context. Tata McGraw Hill Publ. Co., Bombay.
3. Coates, D.R: Geology and Society. Chapman & Hall,New York.
4. Bryant, E.: Natural Hazard. Camb. Univ. Press.

| SEMESTER VI<br>Core Course: Elective 1#<br>GLO6IE01(E01c) – ENGINEERING GEOLOGY AND HYDROGEOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Describe*** basic information regarding groundwater geology | Remember | PSO3 |
| CO2 | ***Examine*** different Surface and subsurface methods of groundwater explorations | Apply | PSO5 |
| CO3 | ***Identify*** preliminary information's about engineering geology | Analyze | PSO6 |

**COURSE CONTENT**

| **Unit 1.** | **9 Hours** |
|---|---|
| 1.1. Hydrologic cycle and its components.<br>1.2. Origin, occurrence, accumulation and migration of water<br>1.3. Introduction to Hydrological properties of rocks | |
| **Unit 2.** | **9 Hours** |
| 2.1. Groundwater geology: Aquifer systems, Type and properties.<br>2.2. Natural and Artificial Recharge of Ground Water<br>2.3. Ground Water flow: Head distribution, Darcy's Law | |
| **Unit 3.** | **10 Hours** |
| 3.1. Surface and Subsurface method of Ground water Exploration<br>3.2. Physical and Chemical Quality of Ground Water.<br>3.3. Ground water provinces of India | |
| **Unit 4.** | **10 Hours** |
| 4.1. Introduction to Role of Geology in civil construction.<br>4.2. Stages of Geological site Investigations for selection of site for engineering | |

structures: **Desk study**: Analysis of Remote sensing data, Geological maps, cross sections and written reports.

4.3. **Subsurface site characterization**: Coring, logging, introduction to application of geophysical methods. Emphasis on preconstruction geological analysis to recognize potential hazards and problems..

| **Unit 5.** | **10 Hours** |
|---|---|

5.1. Physical and Mechanical properties of rocks: Concepts of stress, strain, Mohr circle and failure theories.

5.2. Strength, deformation, hydraulic aspects, geostresses, Weathering and Discontinuities in rock masses. Engineering classification of Rocks. Construction materials

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| Short answer | 12 | Up to 12 | 2 | 20 |

| | | | | |
|---|---|---|---|---|
| Paragraph | 7 | Up to 7 | 5 | 30 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 12 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 12 |

**REFERENCES:**


1. K.R Karanth, 1989. Hydrogeology, Tata McGraw Hill
2. Bell, F.G. 1983. Fundamentals of engineering geology, Butterworths
3. D.K. Todd, 1980.Groundwater Hydrology, John Wiley and Sons.
4. C.F. Tolman, 1937.Groundwater, McGraw Hill, New York.
5. H.M. Raghunath, 1987Groundwater, Wiley Eastern. Calcutta.
6. Beavis, F.C. 1985. Engineering geology.
7. Krynine, D.P. Judd, W.P. 1957, Principles of Engineering Geology, McGraw Hill,
8. Davis, S.N. & De Wiest, R.J.N. 1966. Hydrogeology. John Wiley & Sons, New York.
9. Krynine, D.P. & Judd, W.R. 1957. Principles of engineering geology and geotechnique.
10. McGraw Hill, New Yprk.
11. Goodman, R.E. 1980. Introduction to rock mechanics.
12. Schuster, R.L. & Krizek, R.J. 1978. Landslide analysis and control. National Academy of Science, Washington DC.

| SEMESTER IX<br>Core Course: Elective 2#<br>GLO9IE02(E02a) – ADVANCED ENVIRONMENTAL GEOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Explain*** the major geological processes on the surface of the Earth | Understand | PSO2 |
| CO2 | ***Summarize*** how anthropogenic activities are modifying natural environmental processes | Understand | PSO3 |
| CO3 | ***Develop*** remedial measures for management of natural resources and mitigation of environmental pollution. | Analyze | PSO9 |

**COURSE CONTENT**

| **Unit 1.** | **10 Hours** |
|---|---|
| 1.1. Foundations of Environmental Geology- Environmental Crisis- Human population growth and Sustainability.<br>1.2. Earth Cycles and Systems- hydrologic-, Rock-, Geochemical-, cycles, Earth as a system- Environmental Ethics.<br>1.3. Ecology and geology-ecosystem- ecosystem function-Stream Processes and Ecology. Natural Service Functions of Ecosystems. Geology and Biodiversity- Factors that Increase or Decrease Biodiversity. Human Domination of Ecosystems- Ecological Restoration. | |
| **Unit 2.** | **10 Hours** |
| 2.1. Water: A Brief Global Perspective. Surface Runoff and Sediment Yield. Factors Affecting Runoff and Sediment Yield. Groundwater Movement. Interactions between Surface Water and Groundwater. Desalination. Water use and conservation.Measures of Water Quality, Water management.<br>2.2. Water pollution- Residence Time, Pollutants- Biochemical Oxygen Demand, Eutrophication, Oxygen-Demanding Waste. Pathogenic Organisms, Nutrients, oil. Toxic substances- Synthetic Organic Chemicals. Heavy Metals. | |

| | |
|---|---|
| 2.3. Surface-Water Pollution and Treatment- Point and Nonpoint Sources of Surface-Water Pollution. Reduction of Surface-Water Pollution. Urban Flooding and Water Pollution. Groundwater Pollution and Treatment, Tracing Pollution's Path, Saltwater Intrusion, Water-Quality Standards. Wastewater Treatment- Wetlands as Wastewater Treatment Sites, Reversing the Damage- Surface water and Ground Water- Decontamination after Extraction, In Situ Decontamination | |
| **Unit 3.** | **9 Hours** |
| 3.1. Environmental Impact of Mineral Development- Impact of Mineral Exploration and Testing. Impact of Mineral Extraction and Processing. Recycling Mineral Resources- Minerals and Sustainability, Mine Reclamation.<br>3.2. Energy Supply and Energy Demand- Fossil Fuels- Environmental impact of coal mining- Fossil fuels and acid rain- solution to acid rain problem. Radioactive Waste and Management- Transuranic Waste- High-Level Radioactive Wastes.<br>3.3. Geology of Geothermal Energy- Environmental Impact of Geothermal Energy Development. Renewable Energy Sources- Sustainable Energy Policy. | |
| **Unit 4.** | **10 Hours** |
| 4.1. Soil Profiles- Soil Properties, Soil erosion, Strategies for Reducing Erosion. Sediment Pollution- Land Use and Environmental Problems of Soils. Geology and Environmental Health- Chronic Disease and the Geologic Environment.<br>4.2. Air Pollution- Geologic Perspective, Types and Sources of Air Pollution- Particulate Matter: PM 10 and PM 2.5. Urban Air Pollution. Influence of Meteorology and Topography. Indoor Air Pollution. Air-Quality Standards, Carbon Sequestration<br>4.3. Waste Management and Geology- Integrated Waste Management. Solid Waste Disposal, Reducing Solid-Waste Volume, Recycling, Hazardous Waste Management, Radioactive Wastes, Bedrock Disposal of Solid High-Level Wastes. | |
| **Unit 5.** | **9 Hours** |
| 5.1. Environmental Analysis- Site Selection, Environmental Impact Analysis.<br>5.2. Environmental Law, Pollution and Its Control- International Initiatives. Laws Relating to Geologic Hazards. | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class |

which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Marks** |
|---|---|---|---|---|
| Short answer | 11 | 9 | 2 | 18 |
| Paragraph | 6 | 4 | 8 | 32 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

**UNITS WISE MARK DISTRIBUTION**

| **Units** | **Mark** |
|---|---|
| Unit 1. | 12 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 12 |

**REFERENCES:**

1. Environmental Geology, Tenth Edition, Montgomery, C. W., 2013
2. Introduction to Environmental Geology, V$^{th}$ Edn, Edward A. Keller, Pearson Education, Inc., 2012

| SEMESTER IX<br>Core Course: Elective 2#<br>GLO9IE02(E02b) – PRECAMBRIAN CRUSTAL EVOLUTION | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Explain*** the major geological processes on the surface of the Earth | Understand | PSO2 |
| CO2 | ***Summarize*** the structures of Earth and describe the properties of different layers. | Understand | PSO3 |
| CO3 | ***Explain*** the early atmosphere and how and why free oxygen finally increased. | Understand | PSO3 |
| CO4 | ***Manipulate*** how the early continents came together | Apply | PSO5 |
| CO5 | ***Summarize*** the orogenic processes and mineral deposits through geological time | Understand | PSO3 |

**COURSE CONTENT**

| **Unit 1.** | **9 Hours** |
|---|---|
| 1.1. Geological time span.<br>1.2. Early earth features. Mountain Building activity. Era- Breaking up of Pangea- the Precambrian- Hadean, Archean, Proterozoic, Structure of the Earth. | |
| **Unit 2.** | **10 Hours** |
| 2.1. Magma of Ocean- Composition of early Crust- Solidifying Basalt. The earth hotspot and fluid basalts.<br>2.2. Lithosphere and Mantle reactions.<br>2.3. Origin of the crust. Lower crust-first continents, Early continental crust, Growth of crust- Mechanism of continental growth and its growth rate. Growth of Continents. | |
| **Unit 3.** | **10 Hours** |
| 3.1. Primary Atmosphere. Secondary Atmosphere. Oxygen in the atmosphere, geologic | |

| | |
|---|---|
| indicators of atmosphere-BIFs of Precambrian. Red beds, sulfates and Detrital uraninite and Pyrites, Decreasing Heat in Precambrian Time. paleosols –Biological indicators. Ocean prevailing theory, outgassing.<br>3.2. Life in Archean Proterozoic orogeny. Earth- Moon system. Plate tectonics in the Precambrian. | |
| **Unit 4.** | **9 Hours** |
| 4.1. Precambrian mineral Deposits. Proterozoic life. oldest rocks. Continental foundation.<br>4.2. Distribution of Precambrian rocks. Proterozoic tectonics. Proterozoic assembly of lauresia, Proterozoic oxygen rocks. atmosphere- Precambrian assembly of Rodinia-grenville orogeny – Proterozoic rifting. Mid-continent rift- snowball earth. | |
| **Unit 5.** | **10 Hours** |
| 5.1. Crustal provinces- Precambrian provinces of India.<br>5.2. Cratons of I- hadean Crust. Archean and Proterozoic. Shield areas- Canadian Shield. Archean rocks. Green stone belt of India. Cratons,Origin of Cratons, Rift Valleys, Mobile belts, Archean mineral Resources and Proterozoic Sedimentary Basin in India. | |

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

| **External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21* | | | | |
|---|---|---|---|---|
| **PATTERN OF QUESTION PAPER** | | | | |
| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Marks** |
| Short answer | 11 | 9 | 2 | 18 |
| Paragraph | 6 | 4 | 8 | 32 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 12 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 12 |

**REFERENCES:**


1. Archaean Geology- C.S. Pichamuthu
2. Early Precambrian supracrustal of southern Karnataka-Memoir 112. Geol.Surv. Ind
3. Geology of Karantaka- B.P Radhakrishna
4. Geology of India (Volume 1 and 2)- R.Vaidyanathan and M. Ramakrishnan
5. Geology of India and Burma- M.S Krishnan
6. Geology of India- M. Wadia
7. Crustal Evolution and Metalogeny in India- Sanib Chandra Sarkar and Anupendu Gupta

| SEMESTER IX<br>Core Course: Elective 2#<br>GLO9IE02(E02c) – QUATERNARY GEOLOGY AND PALEOCLIMATE | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Explain*** the Quaternary stratigraphy | Remember | PSO1 |
| CO2 | ***Summarize*** the Quaternary dating methods | Understand | PSO4 |
| CO3 | ***Explain*** the Quaternary stratigraphy of India | Understand | PSO3 |
| CO4 | ***Explain*** the paleoclimate and its reconstruction | Understand | PSO3 |

**COURSE CONTENT**

| **Unit 1.** | **10 Hours** |
|---|---|
| 1.1. Quaternary Geology Definition of Quaternary, The Character of Quaternary, Duration of the Quaternary and development of Quaternary studies.<br>1.2. Quaternary stratigraphy- Oxygen isotope stratigraphy, biostratigraphy and magnetostratigraphy. | |
| **Unit 2.** | **10 Hours** |
| 2.1. Response of geomorphic, neotectonic, active tectonics and their application to natural hazard assessment.<br>2.2. Quaternary dating methods: Radiocarbon, Uranium series Luminescence, Amino Acid, Relative dating methods. | |
| **Unit 3.** | **9 Hours** |
| 3.1. Application of pollen, spores and phytoliths in Quaternary stratigraphy.<br>3.2. Quaternary stratigraphy of India.<br>3.3. Continental records (fluvial, glacial, Aeolian, Paleosols and duricrust); marine records; continental marine correlation of Quaternary record. | |

| | |
|---|---|
| 3.4. Evolution of Man and Stone Age culture.<br>3.5. Plant and animal life in relation to glacial and interglacial cycles during Quaternary. | |
| **Unit 4.** | **10 Hours** |
| 4.1. Paleoclimatology: Introduction to climate and climate systems, Global climate pattern, Climate controlling factors.<br>4.2. Global energy budget, Plate tectonics and climate change, Milankovitch cycles, Atmosphere and Ocean interaction and its effect on climate. | |
| **Unit 5.** | **9 Hours** |
| 5.1. An Overview of Paleoclimatic reconstruction; Pleistocene Glacial-Interglacial cycles<br>5.2. Future Climate: Anthropogenic activity and its effect on Global climate. | |

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

| | | |
|---|---|---|
| a. | Classroom participation (20%): | 3 Mark |
| b. | Test papers I (40%): | 6 Mark |
| c. | Assignment (20%): | 3 Mark |
| d. | Seminar/ Viva (20%): | 3 Mark |

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| Pattern | Total No. of questions | No. of questions to be answered | Marks for each question | Marks |
|---|---|---|---|---|
| Short answer | 11 | 9 | 2 | 18 |
| Paragraph | 6 | 4 | 8 | 32 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 12 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 12 |

**REFERENCES:**


1. Earth's climate past and future By Ruddimen
2. Bigg, G., Ocean and Climate
3. Bradley, Paleoclimatology Reconstructing Climates of the Quaternary.
4. Maher and Thompson, Quaternary Climates, Environments and Magnetism.

| SEMESTER IX<br>Core Course: Elective 3#<br>GLO9IE03(E03a) – MARINE GEOLOGY AND OCEANOGRAPHY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Explain*** the Ocean bottom topography | Remember | PSO1 |
| CO2 | ***Summarize*** the physical and chemical properties of seawater | Understand | PSO4 |
| CO3 | ***Explain*** the distribution and classification of marine sediments | Understand | PSO3 |
| CO4 | ***Explain*** the major Surface currents in world ocean and Atmospheric disturbances – El Nino and LaNina | Understand | PSO3 |
| CO5 | ***Assess*** the coastal geomorphology and processes | Evaluate | PSO10 |

**COURSE CONTENT**

| **Unit 1.** | **10 Hours** |
|---|---|
| 1.1. History of Marine geological studies contribution of Challenger Expedition JOIDES resolution.<br>1.2. Hypsometry-Sea bottom topography, Submarine canyons, trenches, volcanoes, midoceanic ridges and abyssal plains.<br>1.3. Marine Mineral resources: Controlling factors and distribution<br>1.4. Eustatic changes of sea level: evidences. | |
| **Unit 2.** | **10 Hours** |
| 2.1. Physical properties of seawater: distribution of temperature, pressure and density-Thermocline, Pycnocline, halocline.<br>2.2. Chemical properties of seawater elements and dissolved gases present in sea water.<br>2.3. Salinity and distribution of salinity.<br>2.4. Marine sediments: Distribution and classification, CCD, Oxygen Minimum layer | |

| | |
|---|---|
| in Ocean. | |
| **Unit 3.** | **10 Hours** |
| 3.1. Coriolis effect, Circulation: general circulation of the atmosphere boundaries - major surface currents of the world oceans, Ekman spiral, geostrophic currents, upwelling and sinking, diverging and converging surface water<br>3.2. Thermohaline circulation | |
| **Unit 4.** | **9 Hours** |
| 4.1. Coupled ocean atmosphere system.<br>4.2. EL Nino southern oscillation (ENSO), LaNina,<br>4.3. General weather systems of India, Monsoon system<br>4.4. Cyclone and anticyclone, Jet stream. | |
| **Unit 5.** | **9 Hours** |
| 5.1. Coastal processes: waves, currents and tides.<br>5.2. Coastal geomorphology, classification of coasts; Coastal erosion. Coastal protection structures seawalls, jetties, groins.<br>5.3. Coastal Regulatory zone (CRZ) Continental margin: features of continental shelf, continental slope and continental rise. | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br><br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br><br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents. |

| **MODE OF ASSESSMENT** |
|---|
| **Internal Assessment (15 Marks)**<br>a. Classroom participation (20%): 3 Mark<br>b. Test papers I (40%): 6 Mark<br>c. Assignment (20%): 3 Mark |

| |
|---|
| d. Seminar/ Viva (20%): 3 Mark |
| **External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21* |
| **PATTERN OF QUESTION PAPER** |

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Marks** |
|---|---|---|---|---|
| Short answer | 11 | 9 | 2 | 18 |
| Paragraph | 6 | 4 | 8 | 32 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 12 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 12 |

**REFERENCES:**


1. Tom Garrison – Essentials of Oceanography
2. Trujillo and Thurman – Essentials of Oceanography
3. John Marshall, R Alan Plumb – Atmosphere, Ocean and Climate Dynamics- An introductory Text
4. Robert H Stewart – Introduction to physical Oceanography
5. Yasso, W. E., Oceanography
6. Trask, P. D., Recent Marine sediments, Dover publications, 1939
7. Weisberg, J., and Parish, R, Introductory Oceanography. .McGraw Hill, 1974Text Books
8. J.P.Kennet (1982) Marine geology. Printice Hall Inc., New Jersy, 813p.

9. E. Seibold & W.H.Berger (1982) The sea floor. Springer-Verlag, Berlin.
10. J.Weisberg & H. Parish (1974). Introductory Oceanograpghy. McGraw Hill.
11. B.W.Pipkin, D.S.Gorslin, R.E.Casey & D.E. Hammord (1972). Laboratory exercises in oceanography. W.H.Freeman & Co., San Francisco, 255p.

| SEMESTER IX<br>Core Course: Elective 3#<br>GLO9IE03(E03b) - DISASTER MANAGEMENT | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Explain*** the various causes of natural, manmade disasters and mitigation measures to reduce its effects on humans | Remember | PSO1 |
| CO2 | ***Explain*** the major hazards of Kerala, its causes and vulnerability of its communities | Understand | PSO1 |
| CO3 | ***Develop*** strategic approaches towards disaster risk reduction and the relation between vulnerability, disasters, disaster prevention and risk reduction | Analyze | PSO9 |

**COURSE CONTENT**

| **Unit 1.** | **9 Hours** |
|---|---|
| 1.1. Introduction- Hazard and Disaster: Definition and Terminologies, Classification.<br>1.2. Understanding Disaster Management: Comprehensive Disaster Management Plan and it's Elements<br>1.3. Disaster Management Act-2005and its Institutional Framework- Policy and Administrative frame work for Disaster Management | |
| **Unit 2.** | **10 Hours** |
| 2.1. Understanding Natural Disasters: Earth Quake, Landslides, Avalanches, Volcanic eruptions. Heat and Cold waves, Coastal Disasters, Cyclone, Flood, Drought, Tsunami. | |
| **Unit 3.** | **10 Hours** |
| 3.1. Understanding Man-made Disasters: Nuclear Disasters, Chemical Disasters,<br>3.2. Biological Disasters, Building fire, Coal fire, Forest fire and Oil fire, Rail accident, Road accidents, Air accidents, Sea accidents, Dams and Dam bursts, Air pollution, | |

| | |
|---|---|
| 3.3. Water pollution, Industrial pollution, Climate change: Global warming, sea level rise, Ozone Depletion. | |
| **Unit 4.** | **10 Hours** |
| 4.1. Hazard, Risk and Vulnerability: Concept and Elements, Risk Reduction Disaster Management<br>4.2. Prevention, Preparedness and Mitigation<br>4.3. Disaster Preparedness Plan, Role of Information, Education, Communication and Training<br>4.4. Role of various Agencies in Disaster Response, NGO's, Armed Forces, Police and other Forces. | |
| **Unit 5.** | **9 Hours** |
| 5.1. Potential hazards in Kerala with special reference to landslides and coastal erosion during the monsoons.<br>5.2. Manmade drought during summer, saline water intrusion along the coastal aquifers – mitigation measures.<br>5.3. Cyclone, drought and flood in various parts of India – frequency of occurrence, vulnerable areas- reasons. | |

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

| **External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21* | | | | |
|---|---|---|---|---|
| **PATTERN OF QUESTION PAPER** | | | | |
| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Marks** |
| Short answer | 11 | 9 | 2 | 18 |
| Paragraph | 6 | 4 | 8 | 32 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 12 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 12 |

**REFERENCES:**


1. Abbot. P.C (2002): Natural Disaster, McGraw Hill Publications New Delhi
2. Coates. D.R (1985) Geology & Society – Chapman & Hall Publishers New Delhi
3. Davis et.al (1976) Environmental Geosciences – Wiley Eastern
4. Howard A.D & Irwin Remson (1978) – Geology in Environmental Planning – McGraw Hill Publishers 5. Keller E.A (1976) – Environmental Geology – Charles E Merril publishers – New Jersey
5. Lundgren. L(1986) Environmental Geology – Prentice Hall Publication- New Jersey
6. Strahler N & Strahler A.H ( 1973) – Environmental Geosciences Wiley eastern publishers

| SEMESTER IX<br>Core Course: Elective 3#<br>GLO9IE03(E03c) - APPLIED RIVER SCIENCE | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Explain*** the various components of stream hydrology, methods of analyses and representation of hydrological properties | Remember | PSO1 |
| CO2 | ***Explain*** the sediment distribution and its resident time across the basin | Understand | PSO3 |
| CO3 | ***Apply*** quantitative methods for drainage network analyses | Apply | PSO5 |
| CO4 | ***Assess*** the fluvial geomorphological features and explain the formation mechanisms | Evaluate | PSO10 |

**COURSE CONTENT**

| **Unit 1.** | **9 Hours** |
|---|---|
| 1.1. Basic stream hydrology, Physical properties of water, sediment and channel flow, River discharge<br>1.2. River hydrographs (UH, IUH, SUH, GIUH) and its application in hydrological analysis, Flood frequency analysis. | |
| **Unit 2.** | **9 Hours** |
| 2.1. River basin, Sediment source and catchment erosion processes, Sediment load and sediment yield, Sediment transport process in rivers, Erosion and sedimentation processes in channel. | |
| **Unit 3.** | **10 Hours** |
| 3.1. Drainage network, Quantitative analysis of network organization – morphometry<br>3.2. Random Topology (RT) model and fractal analysis, Role of drainage network in flux transfer, Evolution of drainage network in geological time scale. | |

| **Unit 4.** | **10 Hours** |
|---|---|
| 4.1. River diversity in space, Patterns of alluvial rivers - braided, meandering and anabranching channels<br>4.2. Dynamics of alluvial rivers, Channel patterns in Stratigraphic sequences<br>4.3. Different classification approaches in fluvial geomorphology and its applications. | |
| **Unit 5.** | **10 Hours** |
| 5.1. Bedrock channels, Bedrock incision process<br>5.2. River response to climate, tectonics and human disturbance, Bedrock channel processes and evolution of fluvial landscapes.<br>5.3. Fluvial hazards, integrated approach to stream management, Introduction to river ecology. | |

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Marks** |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Short answer | 11 | 9 | 2 | 18 |
| Paragraph | 6 | 4 | 8 | 32 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 12 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 12 |

**REFERENCES:**


1. Davie, T., 2008. Fundamentals of hydrology. Routledge Publications.
2. Knighton, D., 1998. Fluvial forms and processes: A new perspective. Arnold Pubs.
3. Julien, P.Y., 2002. River Mechanics. Cambridge University Press.
4. Robert, A., 2003. River Processes: An introduction to fluvial dynamics. Arnold Publications.
5. Tinkler, K.J., Wohl, E.E. (eds.) 1998. Rivers over rock. American Geophyscial Union Monogrpah, Washington, DC. nd climatic variations within the basin: Environmental Geology, v.43.

| SEMESTER X<br>Core Course: Elective 4#<br>GL10IE04(E04a) - GEOTECHNICAL ENGINEERING | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Classify*** intrusive and non-intrusive techniques of site investigation | Analyze | PSO6 |
| CO2 | ***Choose*** various sampling techniques including drilling and boring | Analyze | PSO6 |
| CO3 | ***Analyze*** borehole monitoring and tests | Analyze | PSO6 |
| CO4 | ***Survey*** logging of soil and rocks | Analyze | PSO6 |
| CO5 | ***Detect*** the application of soil and rock properties in geotechnical engineering | Analyze | PSO8 |
| CO6 | ***Infer*** basics of earth retaining structures | Analyze | PSO6 |

**COURSE CONTENT**

| **Unit 1.** | **9 Hours** |
|---|---|
| 1.1. Planning and reconnaissance: Toposheets, historical maps, geological maps, Aerial photographs and remote sensing<br>1.2. Site investigation: Design of site investigations-selection of methods and geology of the area. Field/Site investigations – Intrusive and non-intrusive methods<br>1.3. Non-intrusive - Geophysical methods - seismic tomography, resistivity, gravity. | |
| **Unit 2.** | **10 Hours** |
| 2.1. Excavations- trial pits<br>2.2. Boreholes-Methods of drilling and boring- cable drilling, rotary drilling, augur drilling, wireline, air hammer etc. Sampling methods associated with above drilling methods. Backfilling excavations and boreholes.<br>2.3. Sampling the ground - Disturbed and undisturbed samples Types of samplers - | |

| | |
|---|---|
| Open-tube samples, Stationary piston sampler, Continuous soil sampling, Sand samplers, Rotary core samplers, Window sampler, Bulk samples. Handling and labelling of samples. | |
| **Unit 3.** | **10 Hours** |
| 3.1. Tests in boreholes: Standard penetration test (SPT). Permeability test and Packer test. Pressure meter test, Pumping tests,Borehole geophysics.<br>3.2. In situ monitoring of borehole and monitoring of groundwater<br>3.3. Soil and Rock Logging as per standards (Indian standards ISI, BS5930 and Eurocode Standards, ASTM). Description of soils and rocks. | |
| **Unit 4.** | **10 Hours** |
| 4.1. Classification and mechanical properties of soils<br>4.2. Soil stress: effective and total stress, pore pressure parameters<br>4.3. Soil testing: triaxial, shear box, Particle size distribution, consistency limits, consolidation, Atterberg limits, California bearing ratio<br>4.4. Rock testing- UCS, point load.<br>4.5. Types of foundations and Bearing capacity: shallow and deep foundations Settlement of foundations. Earth pressures: active and passive pressures and their application in geotechnical engineering.<br>4.6. Stability analysis: basic knowledge and various methods used- application in geotechnical engineering. slope stability analysis. | |
| **Unit 5.** | **9 Hours** |
| 5.1. Basic knowledge of Earth retaining structures; gravity and cantilever retaining walls, diaphragm walls and secant pile walls, sheet piling, reinforced earth. Geotechnical parameters used in the design<br>5.2. Compaction test - MDD vs OMC relationship (proctor), Insitu density calculation. | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br><br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br><br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents. |

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Marks** |
|---|---|---|---|---|
| Short answer | 11 | 9 | 2 | 18 |
| Paragraph | 6 | 4 | 8 | 32 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

**UNITS WISE MARK DISTRIBUTION**

| **Units** | **Mark** |
|---|---|
| Unit 1. | 12 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 12 |

**REFERENCES:**


1. Krynine, D.P. & Judd, W.R. 1957. Principles of engineering geology and geotechnics. McGraw Hill, New York.
2. Bell, F.G. 1983. Fundamentals of engineering geology.
3. Beavis, F.C. 1985. Engineering geology.

4. Goodman, R.E. 1980. Introduction to rock mechanics.
5. Schuster, R.L. & Krizek, R.J. 1978. Landslide analysis and control. National Academy of Science, Washington DC.

| SEMESTER X<br>Core Course: Elective 4#<br>GL10IE04(E04b) - TECTONIC GEOMORPHOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Discuss*** the role of tectonic interaction in landform evolution | Understand | PSO2 |
| CO2 | ***Interrelate*** the effect of tectonics in river systems | Understand | PSO2 |
| CO3 | ***Predict*** landforms associated with faults | Understand | PSO2 |
| CO4 | ***Interpret*** geomorphic indices that help to identify active tectonics in an area | Understand | PSO2 |

**COURSE CONTENT**

| **Unit 1.** | **9 Hours** |
|---|---|
| 1.1. Definition and scope of tectonic geomorphology.<br>1.2. Landscape evolution. Concept of Form-Process relationship in landscape evolution | |
| **Unit 2.** | **9 Hours** |
| 2.1. Geomorphic Markers of active tectonics: Planar and Linear.<br>2.2. Landforms of active strike slip faults, normal faults, reverse faults and folds. | |
| **Unit 3.** | **10 Hours** |
| 3.1. River response to active tectonics.<br>3.2. Sudden (coseismic) versus gradual modifications in river systems.<br>3.3. Tectonic modifications of alluvial and bedrock-channeled rivers: longitudinal profiles, river pattern, sinuosity, drainage patterns and drainage anomalies.<br>3.4. Effects of base level. | |

| **Unit 4.** | **10 Hours** |
|---|---|
| 4.1. Geomorphic Indices of active tectonics – Morphometric analysis: mountain-front sinuosity, hypsometric curve and hypsometric integral, drainage basin asymmetry, stream-length gradient index, and valley-floor width to valley height ratio. | |
| **Unit 5.** | **10 Hours** |
| 5.1. Fundamentals of space geodetic techniques of measuring active tectonic deformations: Global Positioning System (GPS) and Radar Interferometry. | |

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Marks** |
|---|---|---|---|---|
| Short answer | 11 | 9 | 2 | 18 |
| Paragraph | 6 | 4 | 8 | 32 |
| Essay | 2 | 1 | 10 | 10 |

| | |
|---|---|
| **Total** | **60** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 12 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 12 |

**REFERENCES:**


1. Burbank, D.W. and Anderson, R.S. (2011). Tectonic Geomorphology 2nd Edition. Blackwell Science.
2. Burbank, D.W. and Anderson, R.S. (2001). Tectonic Geomorphology 1st Edition. Blackwell Science.
3. Keller, E.A. and Pinter, N. (1996). Active tectonics: Earthquakes, Uplift, and Landscape. Prentice Hall
4. Bull, William. (2009). Tectonically active landscapes. Wiley-Blackwell
5. Schumm, S.A, Dumont, J.F. and Holbrook, J.M. (2000). Active tectonics and alluvial rivers. Cambridge University Press.
6. Bull, W. (2007). Tectonic Geomorphology of Mountains: A new approach to palaeoseismology. Blackwell Publishing

| SEMESTER X<br>Core Course: Elective 4#<br>GL10IE04(E04c) - COAL AND PETROLEUM GEOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Outline*** the origin and classification of coal and petroleum | Analyze | PSO8 |
| CO2 | ***Identify*** the macroscopic and microscopic constituents of coal | Analyze | PSO8 |
| CO3 | ***Discover*** exploration methods for coal and petroleum | Analyze | PSO8 |
| CO4 | ***Analyze*** causes for migration of petroleum and its importance in exploration | Analyze | PSO8 |

**COURSE CONTENT**

| **Unit 1.** | **8 Hours** |
|---|---|
| 1.1. Origin of Coal, sedimentology of coal bearing strata, mode of occurrence of structures associated with coal seams, classification of coal, chemical analysis of coal. | |
| **Unit 2.** | **10 Hours** |
| 2.1. Study of Macroscopic and Microscopic constituents of coals.<br>2.2. Elementary knowledge about the application of reflectance and fluorescence study of coal<br>2.3. Basic idea about the coal preparation, carbonization, coal forming epochs in the geological past.<br>2.4. Coal deposits of India and depositional environment of some important coal fields of India. Methods of Coal prospecting and estimation of its reserves.<br>2.5. Coal Industry in India. | |
| **Unit 3.** | **10 Hours** |

| | |
|---|---|
| 3.1. Historical development of petroleum geology.<br>3.2. Physical and chemical properties of petroleum and related substances.<br>3.3. Surface and subsurface geographic and stratigraphic occurrence of petroleum. | |
| **Unit 4.** | **10 Hours** |
| 4.1. Origin of petroleum: inorganic and organic theories of source of petroleum.<br>4.2. Environments and processes of transformation of source material to petroleum hydrocarbons.<br>4.3. Migration of petroleum hydrocarbons: primary and secondary migration. Factors causing migration of petroleum<br>4.4. Reservoir rocks: characteristics of reservoir rocks and their types. Principles of determination of porosity and permeability.<br>4.5. Traps: characteristics and classification. Structural, stratigraphic, combination and fluid barrier traps. Accumulation of fluid petroleum. | |
| **Unit 5.** | **10 Hours** |
| 5.1. Exploration: a review of prospecting methods as applied to the exploration of petroleum accumulations<br>5.2. Estimation of petroleum reserves: brief outline of methods of estimation of petroleum reserves Petroleum prospects:<br>5.3. Important oil & gas fields and petroleum prospects of India. | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br><br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br><br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents. |

| **MODE OF ASSESSMENT** |
|---|
| **Internal Assessment (15 Marks)**<br>a. Classroom participation (20%): 3 Mark<br>b. Test papers I (40%): 6 Mark |

| | | | | |
|---|---|---|---|---|
| c. Assignment (20%): 3 Mark<br>d. Seminar/ Viva (20%): 3 Mark | | | | |
| **External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21* | | | | |
| **PATTERN OF QUESTION PAPER** | | | | |
| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Marks** |
| Short answer | 11 | 9 | 2 | 18 |
| Paragraph | 6 | 4 | 8 | 32 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 12 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 12 |

**REFERENCES:**


1. Stutzar,O and NOC, A.C.: Geology of Coal. University of Chicago Press, Chicago.
2. Moor, E.S.(ed): Coal, its properties, analysis, classification, geology, extraction, uses and distribution. John Wiley & Sons.
3. Stach et.al. Text book of Coal Petrology. Gebruder Borntraegu, Stuttgart.
4. Scott, A.C.: Coal and Coal-bearing Strata: Recent Advances. Geol. Soc. Publ. No.32, Blackwell.
5. Levorson, A.I. Geology of Petroleum.
6. Lanes, K.K. Petroleum Geology.
7. Russel, W.L. Principles of Petroleum Geology

8. Pirson, S.J. Oil Reservoir Engineering.
9. Lalicker, C.G. Principles of Petroleum Geology

| SEMESTER X<br>Core Course: Elective 5#<br>GL10IE05(E05a) - ADVANCED MAPPING TECHNIQUES AND EXPLORATION GEOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Outline*** the procedure of RADAR and microwave remote sensing | Apply | PSO5 |
| CO2 | ***Examine*** the application of hyperspectral remote sensing in mapping | Apply | PSO5 |
| CO3 | ***Use*** the LIDAR remote sensing techniques | Apply | PSO5 |
| CO4 | ***Illustrate*** geophysical survey methods and their uses in mineral exploration | Analyze | PSO8 |
| CO5 | ***Analyze*** stages of mineral exploration | Analyze | PSO8 |

**COURSE CONTENT**

| **Unit 1.** | **10 Hours** |
|---|---|

1.1. Radar-Real and synthetic aperture radars, - Principles - different platforms and sensors, System parameters, Target parameters, Radar equation measurement and discrimination,

1.2. Airborne Data products and selection procedure - SEASAT, SIRA, SIRB, ERS , JERS, RADARSAT missions.

1.3. Radar data processing - Radar grammetry, Image processing, SAR Interferrometry – Polarimetry- Interpretation of microwave data - Physical mechanism and empirical models for scattering and emission, volume scattering.

1.4. Applications of microwave remote sensing - Geological interpretation of RADAR –sites-default-files, Application in Agriculture -forestry, Hydrology - ice studies – land use mapping and ocean related studies. Introduction to Thermal Remote Sensing.

| Unit 2. | 10 Hours |
|---|---|
| 2.1. Multispectral and hyperspectral remote sensing, Comparison of Multispectral and Hyperspectral Image Data, Spectral Signatures and BRDF in the Visible, Near Infrared and Shortwave Infrared regions of EMR, Hyperspectral Issues.<br>2.2. Sensors and hyperspectral imaging devices - Scanner types and characterization - specifications of various sensors hyperspectral sensors, Design tradeoffs. Data formats and systems, AVIRIS, CASI, NASA Terra Moderate Resolution Imaging Spectrometer (MODIS), Hyperion. | |
| **Unit 3.** | **8 Hours** |
| 3.1. LIDAR remote sensing platforms - Introduction to the LIDAR remote sensing platform - Historical development of LIDAR remote sensing platforms Airborne platforms, Laser Scanning, Fixed- Wing Platforms, Rotary-Wing Platforms - Terrestrial, airborne, and spacebar types – Space borne platforms. Introduction to UAV/drone-based sensing. | |
| **Unit 4.** | **10 Hours** |
| 4.1. Stages of exploration – Reconnaissance survey; criteria for exploration method (guides to ores).<br>4.2. Collection and processing of exploration data. Field work in sedimentary, igneous and metamorphic terrains.<br>4.3. Maps of different scales used in exploration, Trenching and pitting – selection of trench sites, logging and sampling of trenches and pits<br>4.4. Drilling – design of a drilling programme, drilling methods – vertical and inclined drill holes. Types of drilling, logging of boreholes, borehole deviations. Preparation of sections and level plans, mineral maps of the area, fence diagrams.<br>4.5. Subsurface mapping – floor and roof contouring. Sampling –Purpose of sampling. Sample types, methods of sampling; Sample preparation and errors in sampling. | |
| **Unit 5.** | **10 Hours** |
| 5.1. Geophysical survey, surface investigation, subsurface investigation, Gravity survey, Seismic survey, refraction methods, reflection methods, applications, Magnetic survey and Electrical resistivity survey, self-potential methods, potential drop methods, resistivity values, data interpretation, Curve fitting. | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and |

participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Marks** |
|---|---|---|---|---|
| Short answer | 11 | 9 | 2 | 18 |
| Paragraph | 6 | 4 | 8 | 32 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

**UNITS WISE MARK DISTRIBUTION**

| **Units** | **Mark** |
|---|---|
| Unit 1. | 12 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 12 |

**REFERENCES:**


1. Arogyaswamy R. N. P. Courses in Mining Geology. Oxford and IBH, New Delhi.
2. Bagchi T. C. Elements of prospecting and exploration. Kalyan Publishers.
3. Banerjee P. K. and Ghosh S. Elements of prospecting for non – fuel mineral deposits 1997.
4. Boyle R. W. Geochemical prospecting for thorium and uranium deposits. Elsevier.
5. C Gokceoglu, H R Pourghasemi 2019 Spatial Modeling in GIS and R for Earth and Environmental Sciences Berlin: Elsevier Science, 798p
6. Compton R. R. Manual of Field Geology. Wiley.
7. Dobrin M. B. Introduction to geophysical prospecting. Pergamon Press.
8. Drury, S. A. Image interpretation in Geology,. Chapman and Hall, London. 1993
9. Ginzburg D. H. Principles of geochemical prospecting. Pergamon GL Prost 2019
10. Remote Sensing for Geoscientists: Image Analysis and Integration, London:Taylor & Francis 702p
11. Gupta RP 2013 Remote Sensing Geology Springer Berlin 656p
12. Gupta, R.P Remote sensing Geology, Springer, 2003. 32 MS

| SEMESTER X<br>Core Course: Elective 5#<br>GL10IE05(E05b) - ELEMENTS OF MINING AND ORE DRESSING | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Identify*** surface and underground mining methods | Anlayze | PSO8 |
| CO2 | ***Detect*** mining hazards and safety measures | Analyze | PSO8 |
| CO3 | ***Analyze*** ore dressing methods and beneficiation | Analyze | PSO8 |
| CO4 | ***Illustrate*** the processes for the concentration of ores | Analyze | PSO8 |

**COURSE CONTENT**

| **Unit 1.** | **9 Hours** |
|---|---|
| 1.1. Elements of Mining, Classification of mining methods.<br>1.2. Mining Methods: Placer mining methods, open pit methods, Underground mining methods, Coal Mining methods and Ocean bottom mining methods; their advantages and disadvantages. | |
| **Unit 2.** | **8 Hours** |
| 2.1. Ventilation in underground mining: Purpose, types and arrangements of ventilation in underground mining. Mining hazards and safety measures. | |
| **Unit 3.** | **11 Hours** |
| 3.1. Ore Dressing - Ore dressing and its importance, low grade ores and their beneficiation<br>3.2. Ore-microscopy and its contribution to ore-dressing techniques.<br>3.3. Aggregate properties of minerals and rocks and their consideration in ore dressing techniques. | |

| **Unit 4.** | **10 Hours** |
|---|---|
| 4.1. Basic ore dressing operations viz. crushing (Primary crushing and Secondary/Tertiary Crushing), grinding, sizing, screening and classification. | |
| **Unit 5.** | **10 Hours** |
| 5.1. Concentration processes: Magnetic and electrostatic separation, gravity concentration; Froth Floatation, Amalgamation and Agglomeration. | |

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Marks** |
|---|---|---|---|---|
| Short answer | 11 | 9 | 2 | 18 |
| Paragraph | 6 | 4 | 8 | 32 |
| Essay | 2 | 1 | 10 | 10 |

| | |
|---|---|
| **Total** | **60** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 12 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 12 |

**REFERENCES:**


1. McKinstry, H.E. Mining Geology, Prentice Hall, Englewood Clifts, N.J.
2. Clark, G.B. (1967) Elements of Mining, III ed. John Wiley • Arogyaswami, R.P.N. (1996) Courses in Mining Geology, IV Ed. Oxford IBH
3. Gaudin, A.M. Principles of Mineral Dressing. McGaw Hill Pub. Co. Ltd. Bombay
4. Wills, BA. 1988. Mineral Processing Technology. Pergamon Press. Oxford.
5. Vijayendra, MG. 1995. Handbook of Mineral Dressing. Vikas Publishing House Pvt Ltd. 23 Course No. GLM-405: P Dressing of Indian Metallic and non-metallic ores, Beach Sand & coal.

| SEMESTER X<br>Core Course: Elective 5#<br>GL10IE05(E05c) - CLIMATOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Outline*** geographical distribution of climate types and effect of global warming | Analyze | PSO9 |
| CO2 | ***Examine*** the factors affecting atmospheric stability | Analyze | PSO9 |
| CO3 | ***Use*** the effects of changing temperature on weather | Analyze | PSO9 |
| CO4 | ***Develop*** management of natural hazards related to climate | Analyze | PSO9 |

**COURSE CONTENT**

| **Unit 1.** | **10 Hours** |
|---|---|
| 1.1. Latitudes & Longitudes \| Standard Time<br>1.2. Motions of the earth: Rotation and Revolution, Atmosphere: Role, Structure & Composition Temperature Distribution on Earth Insolation & Heat Budget<br>1.3. Geographical distribution of the climatic types – Koppen's and Thornthwaite's classification of climate<br>1.4. Global warming. | |
| **Unit 2.** | **10 Hours** |
| 2.1. Lapse rate – Atmospheric stability, Latent Heat of Condensation, Atmospheric Pressure Belts and Wind Systems<br>2.2. Factors Affecting Wind movement, Coriolis Force, Types of Winds: Permanent, Secondary & Local Winds. | |
| **Unit 3.** | **8 Hours** |
| 3.1. Temperature Inversion: Types & Effects on Weather, Geostrophic Wind, Jet | |

| | |
|---|---|
| Streams & Rossby Waves, Major Jet Steams: Subtropical Jet Stream & Polar Jet Stream. | |
| **Unit 4.** | **10 Hours** |
| 4.1. Air Mass - Air masses based on Source Regions, Fronts, Types of Fronts: Stationary Front, Warm Front, Cold Front & Occluded Front, Humidity: Relative Humidity & Dew point, Condensation, Forms of Condensation: Dew, Fog, Frost, Mist, Types of Clouds. | |
| **Unit 5.** | **10 Hours** |
| 5.1. Smog: Photochemical smog & Sulfurous smog<br>5.2. Precipitation: Types of Precipitation, Types of Rainfall, Thunderstorm, Thunder & Lightning, Tornado,<br>5.3. Tropical Cyclones: Favourable Conditions for Formation, Stages of Formation & Structure, Storm Surge, Naming of Cyclones, Cyclones in Arabian Sea, Bay of Bengal, Temperate Cyclones (Mid Latitude Cyclone or Extra tropical cyclones or Frontal Cyclones). | |

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Mark
b. Test papers I (40%): 6 Mark
c. Assignment (20%): 3 Mark
d. Seminar/ Viva (20%): 3 Mark

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

| PATTERN OF QUESTION PAPER | | | | |
|---|---|---|---|---|
| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Marks** |
| Short answer | 11 | 9 | 2 | 18 |
| Paragraph | 6 | 4 | 8 | 32 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

| UNITS WISE MARK DISTRIBUTION | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 12 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 12 |

**REFERENCES:**


1. Berneard Hauruitz and James, M. Austin, Climatology, Mc Graw Hill publications, Newyork & London.
2. D.S. Lal., Climatology
3. Austin Miller. A., Climatology
4. B.S. Negi., Climatology and oceanography.
5. Climatology: Thomas A Blair
6. Grant R Bigg: The Oceans and Climate

# GENERAL COURSES
## (THEORY)

| SEMESTER III<br>General Course: 1<br>GLO3A11 – BIODIVERSITY – SCOPE AND RELEVANCE | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 4 | 5 | 20 | 80 | 100 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Discuss*** the concept of biodiversity, hotspots and its importance | Understand | PSO3 |
| CO2 | ***Classify*** the components of biodiversity | Understand | PSO3 |
| CO3 | ***Discuss*** the inventorying and Monitoring of Biodiversity | Understand | PSO3 |
| CO4 | ***Integrate*** the loss and conservation of biodiversity | Create | PSO15 |

**COURSE CONTENT**

| **Unit 1. Defining Biodiversity** | **12 Hours** |
|---|---|
| 1.1. The concept of biodiversity.<br>1.2. Biodiversity crisis.<br>1.3. Importance of biodiversity in daily life.<br>1.4. Biodiversity and climate change.<br>1.5. India as mega biodiversity nation.<br>1.6. Hot spots of biodiversity in India. | |
| **Unit 2. Components of Biodiversity** | **12 Hours** |
| 2.1. Genetic diversity, species diversity and ecosystem diversity.<br>2.2. Brief outlines of the magnitude of bacterial, fungal, protist, animal and plant diversity. | |
| **Unit 3. Loss of Biodiversity** | **12 Hours** |
| 3.1. Factors causing loss of genetic-, species- and ecosystem diversity.<br>3.2. Processes responsible for species extinction.<br>3.3. Threatened species and IUCN Red List categories. | |

| |
|---|
| 3.4. Loss of agrobiodiversity.<br>3.5. Significance of wild relatives of cultivated plants and domesticated animals. |
| **Unit 4. Values and uses of biodiversity** — **12 Hours** |
| 4.1. Ethical and aesthetic values of biodiversity.<br>4.2. Direct and indirect economic benefits of biodiversity.<br>4.3. Bio-prospecting – micro-organisms and plants as a source of novel enzymes, antibiotics, antiviral agents, Immunosuppressive agents and other therapeutic agents. |
| **Unit 5. Inventorying and Monitoring of Biodiversity** — **12 Hours** |
| 5.1. The need for inventorying and monitoring of biodiversity.<br>5.2. Methods of inventorying and monitoring of biodiversity and their limitations. |
| **Unit 6. Conservation of biodiversity** — **12 Hours** |
| 6.1. Conservation of genetic-, species- and ecosystem diversity.<br>6.2. In situ and ex situ conservations: biosphere reserves, national parks, wild-life sanctuaries, gene banks, seed banks, botanical gardens, microbial culture collections. |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents. |

| **MODE OF ASSESSMENT** |
|---|
| **Internal Assessment (20 Marks)**<br>a. Classroom participation (20%): 4 Marks<br>b. Test papers I (40%): 8 Marks<br>c. Assignment (20%): 4 Marks |

| |
|---|
| d. Seminar/ Viva (20%): 4 Marks |
| **External Assessment (60 Marks)** *Duration 2.5 Hours, No of Questions: 27* |
| **PATTERN OF QUESTION PAPER** |

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| Short answer | 15 | Up to 15 | 2 | 25 |
| Paragraph | 8 | Up to 8 | 5 | 35 |
| Essay | 4 | 2 | 10 | 20 |
| **Total** | | | | **80** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 13 |
| Unit 2. | 13 |
| Unit 3. | 13 |
| Unit 4. | 15 |
| Unit 5. | 13 |
| Unit 6. | 13 |

**REFERENCES:**


1. Patent, D. H., Munnoz W. 1996. Biodiversity. Clarion Books..
2. Maiti, P. K., Maiti, P. 2011. Biodiversity: Perception, Peril and Preservation. Prentice Hall
3. India. Maclaurin, J. 2008. What is biodiversity? University of Chicago Press.
4. Krishnamurthy, K. V. 2003. Textbook of Biodiversity. SciencePublishers Inc.
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6. Hosetti B.B., Ramkrishna, S. 2016. Biodiversity: Concepts and Conservation. AavishkarPublishers.
7. Kumar A. 2011. Understanding Biodiversity. Discovery Publishing House.

8. Hendon, J. 2017. Textbook of Biodiversity. Syrawood Publishing House.
9. Adom, D. Umachandran, K., Ziarati, P., Sawicka, B., Sekyere, P. 2019. The Concept of Biodiversity and its Relevance to Mankind: A Short Review. Journal of Agriculture andSustainability 12(2): 219-231.
10. Ehrlich, P.R., Ehrlich, A.H. 1992. The Value of Biodiversity. Stanford University Press.

| SEMESTER III<br>General Course: 2<br>GLO3A12 – RESEARCH METHODOLOGY | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 4 | 5 | 20 | 80 | 100 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Choose*** the research topic and preparation of project proposal | Create | PSO3 |
| CO2 | ***Make*** literature collection | Create | PSO5 |
| CO3 | ***Construct*** thesis structure | Create | PSO3 |
| CO4 | ***Plan*** to publish articles | Create | PSO3 |

**COURSE CONTENT**

| **Unit 1.** | **13 Hours** |
|---|---|
| 1.1. Topic selection - Planning research – defining objectives - Preparation of work plans.<br>1.2. Identification of suitable methodology - Preparation of project proposal –Summer Schools – Training in research institutes | |
| **Unit 2.** | **14 Hours** |
| 2.1. Collection of literature- News articles – Newsletters – Magazines – Books - Journals.<br>2.2. Digital library and search of articles - Keywords and search - Internet – Google Scholar – PubMed – Inflibnet – Medline – Agricola – Science direct -Open access Journals - virtual sources – other sources.<br>2.3. Short communications –review articles | |
| **Unit 3.** | **15 Hours** |
| 3.1. Collection of protocols and selection of suitable methods according to work plan.<br>3.2. Observational and experimental research. | |

| | |
|---|---|
| 3.3. Data analysis – Construction of tables – headings - footer -Tabulation – Presentation of results - Use of statistical software to analyze the results- SPSS. | |
| **Unit 4.** | **15 Hours** |
| 4.1. Thesis structure –Components - Writing Introduction – review of literature – Materials & Methods – Presentation of results – Discussion of Results based on literature – Arriving at conclusions – Preparation of Summary/abstract – Arrangement of Bibliography and how to quote reference in thesis - Appendix. | |
| **Unit 5.** | **15 Hours** |
| 5.1. Publishing of Articles in newspapers /newsletters - Selection of journals – ISSN Number – Peer reviewed Journals – Science citation index – impact factor and importance.<br>5.2. Manuscripts preparation for Journals – components – Plagiarism - Submission and Publication – reprints and pdf formats.<br>5.3. Paper presentation in Conferences. | |

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (20 Marks)**

a. Classroom participation (20%): 4 Marks
b. Test papers I (40%): 8 Marks
c. Assignment (20%): 4 Marks
d. Seminar/ Viva (20%): 4 Marks

**External Assessment (60 Marks)** *Duration 2.5 Hours, No of Questions: 27*

| PATTERN OF QUESTION PAPER | | | | |
|---|---|---|---|---|
| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
| Short answer | 15 | Up to 15 | 2 | 25 |
| Paragraph | 8 | Up to 8 | 5 | 35 |
| Essay | 4 | 2 | 10 | 20 |
| **Total** | | | | **80** |

| UNITS WISE MARK DISTRIBUTION | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 15 |
| Unit 2. | 17 |
| Unit 3. | 16 |
| Unit 4. | 16 |
| Unit 5. | 16 |

**REFERENCES:**


1. Anderson, Durston & Polle 1970: Thesis and assignment, writing. Wiley Eastern Limited.
2. Booth W. C. et al. 2016. The Craft of Research. University of Chicago Press.
3. Rajendrakumar C. 2008. Research Methodology. APH publishing Corporation.
4. Kothari C. R. 2004. Research Methodology. New Age International Publishers.
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6. Marczyk, G., DeMatteo, D., Festinger, D. 2005. Essentials of research design and
7. methodology. John Wiley.
8. Katz, M. J. 2009. From Research to Manuscript: A Guide to Scientific Writing. Springer.
9. Michael Alley. The Craft of Scientific Writing (3rd Edition) Publisher: Springer.
10. Cargill, M., O.Connor, P. 2013. Writing Scientific Research Articles: Strategy and Steps.

11. Wiley-Blackwell.
12. Blake, G. and Bly, R. W. 2000. The Elements of Technical Writing. Pearson.
13. Reep, D. C. 2014. Technical Writing: Principles, Strategies, and Readings. Longman.

| SEMESTER IV<br>General Course: 3<br>GLO4A13 – NATURAL RESOURCE MANAGEMENT | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 4 | 5 | 20 | 80 | 100 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Explain*** the renewable and non-renewable energy | Create | PSO3 |
| CO2 | ***Develop*** sustainable utilization of land, water, biological resources | Create | PSO5 |
| CO3 | ***Plan*** contemporary practices in natural resource management | Create | PSO3 |

**COURSE CONTENT**

| **Unit 1. Introduction to natural resources** | **8 Hours** |
|---|---|
| 1.1. Definition of natural resources.<br>1.2. Types of natural resources.<br>1.3. Need for protecting natural resources | |
| **Unit 2. Sustainable Utilization** | **8 Hours** |
| 2.1. Concept of sustainable utilization.<br>2.2. Economic, ecological and socio-cultural approaches. | |
| **Unit 3. Land** | **8 Hours** |
| 3.1. Agricultural, pastoral, horticultural and silvicultural land utilization.<br>3.2. Soil degradation and soil management. | |
| **Unit 4. Water** | **8 Hours** |
| 4.1. Fresh water (rivers, lakes, groundwater); Marine; Estuarine; Wetlands<br>4.2. Threats and management strategies. | |

| Unit 5. Biological Resources | 8 Hours |
|---|---|
| 5.1. Biodiversity-definition and types; Significance; Threats; Management strategies.<br>5.2. Bioprospecting.<br>5.3. National Biodiversity Action Plan. | |
| **Unit 6. Forests** | **8 Hours** |
| 6.1. Definition.<br>6.2. Types of forests.<br>6.3. Forest cover and its significance (with special reference to India); Major and minor forest products; Forest depletion.<br>6.4. Forest Management. | |
| **Unit 7. Energy** | **8 Hours** |
| 7.1. Renewable and non-renewable sources of energy. | |
| **Unit 8. Contemporary practices in natural resource management** | **8 Hours** |
| 8.1. Environmental Impact Assessment<br>8.2. Remote Sensing, Geographic Information System<br>8.3. Participatory Resource Appraisal.<br>8.4. Ecological footprint with emphasis on carbon footprint.<br>8.5. Resource Accounting. Waste management. | |
| **Unit 9.** | **8 Hours** |
| 9.1. National and international efforts in natural resource management and conservation | |

| MODE OF TRANSACTION |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents. |

**MODE OF ASSESSMENT**

**Internal Assessment (20 Marks)**

a. Classroom participation (20%): 4 Marks
b. Test papers I (40%): 8 Marks
c. Assignment (20%): 4 Marks
d. Seminar/ Viva (20%): 4 Marks

**External Assessment (60 Marks)** *Duration 2.5 Hours, No of Questions: 27*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| Short answer | 15 | Up to 15 | 2 | 25 |
| Paragraph | 8 | Up to 8 | 5 | 35 |
| Essay | 4 | 2 | 10 | 20 |
| **Total** | | | | **80** |

**UNITS WISE MARK DISTRIBUTION**

| **Units** | **Mark** |
|---|---|
| Unit 1. | 7 |
| Unit 2. | 8 |
| Unit 3. | 8 |
| Unit 4. | 12 |
| Unit 5. | 8 |
| Unit 6. | 10 |
| Unit 7. | 8 |
| Unit 8. | 12 |
| Unit 9. | 7 |

**REFERENCES:**

1. Singh K. K. 2008. Natural Resources Conservation & Management. M D Publications Pvt. Ltd.
2. Singh, J. S., Singh, S.P. and Gupta, S. 2006. Ecology, Environment and Resource Conservation. Anamaya Publications.
3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. 2008. An Introduction to SustainableDevelopment. Prentice Hall of India.
4. Pandey, B. W. 2005. Natural Resource Management. Mittal Publications.
5. Lynch D. R. 2011. Sustainable Natural Resource Management. Cambridge University Press.
6. Nuberg, I., George, B., Reid, R. 2009. Agroforestry For Natural Resource Management. CSIRO Publishing.
7. Camp, W. G., Heath-Camp, B. 2016. Managing Our Natural Resources. Cengage Learning Pte. Ltd
8. Chiras, D. D., Reganold, J. P. 2009. Natural Resource Conservation: Management for a Sustainable Future. Pearson.
9. Campbell, B. M., Sayer, J. A. 2003. Integrated Natural Resource Management: Linking Productivity, the Environment and Development. CABI Publishing.
10. Deal, K. H. 2011. Wildlife and Natural Resource Management. Delmar Cengage Learning.

| SEMESTER IV<br>General Course: 4<br>GLO4A14 – INTELLECTUAL PROPERTY RIGHTS | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 4 | 5 | 20 | 80 | 100 |

**COURSE OUTCOMES**

| Course Outcomes | Expected Course Outcome<br>Upon completion of this course, students will be able to; | Learning Domain | PSO No |
|---|---|---|---|
| CO1 | ***Discuss*** the concepts of IPR | Create | PSO3 |
| CO2 | ***Construct*** how to do the patenting | Create | PSO5 |
| CO3 | ***Explain*** the concepts and registration of copyright, trademark, GI, Industrial design | Create | PSO3 |
| CO4 | ***Formulate*** application of IPR in biotechnology | Create | PSO3 |

**COURSE CONTENT**

| **Unit 1. Overview of intellectual property** | **4 Hours** |
|---|---|
| 1.1. Introduction and the need for intellectual property right (IPR).<br>1.2. IPR in India – Genesis and Development.<br>1.3. Some important examples of IPR. | |
| **Unit 2. Patents** | **10 Hours** |
| 2.1. Macro-economic impact of the patent system. Patent and kind of inventions protected by a patent. Patent document. How to protect your inventions? Granting of patent. Rights of a patent. How extensive is patent protection? Why protect inventions by patents? Searching a patent. Drafting of a patent. Filing of a patent | |
| **Unit 3. Copyright** | **10 Hours** |
| 3.1. What is copyright? What is covered by copyright? How long does copyright last? Why protect copyright?<br>3.2. Related rights: What are related rights? Distinction between related rights and copyright. Rights covered by copyright. | |

| Unit 4. Trademarks | 14 Hours |
|---|---|
| 4.1. Definition of trademark. Rights of trademark. Kinds of signs that can be used as trademarks. Types of trademark. Function that a trademark performs. How is a trademark protected? How is a trademark registered? How long is a registered trademark protected for? How extensive is trademark protection? What are well-known marks and how are they protected? Domain name and how does it relate to trademarks? | |
| **Unit 5. Geographical Indications** | **4 Hours** |
| 5.1. What is a geographical indication? How is a geographical indication protected? Why protect geographical indications? | |
| **Unit 6. Industrial Designs** | **10 Hours** |
| 6.1. What is an industrial design? How can industrial designs be protected? What kind of protection is provided by industrial designs? How long does the protection last? Why protect industrial designs? | |
| **Unit 7. Biotechnology and IPR** | **20 Hours** |
| 7.1. Rationale for Intellectual Property Protection in biotechnology. Concept of Novelty in Biotechnological Inventions. Concept of Inventive Step in Biotechnological Inventions. Microorganisms as Biotechnological Inventions. Patenting biological inventions. Patenting microorganisms. Patenting other biological processes and products. Protection of new varieties of plants. Justification for Protection. Biotechnology and International Treaties such as Convention on Biological Diversity and TRIPs. | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students. |
| **Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback. |
| **Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents. |

**MODE OF ASSESSMENT**

**Internal Assessment (20 Marks)**

a. Classroom participation (20%): 4 Marks
b. Test papers I (40%): 8 Marks
c. Assignment (20%): 4 Marks
d. Seminar/ Viva (20%): 4 Marks

**External Assessment (60 Marks)** *Duration 2.5 Hours, No of Questions: 27*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| Short answer | 15 | Up to 15 | 2 | 25 |
| Paragraph | 8 | Up to 8 | 5 | 35 |
| Essay | 4 | 2 | 10 | 20 |
| **Total** | | | | **80** |

**UNITS WISE MARK DISTRIBUTION**

| **Units** | **Mark** |
|---|---|
| Unit 1. | 8 |
| Unit 2. | 15 |
| Unit 3. | 12 |
| Unit 4. | 10 |
| Unit 5. | 10 |
| Unit 6. | 10 |
| Unit 7. | 15 |

**REFERENCES:**

1. T. M Murray, M.J. Mehlman. 2000. Encyclopaedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons.

2. P.N. Cheremisinoff, R.P. Ouellette and R.M. Bartholomew.1985. Biotechnology Applications and Research, Technomic Publishing Co., Inc.
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5. Ajit Parulekar, Sarita D' Souza. 2006. Indian Patents Law – Legal & Business Implications; Macmillan India,
6. B.L. Wadehra. 2000. Law Relating to Patents, Trade Marks, Copyright, Designs &Geographical Indications; Universal law Publishing Pvt. Ltd.
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9. Ramakrishan (Ed.). 2003. Biotechnology and Intellectual Property Rights.CIPRA, NLSIU, Bangalore.
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11. M. M. S. Karki. 2009. Intellectual Property Rights: Basic Concepts. Atlantic Publishers.
12. N. S. Sreenivasalu. 2007. Intellectual Property Rights. Neha Publishers & Distributors.
13. Pal P. 2008.Intellectual Property Rights in India: General Issues and Implications. Regal Publications

# CORE COURSE: OPEN COURSE
## (THEORY)

| SEMESTER V<br>Open Course: 1a<br>GLO5ID01 – GEOSCIENCE AND ENVIRONMENT | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Memorize*** various concepts of geology and planet earth | Remember | PSO1 |
| CO2 | ***Define*** various concepts minerals and Rocks | Remember | PSO1 |
| CO3 | ***Identify*** structural features | Analyze | PSO8 |
| CO4 | ***Discuss*** the concepts; ***classify*** causes and mitigation of natural hazards | Understand<br>Analyze | PSO2<br>PSO9 |
| CO5 | Make ***use*** of concepts and theories in in the context of current natural hazards like earthquake, volcanic eruption etc. | Apply | PSO5 |

**COURSE CONTENT**

| **Unit 1.** | **9 Hours** |
|---|---|
| 1.1. Introduction to Geology - branches of Geology, the earth - size, shape, density, volume and internal structure.<br>1.2. Hydrologic cycle, groundwater - Infiltration, zones of groundwater, ground and perched water tables, open wells and bore wells. | |
| **Unit 2.** | **9 Hours** |
| 2.1. Exogenic processes: Weathering – agents, types and products of weathering. Mass wasting - types,<br>2.2. Landslides. Brief ideas of role played by streams, oceans, wind and glaciers on earth's surface. | |
| **Unit 3.** | **10 Hours** |

| | |
|---|---|
| 3.1. Endogenic processes: Volcanoes – types and distribution of major volcanoes, products of volcanism - gas, dust, lava and pyroclastics. | |
| **Unit 4.** | **10 Hours** |
| 4.1. Earthquakes – Seismic waves and propagation, epicenter and focus, intensity and magnitude scales, Seismographs and seismogram, Tsunami. | |
| **Unit 5.** | **10 Hours** |
| 5.1. Global Climate change: Greenhouse effect, Global warming, Ozone depletion - causes and effects.<br>5.2. Pollution and waste disposal – air, water and land pollution; brief ideas of causes and effects. | |

**MODE OF TRANSACTION**

**Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.

**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.

**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents.

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Marks
b. Test papers I (40%): 6 Marks
c. Assignment (20%): 3 Marks
d. Seminar/ Viva (20%): 3 Marks

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| Pattern | Total No. of questions | No. of questions to be answered | Marks for each question | Ceiling of Marks |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Short answer | 12 | Up to 12 | 2 | 20 |
| Paragraph | 7 | Up to 7 | 5 | 30 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 12 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 12 |

**REFERENCES:**


1. Carlson, D. and Plummer, C. (2010) Physical Geomorphology: Earth Revealed. 9th Edn., Mc-Graw Hill Co.
2. Bloom, A. L. (1992) Geomorphology, Second Edition, Prentice Hall India Pvt. Ltd., New Delhi.
3. Holmes, A. (1981) Principles of Physical Geology, ELBS, Third Edition. Thomas Nelson.
4. Judson, S. and Kauffman, M. E. (1990) Physical Geology. Eighth Edition, Prentice Hall, New Jersey.
5. Parbin Singh (2012) General and Engineering Geology. S. K. Kataria and Sons.
6. Mukherjee, P.K. (1984) A Text Book of Geology, World Press.
7. Valdiya, K.S. (1987) Environmental Geology: Indian Context, Tata Mc-Graw Hills.
8. Strahler, A.N. and Strahler, A.H. (1973) Environmental Geosciences: Interaction between natural systems and man. John Wiley & Sons Inc.
9. Donald R Caotes (1981) Environmental Geology. John Wiley and Sons.

| SEMESTER V<br>Open Course: 1b<br>GLO5ID02 – DISASTER MANAGEMENT | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Explain*** various components of stream hydrology, methods of analyses and representation of hydrological properties | Remember | PSO1 |
| CO2 | ***Explain*** the sediment distribution and its resident time across the basin | Understand | PSO3 |
| CO3 | ***Apply*** quantitative methods for drainage network analyses | Apply | PSO5 |
| CO4 | ***Assess*** fluvial geomorphological features and explain the formation mechanisms | Evaluate | PSO10 |

**COURSE CONTENT**

| **Unit 1.** | **9 Hours** |
|---|---|
| 1.1. Introduction – Hazard and Disaster: Definition and Terminologies - Classification.<br>1.2. Concept of Disaster management - Comprehensive Disaster Management Plan. Elements of Disaster Management Plan. | |
| **Unit 2.** | **10 Hours** |
| 2.1. Natural Disasters - Earthquake, Landslide, Avalanches, Volcanic eruptions - Their case studies. Heat and Cold Waves, Coastal disasters, Coastal regulation Zone, Cyclone, Flood, Drought, Tsunami.<br>2.2. Environmental Disasters - Dam collapse and Mitigation measures. Nuclear disasters, Chemical Disasters, Biological Disasters, Forest fire and Oil fire. | |
| **Unit 3.** | **9 Hours** |
| 3.1. Climate change: global warming, sea level rise, ozone depletion, carbon sink and sources - causes and effects. | |

| **Unit 4.** | **10 Hours** |
|---|---|
| 4.1. Disaster Risk Management; Institutional arrangement: Prevention, Preparedness, and Mitigation; Disaster Preparedness Plan. Application of Information Technology in Disaster Preparedness.<br>4.2. Hazards and Vulnerability scenario in India; Disaster relief and its components – water, food, sanitation, shelter, health and waste management; Disaster Management Act and Policy. | |
| **Unit 5.** | **10 Hours** |
| 5.1. Kerala and disasters: types – Flood, Drought, Coastal erosion, Landslides, Pesticide contaminations. Accident-related disasters, their prevention and mitigation.<br>5.2. Application of GIS in Disaster Management.<br>5.3. Emergency procedures and warning systems. | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents. |

| **MODE OF ASSESSMENT** |
|---|
| **Internal Assessment (15 Marks)**<br>a. Classroom participation (20%): 3 Marks<br>b. Test papers I (40%): 6 Marks<br>c. Assignment (20%): 3 Marks<br>d. Seminar/ Viva (20%): 3 Marks |
| **External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21* |
| **PATTERN OF QUESTION PAPER** |

| Pattern | Total No. of questions | No. of questions to be answered | Marks for each question | Ceiling of Marks |
|---|---|---|---|---|
| Short answer | 12 | Up to 12 | 2 | 20 |
| Paragraph | 7 | Up to 7 | 5 | 30 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

| **UNITS WISE MARK DISTRIBUTION** | |
|---|---|
| **Units** | **Mark** |
| Unit 1. | 12 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 12 |

**REFERENCES:**


1. David Alexander (1993) Natural Disasters, UCL Press, London.
2. Edward Bryant (2005) Natural Hazards, Cambridge University Press.
3. Patrick L. Abbott (2008) Natural Disasters, McGraw Hill International edition.
4. Rajib Shaw and Krishnamurthy R.R. (2008) Disaster management: Global Challenges and Local Solutions, Universities Press, Hyderabad, India.
5. Govt. of India (2005) Disaster Management Act, New Delhi.
6. Govt. of India (2009) National Disaster Management Policy.
7. Gupta, A.K. and Nair, S.S. (2011) Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi.
8. Murthy, R.K. (2012) Disaster management, Wisdom Press, New Delhi.
9. Vasudevan, V., Krishnan, K.R.S., Baba, M. and Kumar, P. (Eds.) (2006) Natural Hazards and Management Strategies, XVIII Kerala Science Congress – 2006, KSCSTE.

| SEMESTER V<br>Open Course: 1c<br>GLO5ID03– GROUND WATER EXPLORATION AND MANAGEMENT | | | | |
|---|---|---|---|---|
| Credit | Hours/week | Marks | | |
| | | Internal | External | Total |
| 3 | 3 | 15 | 60 | 75 |

**COURSE OUTCOMES**

| **Course Outcomes** | **Expected Course Outcome**<br>Upon completion of this course, students will be able to; | **Learning Domain** | **PSO No** |
|---|---|---|---|
| CO1 | ***Explain*** the basic concepts, terminologies and classification of Hazard and Disaster; Disaster Management and Disaster Management Plan. | Remember | PSO1 |
| CO2 | ***Detect*** various natural disasters with suitable examples; Understand and explain the Environmental disasters by citing suitable examples; Describe facts related to climate change, causes and effects. | Analyze | PSO9 |
| CO3 | ***Apply*** disaster risk management strategies; the institutional frameworks; explain the application of IT in Disaster Risk management; understand, categorize and describe disaster relief and its components; and explain Disaster Management Act and Policy. | Analyze | PSO9 |
| CO4 | ***Assess*** the hazard and vulnerability situation in India and Kerala; types of disasters in Kerala; explain accident-related disasters, their prevention and mitigation; the application of GIS in Disaster management; and describe the significance of Emergency procedures and warning systems. | Evaluate | PSO10 |

**COURSE CONTENT**

| **Unit 1.** | **10 Hours** |
|---|---|
| 1.1. Origin- meteoritic, juvenile and connate waters. Hydrological cycle, occurrence; ground water occurrences in igneous, sedimentary and metamorphic rocks- vertical distribution of ground water, movement; classification and types of aquifers, definition of porosity, permeability, specific yield, specific retention, storage and transmissibility | |

| Unit 2. | 10 Hours |
|---|---|
| 2.1. Groundwater detection; surface methods-geomorphological, structural and biological evidences. Surface geophysical methods; principles, field procedures, electrode arrangements, instruments and interpretations involved in electrical resistivity method of ground water exploration. Brief account of role of remote sensing in ground water targeting | |
| **Unit 3.** | **10 Hours** |
| 3.1. Well design and well development; brief introduction about dug wells, tube wells, jetted wells, infiltration galleries and collector wells, well screening and artificial packing.<br>3.2. Well development through surging and acidizing.<br>3.3. Methodology and need for pump test | |
| **Unit 4.** | **9 Hours** |
| 4.1. Water quality; Quality of water in various rock types, water quality parameters and their standards proposed by WHO and BIS.<br>4.2. Physical parameters of water quality. Chemical parameters and determining methods.<br>4.3. Diseases and virological aspects of ground water and remedial measures | |
| **Unit 5.** | **9 Hours** |
| 5.1. Kerala and disasters: types – Flood, Drought, Coastal erosion, Landslides, Pesticide contaminations. Accident-related disasters, their prevention and mitigation.<br>5.2. Application of GIS in Disaster Management.<br>5.3. Emergency procedures and warning systems. | |

| **MODE OF TRANSACTION** |
|---|
| **Face to Face Instruction:** This involves attending traditional classroom lectures and participating in in-person discussions and activities with the instructor and fellow students.<br><br>**Peer to Peer learning:** Students have to select a topic in the course and present it in the class which providing opportunity for critical thinking and feedback.<br><br>**Group Discussion:** Group discussion will be conducted based on the relevant topic in the course that will improve students' thinking and help them to construct their own meaning about academic contents. |

**MODE OF ASSESSMENT**

**Internal Assessment (15 Marks)**

a. Classroom participation (20%): 3 Marks
b. Test papers I (40%): 6 Marks
c. Assignment (20%): 3 Marks
d. Seminar/ Viva (20%): 3 Marks

**External Assessment (60 Marks)** *Duration 2 Hours, No of Questions: 21*

**PATTERN OF QUESTION PAPER**

| **Pattern** | **Total No. of questions** | **No. of questions to be answered** | **Marks for each question** | **Ceiling of Marks** |
|---|---|---|---|---|
| Short answer | 12 | Up to 12 | 2 | 20 |
| Paragraph | 7 | Up to 7 | 5 | 30 |
| Essay | 2 | 1 | 10 | 10 |
| **Total** | | | | **60** |

**UNITS WISE MARK DISTRIBUTION**

| **Units** | **Mark** |
|---|---|
| Unit 1. | 12 |
| Unit 2. | 12 |
| Unit 3. | 12 |
| Unit 4. | 12 |
| Unit 5. | 12 |

**REFERENCES:**


1. Davis S.N and Dewiest(1966)-Hydrogeology, John wiley and sons.
2. Bouwer . H. Ground water hydrology,1978
3. Todd,D,K. ground water hydrology,John wiley and sons 1980
4. Tolman C. F, Ground water,Mc Graw Hill

5. Walton,W.C., Ground water resource evaluation, Mc Graw Hill,1970

# MODEL QUESTION PAPERS FOR CORE COURSES

## (THEORY)

**First Semester Integrated M.Sc. Geology Degree Examination**
**GLO11B01 - EARTH AND ENVIRONMENT**

Time : 2 Hours Maximum Marks : 60

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer ***all*** questions.

Each question carries **Two** mark.

**Ceiling -20 Marks**

1. What is the Nebular Hypothesis regarding the origin of planets?
2. Define plate tectonics and its significance in geology?
3. Explain the concept of geological time scale and list its major divisions?
4. What are rock-forming minerals? Give examples?
5. Distinguish between igneous, sedimentary, and metamorphic rocks?
6. Describe the properties used to identify minerals?
7. What is the significance of fossils in understanding geological history?
8. Define seismic waves and their types?
9. What is isostasy? Briefly explain the Airy and Pratt theories?
10. Explain the concept of tsunamis and their causes?
11. What are the primary factors that influence the evolution of the continents?
12. Describe the effects of climate on natural hazards like landslides and earthquakes.

**PART – B**

Answer ***all*** questions.

Each question carries **Five** marks.

**Ceiling -30 Marks**

13. Discuss the different hypothesis concerning the origin of the Earth?
14. Explain the methods used to determine the age of the Earth, including both radioactive and non-radioactive methods?
15. Describe the processes of rock deformation, including folds and faults, and their geological significance?
16. Discuss the different types of natural hazards, particularly focusing on volcanism and earthquakes?
17. Explain the classification of volcanoes based on lava types and eruption styles, including their global distribution and impacts?
18. Discuss the evolution of continents and the factors influencing continental movement?
19. Describe the significance of the rock cycle in understanding Earth's materials and processes?

**PART - C**

Answer any ***one*** question.

Each question carries **Ten** marks.

20. Discuss the properties of seismic waves, how they are measured, and their significance in understanding earthquakes, including the Richter and Mercalli scales.
21. Explain the causes, types, and effects of volcanism, along with prediction methods and risk mitigation strategies.

**1 x 10 = 10 Marks**

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**Third Semester Integrated M.Sc. Geology Degree Examination**
**GLO2IB02 – GEOMORPHOLOGY**

Time : 2 Hours Maximum Marks : 60

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer ***all*** questions.
Each question carries **Two** mark.
**Ceiling -20 Marks**

1. What do you mean by suspension, traction and saltation?
2. Describe the formation of Oases
3. Distinguish the topographic map and road map.
4. Differentiate between pediments and bajada
5. Define hamada.
6. What are Einkanters, Zweikanter and Dreikanters
7. Define water cycle
8. Describe the different types of moraines.
9. What is meant by Porosity and permeability?
10. Explain Hydraulic action, abrasion, attrition and cavitation.
11. Role of plants and animals in the physical breaking down of rock?
12. What do you mean by Frost Action weathering?

**PART – B**

Answer ***all*** questions.
Each question carries **Five** marks.
**Ceiling -30 Marks**

13. List out the salient features of 'fluvial cycle of erosion'
14. Describe the different types of coral reefs.
15. Define Brunton Compass. Describe the various parts of a Brunton Compass
16. Discuss the various landforms produced in a karst region
17. Describe the soil profile and its different layers in detail.
18. Give an account of lakes and its classification
19. Write brief explanatory note on various drainage patterns.

**PART - C**

Answer any ***one*** question.
Each question carries **Ten** marks.

20. Write a detailed essay on Mass-movement. State the conditions favouring mass-wasting and its classification.

21. Explain the processes involved in glacial erosion. List and briefly describe the important erosional and depositional features of a glacier

**1 x 10 = 10 Marks**

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**Second Semester Integrated M.Sc. Geology Degree Examination**
**GLO3IB03– CRYSTALLOGRAPHY AND MINERALOGY**

Time : 2 Hours Maximum Marks : 60

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer ***all*** questions.

Each question carries **Two** mark.

**Ceiling -20 Marks**

1. Differentiate crystalline and amorphous materials.
2. Draw and explain Contact Goniometer?
3. How crystallographic axes are used in naming of crystal faces?
4. What do you mean by *enantiomorphous* forms?
5. Define specific gravity.
6. Write about morphological characters of crystal.
7. Briefly explain chemical properties of mineral.
8. How isomorphism is different from polymorphism?
9. What are *holohedral* and *hemihedral* forms?
10. What do you mean by crystal coordination?
11. What is crystal zone axis and how it is found out?
12. Describe pseudomorphism?

**PART – B**

Answer ***all*** questions.

Each question carries **Five** marks.

**Ceiling - 30 Marks**

13. Describe various point group Symmetry elements in a crystal.
14. Explain Laws of crystallography.
15. Write about the Symmetry and forms present in *Normal class* of the triclinic system.
16. What is solid solution series and how they are formed?
17. Explain crystallographic notation.
18. What is called twinning? Explain the types of twinning.
19. Write a short note on Walker's Steel Yard & Jolly's Spring balance

**PART - C**

Answer any ***one*** question.

20. Describe the symmetry elements and forms present in the *Zircon type class* of the Tetragonal system
21. What is silicate mineral and explain various silicate structures.

**1 x 10 = 10 Marks**

**Third Semester Integrated M.Sc. Geology Degree Examination**
**GLO3A11-BIODIVERSITY – SCOPE AND RELEVANCE**

Time : 2.5 Hours Maximum Marks : 80

*(Draw neat sketches, wherever necessary)*

**PART – A**

Answer ***all*** questions.

Each question carries **Two** mark.

**Ceiling -25 Marks**

1. How biodiversity is linked to our daily life?
2. What is Hotspot in Biodiversity?
3. Write about ecosystem biodiversity.
4. What is Bioprospecting?
5. What is endemic species?
6. Write about the magnitude of fungal and bacterial diversity.
7. Discuss loss of agrobiodiversity.
8. Write about minimum four components of biodiversity values.
9. What is called inventorying of biodiversity?
10. Why wild relatives of cultivated plants and domesticated animals are important?
11. What is gene bank?
12. What are the steps involved in Bioprospecting?
13. What is indicator species?
14. What is species abundance and species richness?
15. What is keystone species?

**PART – B**

Answer ***all*** questions.

Each question carries **Five** marks.

**Ceiling -35 Marks**

16. Write a short note on Genetic Biodiversity.
17. Write about the process responsible for species extinction.
18. Briefly write about Ex-situ conservation of Biodiversity.
19. How climate change affect different ecosystem.
20. Why monitoring and inventorying needed?
21. What are the applications of Bioprospecting?
22. Briefly explain the measurement techniques of genetic biodiversity.
23. Write a short note on Species Biodiversity.

**PART - C**

Answer any ***two*** questions.

Each question carries **Ten** marks.

24. Discuss about the Animal Diversity.
25. Why India is a mega biodiversity nation?
26. How the IUCN Red List classifies the species?
27. Write about the methods of conservation of Biodiversity.

**2 x 10 = 20 Marks**

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**Third Semester Integrated M.Sc. Geology Degree Examination**
**GLO3A12–RESEARCH METHODOLOGY**
(2020 Admission onwards)

Time : 2.5 Hours Maximum Marks : 80

*(Draw neat sketches, wherever necessary)*

**PART – A**
Answer ***all*** questions.
Each question carries **Two** mark.
**Ceiling -25 Marks**

1. What is Research?
2. Explain the role of references in a manuscript.
3. Define Impact Factor of a journal.
4. Why do academics publish in predatory journals?
5. What is ISSN Number?
6. Differentiate between journal articles and books.
7. What type of literature is short communication?
8. What is Newsletter?
9. List out the criteria's for choosing the Research Methodology.
10. What do you meant by AGRICOLA?
11. Explain peer-review process
12. Distinguish between methodology and methods?
13. What is Scopus?
14. What are the main parts of a statistical table?
15. Difference between primary and secondary sources of literature.

**PART – B**
Answer ***all*** questions.
Each question carries **Five** marks.
**Ceiling -35 Marks**

16. Give an account on Thesis components
17. Describe the different types of Research Methodology.
18. Briefly explain the steps in preparing and presenting a conference paper
19. Differentiate between observational and experimental research.
20. Write about the importance of review of literature in research.
21. Explain the scholarly journals, popular journals and trade journals?
22. Describe industrial training. Briefly explain the objectives and benefits of industrial training.
23. Write a short note on SPSS software. Discuss about the advantages and disadvantages of SPSS software.

**PART - C**

Answer any ***two*** questions.

Each question carries **Ten** marks.

24. What is a research project proposal? What are the different components of a project proposal?
25. Write a detailed essay on selection of journal. Explain the factors to consider for selecting the right journal for publication.
26. What are the main steps involved in the selection of research topics and planning of research.
27. Explain about manuscript preparation, Plagiarism and different types of plagiarism.

**2 x 10 = 20 Marks**

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**Fourth Semester Integrated M.Sc. Geology Degree Examination**
**GLO4IB04 – OPTICAL AND DESCRIPTIVE MINERALOGY**

Time : 2 Hours Maximum Marks : 60

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer ***all*** questions.

Each question carries **Two** mark.

**Ceiling -20 Marks**

1. Define ordinary and polarized light.
2. What is the refractive index?
3. Explain total internal reflection?
4. What is a Nicol Prism?
5. Differentiate between isotropic and anisotropic minerals?
6. Define extinction and explain its significance?
7. What is the optic axis in uniaxial minerals?
8. Explain the concept of birefringence?
9. Define optic sign of uniaxial minerals?
10. What is the role of a Quartz wedge in determining interference color?
11. List any two optical properties of garnet?
12. Define pleochroism?

**PART – B**

Answer ***all*** questions.

Each question carries **Five** marks.

**Ceiling -30 Marks**

13. Describe the principles of polarized light in mineralogy?
14. Explain the differences between isotropic and anisotropic minerals with examples?
15. Write an explanatory note on optical properties of uniaxial and biaxial minerals?
16. Describe the construction and working of a petrological microscope?
17. Discuss the importance of interference figures in mineral identification?
18. Describe the chemistry and optical properties of feldspar minerals?
19. Explain the role of optical accessories such as the gypsum plate and mica plate?

**PART - C**

Answer any ***one*** question.

Each question carries **Ten** marks.

20. Give a detailed account of birefringence, extinction, and their applications in mineral identification.
21. Explain the optical and physical properties, modes of occurrence, and uses of any four of the following minerals: Olivine, Pyroxene, Amphibole, Mica and Quartz.

**Fourth Semester Integrated M.Sc. Geology Degree Examination**
**GLO4A13-NATURAL RESOURCE MANAGEMENT**
(2020 Admission onwards)

Time : 2.5 Hours Maximum Marks : 80

*(Draw neat sketches, wherever necessary)*

**PART – A**
Answer ***all*** questions.
Each question carries **Two** mark.
**Ceiling -25 Marks**

1. What are the different types of natural resources?
2. Define biodiversity.
3. Define biotic and abiotic natural resources.
4. What is Lagoon-type estuary?
5. What is neritic zone?
6. Define *oligotrophic*, *mesotrophic*, *eutrophic* and *hypertrophic* lakes.
7. Purpose of Vienna Convention.
8. Define Montane wet temperate forest
9. Classification of organisms based on lifestyle
10. What do you mean by biodiversity hot-spot?
11. Define beach forest.
12. What do you mean by Carbon footprint?
13. Distinguish lentic and lotic ecosystem?
14. What is sustainable utilization?
15. Define deforestation.

**PART – B**
Answer ***all*** questions.
Each question carries **Five** marks.
**Ceiling -35 Marks**

16. What are the threats of natural resources? Give a note on conservation of natural resources.
17. Briefly explain the different types of Tropical moist forests.
18. What do you meant by soil degradation? Explain the triggering factors and causes of soil degradation.
19. Discuss in detail about the different types of land utilisation.
20. Describe water cycle with neat sketches. Write a note on lakes and its classification.
21. Write a note on bioprospecting derived resources
22. Explain in brief various steps and processes of EIA.
23. What are the major zones in the Ocean?

**PART - C**

Answer any ***two*** questions.

Each question carries **Ten** marks.

24. What is Ramsar Convention? Give a detailed account on Wetlands, types of wetlands and threats to wetland ecosystem.
25. Give an account on National and international efforts in natural resource management and conservation.
26. Write a detailed essay on 'Applications of Remote sensing and GIS' in Natural resource management.
27. Explain sustainable utilization? Give an account on ecological, economic and socio cultural sustainability.

**2 x 10 = 20 Marks**

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**Fourth Semester Integrated M.Sc. Geology Degree Examination**
**GLO4A14-INTELLECTUAL PROPERTY RIGHTS**
(2020 Admission onwards)

Time : 2.5 Hours Maximum Marks : 80

*(Draw neat sketches, wherever necessary)*

**PART – A**

Answer ***all*** questions.
Each question carries **Two** mark.
**Ceiling -25 Marks**

1. What is trade secret?
2. Define design?
3. What is the need of IPR?
4. What is TRIP?
5. What is the plant variety protection act?
6. What is meant by registered trademark marks with example?
7. What is Madrid convention?
8. List out the categories of IPR?
9. What is meant by the right of GI?
10. What is the difference between generic and homonymous GI?
11. What is patent infringement?
12. What is prior art search?
13. Write any four examples of Industrial design?
14. Write about economic rights?
15. What is related rights?

**PART – B**

Answer ***all*** questions.
Each question carries **Five** marks.
**Ceiling -35 Marks**

16. Differences between domain name and well-known marks?
17. Differentiate service marks, product marks and sound marks?
18. What are the procedures of GI registration?
19. What is meant by assignment and infringement of copyright?
20. How to patent biological inventions?
21. What are different functions of trade mark?
22. Briefly explain the procedures of filing a patent?
23. What are the benefits of IPR in industrial design?
24. How long does the different types of IPR lasts?

**PART - C**

Answer any ***two*** questions.

Each question carries **Ten** marks.

25. Explain the parts and drafting of a patent? What are the different types of patent searches?
26. Explain plant breeders right and different criteria of plant variety protection? What are the rights granted under this act?
27. Briefly explain different patent laws in India?
28. Brief the concepts of patent, copyright, Industrial design, trademark, and geographical indications with examples?

**2 x 10 = 20 Marks**

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**Fifth Semester Integrated M.Sc. Geology Degree Examination**
**GLO5IB05 – IGNEOUS PETROLOGY**

Time : 2 Hours Maximum Marks : 60

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer ***all*** questions.
Each question carries **Two** mark.
**Ceiling -20 Marks**

1. Define primary and parental magmas?
2. What are the concordant forms of intrusive igneous rocks? List examples?
3. Differentiate between extrusive and intrusive igneous rocks?
4. Describe the vesicular and amygdaloidal structures?
5. What is a pyroclastic deposit? Give examples?
6. Define crystallinity in the context of igneous rocks?
7. What is the significance of devitrification in igneous petrology?
8. Explain the terms "allotriomorphic" and "hypidiomorphic" textures?
9. List the bases of classification for igneous rocks?
10. What is the CIPW classification system?
11. Describe Tyrrel's tabular classification?
12. What is meant by "eutectic" in the context of binary magmas?

**PART – B**

Answer ***all*** questions.
Each question carries **Five** marks.
**Ceiling -30 Marks**

13. Explain the formation of intrusive igneous rock forms such as sills and laccoliths?
14. Discuss the different structures found in igneous rocks with examples?
15. Describe the various textures observed in igneous rocks?
16. Explain the crystallization behavior of unicomponent magma and its significance?
17. Discuss the petrogenetic significance of binary magmas, including the diopside-anorthite eutectic system?
18. Describe the mineralogical composition of common rock types in igneous petrology?
19. Discuss the reasons for diversity in igneous rocks and their classifications?

**PART - C**

Answer any ***one*** question.
Each question carries **Ten** marks.

20. Discuss the history and development of igneous petrology, highlighting significant milestones and advancements in the field?

21. Explain the processes of crystallization in magmas, focusing on the implications for the classification and occurrence of different igneous rock types?

**1 x 10 = 10 Marks**

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**Fifth Semester Integrated M.Sc. Geology Degree Examination**
**GLO5IB06 – METAMORPHIC PETROLOGY**

Time : 2 Hours Maximum Marks : 60

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer ***all*** questions.
Each question carries **Two** mark.
**Ceiling -20 Marks**

1. Define metamorphism and its significance in geology?
2. What are the low and high temperature/pressure limits of metamorphism?
3. List the principal agents of metamorphism?
4. Differentiate between dynamic and thermal metamorphism?
5. What is contact metamorphism? Provide an example?
6. Describe the concept of lithostatic pressure in metamorphism?
7. What is the role of fluids in metamorphism?
8. Classify metamorphic rocks based on foliation and lineation?
9. Explain the term "metamorphic texture" and provide examples?
10. What are isograds, and how are they used in metamorphic studies?
11. Define Barrovian metamorphism and its significance?
12. Describe the petrographic features of schistosity?

**PART – B**

Answer ***all*** questions.
Each question carries **Five** marks.
**Ceiling -30 Marks**

13. Discuss the classification of metamorphic rocks and provide examples for each category?
14. Explain the factors that influence metamorphic processes?
15. Describe the various metamorphic grades and their associated mineral assemblages?
16. What are metamorphic facies? Discuss the significance of the greenschist and eclogite facies?
17. Explain the concept of paired metamorphic belts in relation to plate tectonics?
18. Describe the textures of metamorphic rocks and their geological significance?
19. Briefly discuss the petrography and origin of two metamorphic rock types?

**PART - C**

Answer any ***one*** question.
Each question carries **Ten** marks.

20. Give a detailed account of the different types of metamorphism, including examples and their geological settings?

21. Discuss ten metamorphic textures and their significance.

**1 x 10 = 10 Marks**

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**Fifth Semester Integrated M.Sc. Geology Degree Examination**
**GLO5IB07 - SEDIMENTARY PETROLOGY**

Time : 2 Hours Maximum Marks : 60

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer ***all*** questions.

Each question carries **Two** mark.

**Ceiling -20 Marks**

1. Sedimentary rock classification based on composition and origin.
2. What is Insolation Weathering?
3. Describe particle roundness.
4. Define load casts
5. Explain bounce, brush, prod, roll, and skip marks?
6. Define peloids
7. What are stromatolites?
8. Differentiate between extraclasts and intraclasts.
9. What is hybrid sandstone?
10. Explain dolomitization.
11. Define the compositional maturity of sandstone.
12. What do you mean by aggregate grains?

**PART – B**

Answer ***all*** questions.

Each question carries **Five** marks.

**Ceiling -30 Marks**

13. Write the Udden-Wentworth classification for sediments.
14. Describe the textural components of limestone
15. Give an account on products of subaerial weathering
16. Briefly explain the mineralogy, chemical composition and classification of shale
17. Describe bed load , suspended load and wash load transportation
18. Discuss the conglomerates classification based on clast lithology
19. (**a**). Determine the paleocurrent direction of the given data.

| **Class interval** | **Frequency** | **Frequency %** |
|---|---|---|
| 0-29 | 0 | 0 |
| 30-59 | 21 | 19.44 |
| 60-89 | 30 | 27.78 |
| 90-119 | 33 | 30.56 |
| 120-149 | 15 | 13.90 |

| | | |
|---|---|---|
| 150-169 | 9 | 8.33 |

(**b**). Calculate the statistical parameters for the given sediment sieve data and interpret the depositional environment. *(Φ5=0.40, Φ16=0.83, Φ25=1.52, Φ50=2.03, Φ75=2.72, Φ84=2.92, Φ95=3.62)*

## PART - C

Answer any ***one*** question.
Each question carries **Ten** marks.

20. What is a sedimentary rock? Give a detailed account on various structures of sedimentary rock.
21. Describe in detail about various diagenetic stages, processes and effects of siliciclastic sedimentary rocks.

**1 x 10 = 10 Marks**

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**Fifth Semester Integrated M.Sc. Geology Degree Examination**
**GLO5IB08 - STRUCTURAL GEOLOGY AND GEOTECTONICS**

Time : 2 Hours Maximum Marks : 60

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer ***all*** questions.
Each question carries **Two** mark.
**Ceiling -20 Marks**

1. Define force and stress in the context of geology?
2. What is the difference between normal stress and shear stress?
3. Explain the concept of strain and its types?
4. What is the strain ellipsoid, and what does it represent?
5. Distinguish between elastic and plastic behavior of rocks?
6. Describe the basic fold geometry and its components?
7. What are the different types of folds? Provide examples?
8. Explain the concept of unconformity and its significance?
9. Define fault geometry and its associated features?
10. List and describe the types of faults?
11. What is a shear zone, and how does it relate to faulting?
12. Explain the importance of joints in structural geology?

**PART – B**

Answer ***all*** questions.
Each question carries **Five** marks.
**Ceiling -30 Marks**

13. Discuss the concept of hydrostatic and deviatoric stresses with examples?
14. Explain the classification of folds and their relationship to ductile deformation?
15. Describe the criteria for recognizing different types of unconformities in the field?
16. Discuss faulting mechanisms and their relationship with earthquakes?
17. Explain the significance of linear structures such as lineations and cleavages?
18. Describe the historical development of the plate tectonics theory?
19. Discuss the concepts of continental drift and sea-floor spreading in detail?

**PART - C**

Answer any ***one*** questions.
Each question carries **Ten** marks.

20. Discuss in detail the different types of rock deformation, including associated pressure and temperature conditions, and the stages of deformation?

21. Explain the concept of plate tectonics, including the structure of lithospheric plates, their movements, and the effects on Earth's surface features?

**1 x 10 = 10 Marks**

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**Sixth Semester Integrated M.Sc. Geology Degree Examination**
**GLO6IB09 - ECONOMIC GEOLOGY**

Time : 2 Hours Maximum Marks : 60

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer ***all*** questions.

Each question carries **Two** mark.

**Ceiling -20 Marks**

1. What is ore grade?
2. Write about evaporate deposits?
3. How kerogen is different from macerals?
4. What is skarn deposit?
5. What is oil trap?
6. What are refractory minerals?
7. What are source rocks in oil formation?
8. What are manganese nodules?
9. What is meant by siderophile elements?
10. Difference between saddle reef and stock-work deposits?
11. Write about epithermal deposits?
12. What are fissure veins?

**PART – B**

Answer ***all*** questions.

Each question carries **Five** marks.

**Ceiling -30 Marks**

13. Define placer deposits? Explain different types of placers?
14. Elaborate process of residual concentration with an example?
15. Differentiate cavity filling and replacement deposits?
16. Explain metamorphic process? How graphite and asbestos formed by this process?
17. Brief different metallogenic provinces of India?
18. What are the important petroliferous basins of India?
19. What are the radioactive minerals present in Kerala, write about their distinguishing properties, uses and distribution?

**PART - C**

Answer any ***one*** question.

Each question carries **Ten** marks.

20. Write an essay on oxidation and supergene enrichment process with illustration?
21. Explain the magmatic ore forming processes with neat sketches and examples from India

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**Sixth Semester Integrated M.Sc. Geology Degree Examination**
**GLO6IB10 - PALAEONTOLOGY**

Time : 2 Hours Maximum Marks : 60

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer ***all*** questions.

Each question carries **Two** marks.

**Ceiling -20 Marks**

1. What is lophophore?
2. Define rhabdosome. Write about different types of rhabdosomes.
3. Write about the shapes of the corallites.
4. Define the following (***i***) *Sphaerocone* (***ii***) *Cadicone* (***iii***) *Oxycone* (*iv*) *Platycone*.
5. What is meant by carapace?
6. Briefly explain the characteristics of vertebrates.
7. What do you meant by *protosepta* and *metasepta*?
8. Write about cheeks of trilobites.
9. What is permineralisation and carbonization?
10. Define deltidium, Foramen and pseudodeltidium?
11. Write about test of Foraminifera.
12. What is meant by Conispiral, Involute, Advolute, and Planispiral types of coiling?

**PART – B**

Answer ***all*** questions.

Each question carries **Five** marks.

**Ceiling -30 Marks**

13. Write a brief descriptive note on outline of life through ages, its evolution and distribution.
14. Give an account on dentition pattern of Lamellibranchia
15. Explain the classification of class Graptozoa
16. Write short note on the following: (***i***) Glossopteris (***ii***) Ptilophyllum (***iii***) Sigillaria (***iv***) Calamites
17. Distinguish brachiopods and pelecypods
18. Write about subclass Dibranchia and its classification.
19. Explain the uses of fossils.

**PART - C**

Answer any ***one*** question.

Each question carries **Ten** marks.

20. Write about Phylum Echinodermata. Give a detailed account on the morphology, classification and geological history of Class Echinoidea
21. Explain the general morphology, classification and geological history of Class Gastropoda.

**2 x 10 = 20 Marks**

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**Sixth Semester Integrated M.Sc. Geology Degree Examination**
**GLO6IB11 - STRATIGRAPHY AND INDIAN GEOLOGY**

Time : 2 Hours Maximum Marks : 60

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer ***all*** questions.
Each question carries **Two** marks.
**Ceiling -20 Marks**

1. Define the scope of stratigraphy and its importance in geology?
2. What are the basic principles of stratigraphy?
3. Describe the Indian Time Scale and its significance?
4. Explain the concept of correlation in stratigraphy?
5. What are facies, and how do they relate to stratigraphic records?
6. Define lithofacies and biofacies with examples?
7. What is a diastem, and how does it affect stratigraphic records?
8. Describe the classification of stratigraphy?
9. What is Walters' Law, and how is it applied in geology?
10. Define biostratigraphic classification and explain its significance?
11. What are index fossils, and why are they important in stratigraphy?
12. Differentiate between lithostratigraphic and chronostratigraphic classifications?

**PART – B**

Answer ***all*** questions.
Each question carries **Five** marks.
**Ceiling -30 Marks**

13. Discuss the Early Precambrian stratigraphy, including the concept of craton and mobile belts?
14. Explain the significance of the Dharwar Supergroup in South India's geology?
15. Describe the Late Precambrian stratigraphy, focusing on the Delhi and Cudappah Supergroups?
16. Give an overview of the Gondwana Supergroup, including its classification and distribution in India?
17. Discuss the lithology and fossil content of the Triassic rocks of Spiti?
18. Explain the characteristics and distribution of Jurassic rocks in Kutch?
19. Describe the Deccan Traps, including their origin, composition, and significance?

**PART - C**

Answer any ***one*** question.

Each question carries **Ten** marks.

20. Provide a detailed account of the stratigraphy and geology of Kerala, including its lithological features and fossil content?
21. Discuss the stratigraphy of the Siwalik system, emphasizing its fauna and flora?

**1 x 10 = 10 Marks**

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**Sixth Semester Integrated M.Sc. Geology Degree Examination**
**GLO6IE01(E01a) - REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM**

Time : 2 Hours Maximum Marks : 60

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer ***all*** questions.
Each question carries **Two** mark.
**Ceiling -20 Marks**

1. What is GIS?
2. List out the various resolution concepts in RS
3. Define scale of a map.
4. What is meant by Choropleth Map?
5. Role of platforms in Remote sensing
6. Describe *latitude* and *longitude*.
7. Distinguish *surface phenomena* and *volume phenomena*
8. Define the *in-situ sensing* with an example
9. Difference between *low resolution* and *high resolution* images.
10. Define Electromagnetic Radiation
11. Explain Swath.
12. What do you mean by picture elements?

**PART – B**

Answer ***all*** questions.
Each question carries **Five** marks.
**Ceiling -30 Marks**

13. Write an explanatory note on Geostationary satellites and Near-polar satellites
14. Explain the different types of Remote sensing
15. Write a note on types of spatial data in GIS.
16. Explain the concepts and principles of Remote sensing
17. Give an account of components of GIS.
18. Briefly explain the various methods for photogrammetric measurements and processing data. Describe in short several applications of photogrammetry.
19. Define Database Management System (DBMS) in GIS. Explain different DBMS models used in GIS.

## PART - C

Answer any ***one*** question.
Each question carries **Ten** marks.

20. Give an account on Global positioning system. Briefly explain following with respect to GPS.
    (i) Parts of GPS
    (ii) GPS constellation
    (iii) How does it work in determining the geographic position and
    (iv) Its accuracy, various applications and uses.

21. Explain the following in detail.
    (i) History and development of Remote sensing.
    (ii) Historical overviews and various applications of Geographic Information System.

**1 x 10 = 10 Marks**

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**Seventh Semester Integrated M.Sc. Geology Degree Examination**

**GLO7IB12 - ADVANCED CRYSTALLOGRAPHY AND MINERALOGY**

Time : 2.5 Hours Maximum Marks : 80

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer any ***ten*** questions.

Each question carries **Two** mark.

1. Define crystallography and its significance in mineralogy?
2. What are point groups, and how are they derived?
3. Explain the concept of space groups?
4. What is translation periodicity in crystals?
5. Describe the basic rotational symmetries found in crystals?
6. What is a stereographic projection?
7. Define Schoenflies notation and its use in crystallography?
8. Explain Herman Mauguin symbols and compare them with Schoenflies notation?
9. What is the significance of the tangent relation in crystallography?
10. Describe the process of forming interference figures under a petrological microscope?
11. What are uniaxial and biaxial interference figures?
12. Define pleochroism and explain its significance in mineralogy?

**PART – B**

Answer any ***five*** questions.

Each question carries **Eight** marks.

13. Discuss the derivation of the 32 crystal classes?
14. Explain the concept of optical indicatrix in uniaxial and biaxial minerals?
15. Describe the process of determining the optic sign of minerals?
16. What is the significance of extinction angles in mineralogy?
17. Discuss mineral classification based on chemical properties?
18. Explain the techniques of XRD and its applications in mineralogy?
19. Describe the principles and applications of SEM in mineral analysis?

**PART - C**

Answer any ***two*** question.

Each question carries **Ten** marks.

20. Discuss the mineralogical expressions of radioactivity, including metamictization and fission tracks?
21. Explain the average mineralogical composition of the Earth's crust and mantle, including mineral transformations with depth?
22. Give the Herman-Mougan notation for the classes of the orthorhombic system and explain its symmetry elements using a stereogram.

23. Give a detailed account on crystal chemistry and structure of Silicate family.

**2 x 10 = 20 Marks**

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**Seventh Semester Integrated M.Sc. Geology Degree Examination**
**GLO7IB13 - ADVANCED GEOMORPHOLOGY**

Time : 2.5 Hours Maximum Marks : 80

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer any ***ten*** questions.
Each question carries **Two** mark.

1. Define geomorphology and its importance in geological studies?
2. What is the theory of uniformitarianism, and how does it apply to geomorphological processes?
3. List the factors controlling geomorphological features?
4. Explain the concept of anthropogenic effects on geomorphic processes?
5. Describe the process of ocean basin shape formation due to heat conduction?
6. What is isostasy, and how does it relate to ocean basin shape?
7. Define crustal thickening and its implications for tectonic geomorphology?
8. What are the geomorphic evidences of long-term deformation?
9. Explain the relationship between hillslope forms and lithology?
10. Describe the concept of mass movement and its environmental controls?
11. What is applied geomorphology? Give an example of its application in civil engineering?
12. Discuss the significance of wetlands in geomorphology?

**PART – B**

Answer any ***five*** questions.
Each question carries **Eight** marks.

13. Explain the control of geomorphological features by geological structures and lithology?
14. Discuss the role of climate and time in shaping geomorphological features?
15. Describe the processes involved in fault-scale tectonic deformation?
16. What are the implications of paleo seismology in understanding geomorphological changes?
17. Explain the environmental significance of backwaters (kayals) in Kerala?
18. Discuss the soil formation processes and classification of soils in Kerala?
19. Provide an overview of the geomorphic features of the extra-peninsular region of India?

**PART - C**

Answer any ***two*** question.

Each question carries **Ten** marks.

20. Discuss the key geomorphic features of India and provide a brief explanation of their geomorphic evolution.
21. Explain the elementary concepts of environmental geomorphology and its applications?
22. What are wetlands? Discuss their significance, classification, and the processes involved in their formation.
23. Discuss the geomorphic evolution of the Indo-Gangetic plain and its significance in regional geomorphology?

**2 x 10 = 20 Marks**

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**Seventh Semester Integrated M.Sc. Geology Degree Examination**
**GLO7IB14 – ADVANCED IGNEOUS AND METAMORPHIC PETROLOGY**

Time : 2.5 Hours Maximum Marks : 80

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer any ***ten*** questions.
Each question carries **Two** mark.

1. How temperature affect rate of diffusion in igneous texture?
2. Expand the term Epitaxis?
3. Explain floor accretion and roof accretion in magmatic processes?
4. Explain floor accretion and roof accretion in magmatic processes?
5. What are the factors controlling textures of igneous rocks?
6. Explain the term Liquid immiscibility?
7. List the primary minerals found in basalt and explain their significance in oceanic crust formation?
8. Illustrate Zeolite facies of Metamorphism?
9. Name two important igneous rocks associated with continental settings and provide a brief mineralogical description of each?
10. Write a short note on the igneous rock classification based on silica percentage?
11. Define Experimental petrology?
12. Define isotope with suitable examples?

**PART – B**

Answer any ***five*** questions.
Each question carries **Eight** marks.

13. Discuss the igneous structures formed due to cooling of magma?
14. Explain ACF and AKF diagrams?
15. Explain the relationship between the rate of nucleation and rate of crystal growth in determining the final texture of an igneous rocks?
16. How do the norm classification contribute to the understanding of mineral composition of igneous rocks?
17. Explain the Gibbs Phase Rule, and how is it applied to igneous systems?
18. Give a brief account of Blue Schist and Eclogite Facies of Metamorphism and their relationships to plate tectonics?
19. Explain Barrovian and Abukuma types of Metamorphism?

**PART - C**

Answer any ***two*** question.
Each question carries **Ten** marks.

20. Explain the crystallization process of forsterite-diopside-silica system with special reference to univariant, Di variant and invariant points?
21. Give a detailed outline of genetic significance of textures in igneous rocks?
22. What are the various types of textures in metamorphic rock and add a note on its significance?
23. What are metamorphic facies and metamorphic facies series? Give suitable examples?

**2 x 10 = 20 Marks**

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**Seventh Semester Integrated M.Sc. Geology Degree Examination**
**GLO7IB15 – ADVANCED STRATIGRAPHY**

Time: 2.5 Hours Maximum Marks: 80

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer any ***ten*** questions.
Each question carries **Two** mark.

1. Write a short note on Son Narmada North Fault.
2. Illustrate Paraconformity?
3. Why Dharwad Batholith is important?
4. Write about Pala Lahara Gneiss
5. Define sequence stratigraphy?
6. What is Cyclostratigraphy?
7. Expand the term by Eonothem?
8. Differentiate intertrappean and infratrappean beds?
9. Describe the Holocene epoch and its divisions with respect to the Geological timescale?
10. Write about the Lateral Depositional Contacts?
11. Write a short note about distribution of Cuddapahrocks?
12. Distinguish stage and series in stratigraphy?

**PART – B**

Answer any ***five*** questions.
Each question carries **Eight** marks.

13. Give an account on stratigraphy of the Siwalik Group
14. Write about the Palaeogene Sequences of Assam
15. Briefly explain Dalmavolcanics
16. Give principle of lithostratigraphy and explain the different Lithostratigraphic units.
17. Give a brief account on distribution and classification of Deccan Traps.
18. Write a note on Rewa and Kaimur Groups.
19. Write an explanatory note on K-T boundary extinction and its causes.

**PART – C**

Answer ***any two questions***.
Each question carries **ten** marks.

20. Discuss in detailed about the Geology of Kerala.
21. Discuss in detail stratigraphy, depositional characteristics and paleogeography of the Gondwana Supergroup.
22. Describe the Mesozoic stratigraphic succession, classification and depositional characteristics of Spiti Valley.
23. Describe structure, stratigraphy and economic deposits of Dharwar craton

**2 x 10 = 20 Marks**

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**Eighth Semester Integrated M.Sc. Geology Degree Examination**
**GLO8IB16 – ADVANCED STRUCTURAL GEOLOGY**

Time: 2.5 Hours Maximum Marks: 80

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer any ***ten*** questions.
Each question carries **Two** mark.

1. Write down the mineralogical and microstructural signatures of shear zones?
2. Write a short note on deformation?
3. Distinguish between joints and fractures
4. Define Petro- fabric analysis?
5. Differentiate kinematic and dynamic analysis in structural geology
6. How Pumpelly's rule is useful in structural geology?
7. What is slip and separation of a fault?
8. Explain briefly oblique-slip fault classification,
9. Discuss the factors influence the initiation of fractures in rocks
10. Discuss about the strain acting in one dimension
11. What is displacement distribution of a fault system?
12. Explain the importance of angular unconformity in tectonostratigraphic correlation

**PART – B**

Answer any ***five*** questions.
Each question carries **Eight** marks.

13. Explain different types of strain ellipsoid and its geological significance with the help of a diagram.
14. Give a detailed note on five different geometrical classifications of fault.
15. Discuss the four types of fold interference and the outcrop pattern shown by them.
16. Describe the process of joint formation in response to loading and stress.
17. Explain briefly the concept of shear zone and the strain involved in shear zone
18. Briefly explain stereographic projection and discuss the linear and planar features in stereographic projection.
19. Describe the classification of tectonic fabrics and provide examples.

**PART – C**

Answer ***any two questions***.
Each question carries **ten** marks.

20. Provide a detailed comparison of L-, L-S, and S-tectonic fabrics with examples
21. Describe all shear sense indicators that develop in shear zone.
22. Write a detailed note on classification of joints.

23. Discuss the classification of fold made by Ramsay in detail and the strain development in the various stages of formation of fold Each question carries **ten** marks.

**2 x 10 = 20 Marks**

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**Eighth Semester Integrated M.Sc. Geology Degree Examination**
**GLO8IBI7 – EXPLORATION GEOPHYSICS AND FIELD TECHNIQUES**

Time: 2.5 Hours Maximum Marks: 80

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer any ***ten*** questions.
Each question carries **Two** mark.

1. Explain Nernst potential?
2. What is Gamma- Gamma log?
3. Define Newton's Law of gravitation?
4. List out the five factors considered in designing a gravity surveying?
5. What are the components of the magnetism?
6. Define Rigidity Modulus?
7. What is temperature log?
8. What is magnetic gradiometer?
9. What is Curie temperature?
10. What is artificial radioactivity?
11. Define Second Law of Radioactivity?
12. Define Ohm's Law?

**PART – B**

Answer any ***five*** questions.
Each question carries **Eight** marks.

13. Define elastic theory with the help of Elastic, Anelastic and Plastic behaviour
14. What is mineral magnetism? Add a note on its types?
15. Define Fermat's principle and state the law of refraction.
16. Discuss the Worden gravimeter, its advantages, and disadvantages.
17. Explain how gravity can be accurately measured on moving platforms?
18. Write a short note on Self- potential logging and its uses?
19. Write a note on telluric currents and its measurements?

**PART – C**

Answer ***any two questions***.
Each question carries **ten** marks.

20. Briefly explain Huygens's Principle and discuss its significance in understanding wave propagation.
21. Explain in detail on radiometric logging and its uses?
22. Write short notes on the gravity method, outlining its principles, techniques data interpretation, and diverse applications in geophysics and resource exploration.

23. Discuss seismic waves, their types, propagation characteristics, and illustrate their propagation with a neat sketch.

**2 x 10 = 20 Marks**

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**Eighth Semester Integrated M.Sc. Geology Degree Examination**
**GLO8IBI8 – ADVANCED ECONOMIC GEOLOGY**

Time: 2.5 Hours Maximum Marks: 80

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer any ***ten*** questions.
Each question carries **Two** mark.

1. Define the different types of mineral deposits.
2. What are the primary sources of ore-forming materials?
3. Describe the physico-chemical environment necessary for ore formation.
4. Name two examples of magmatic ore deposits.
5. What is the significance of fluid inclusion studies in mineralogy?
6. Define ore genesis and paragenetic sequences.
7. What are VMS deposits and where are they typically found?
8. Explain the concept of metallogenic epochs.
9. What are the key differences between IOCG and SEDEX deposits?
10. Describe the role of plate tectonics in the formation of ore deposits.
11. What are placer deposits, and how do they form?
12. What is the significance of supergene enrichment in ore deposits?

**PART – B**

Answer any ***five*** questions.
Each question carries **Eight** marks.

13. Discuss the types, charecteristics, and forms of ore bodies in mineral deposits.
14. Explain the genetic classification of mineral deposits with examples.
15. Describe the nature and origin of magmatic ore deposits associated with ultramafic and mafic rocks.
16. Explain the importance of ore microscope studies, including polishing and mounting of ores.
17. Discuss the physical and optical properties of important ore minerals.
18. Explain the tectonic setting and metallogeny patterns of mineral deposits
19. Discuss the genesis and characteristics of U and Th deposits with reference to Indian examples.

**PART – C**

Answer ***any two questions***.
Each question carries **ten** marks.

20. Explain the origin and characteristics of hydrothermal deposits, with examples like VMS, Porphyry, and MVT.

21. Discuss the distribution, form, and origin of strata-bound and stratiform ore deposits.
22. Describe the mineral deposits associated with different rocks in India, including magmatic, post-magmatic, and sedimentary deposits.
23. Discuss the significance of the National Mineral Policy of India and its impact on mineral resource management.

**2 x 10 = 20 Marks**

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**Ninth Semester Integrated M.Sc. Geology Degree Examination**
**GLO9IB19 – APPLIED SEDIMENTOLOGY**

Time: 2.5 Hours Maximum Marks: 80

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer any ***ten*** questions.
Each question carries **Two** mark.

1. Define sedimentary processes and provide examples?
2. What is weathering in the context of sedimentology?
3. Describe the significance of sediment transport by fluids?
4. Explain the classification of sedimentary structures?
5. What are the main textures of clastic rocks?
6. Distinguish between clastic and non-clastic rocks?
7. What are the processes influencing sediment and sedimentary rock formation?
8. Define sediment maturity and its importance in sedimentology?
9. What is the role of physical and chemical properties in depositional environments?
10. Explain the term provenance in relation to sedimentary studies?
11. Describe diagenesis and its stages?
12. What is the relationship between tectonics and sedimentation?

**PART – B**

Answer any ***five*** questions.
Each question carries **Eight** marks.

13. Discuss the principles of fluid dynamics relevant to the transport and deposition of sediments?
14. Explain various sedimentary structures and their genesis?
15. Describe the methods of classification of siliciclastic rocks?
16. Discuss the different sedimentary environments and their characteristics?
17. Explain the significance of clay minerals in sedimentology?
18. Describe the process of sedimentation and its relation to tectonics?
19. Discuss the methods of identifying clay minerals and their environmental significance?

**PART – C**

Answer ***any two questions***.
Each question carries **ten** marks.

20. Provide a comprehensive overview of the sedimentary processes, including weathering, transportation, and deposition. Discuss their importance in sedimentology?

21. Explain the history and development of sedimentology as a discipline. Include discussions on key concepts and applications in geological studies?
22. Briefly explain the analytical techniques used in sedimentology, such as petrography, grain size analysis, and geochemistry, and discuss their applications.
23. Explain the sedimentary processes of weathering and fluid transport. Discuss the textures of clastic and non-clastic rocks and their role in basin studies.

**2 x 10 = 20 Marks**

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**Ninth Semester Integrated M.Sc. Geology Degree Examination**
**GLO9IB20 – HYDROGEOLOGY**

Time: 2.5 Hours Maximum Marks: 80

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer any ***ten*** questions.
Each question carries **Two** mark.

1. Explain the concept of a perched water table, how it differs from the main water table?
2. Discuss the formation and significance of the cone of depression in groundwater extraction?
3. Enumerate the benefits of artificial recharge?
4. What factors influence the permeability of a rocks?
5. How does high salinity affect irrigation water?
6. Write a short note on non-recording rain gauge?
7. What is piping failure in hydraulic structures?
8. Point out any two factors affecting hydrograph?
9. Briefly explain induced recharge?
10. What are the consequences of high SAR in irrigation water?
11. Compare the porosity and permeability of sedimentary and igneous rocks?
12. What are the principles of pumping test?

**PART – B**

Answer any ***five*** questions.
Each question carries **Eight** marks.

13. Explain the physical properties of reservoir rocks and how they affect groundwater storage and movement?
14. Expand the term Ghyben-Herzberg principle?
15. What happens to the freshwater-saltwater boundary in coastal area when groundwater is overexploited?
16. Given outline of groundwater geochemistry?
17. Discuss the impact of drinking water pollution in human body?
18. Explain groundwater flow under both study and unsteady conditions?
19. Describe methods used for the prevention and control of seawater intrusion?

**PART – C**

Answer ***any two questions***.
Each question carries **ten** marks.

20. Discuss in detail the darcy's law?
21. What is the relationship between freshwater and saltwater in coastal aquifers?
22. Discuss in detail the water quality parameters with special reference to BIS?
23. Explain the advantages of Geophysical method in groundwater prospecting?

**2 x 10 = 20 Marks**

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**Ninth Semester Integrated M.Sc. Geology Degree Examination**
**GLO9IB21 – ADVANCED REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM**

Time: 2.5 Hours Maximum Marks: 80

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer any ***ten*** questions.
Each question carries **Two** mark.

1. What is multispectral remote sensing?
2. Define digital image processing in the context of satellite imagery?
3. What are the main types of satellite imageries?
4. Explain the concept of Principal Component Analysis (PCA) in image processing?
5. What is image classification, and what are its types?
6. Describe the significance of spectral signatures in remote sensing?
7. What are the principles of thermal radiation as they relate to remote sensing?
8. Distinguish between passive and active microwave remote sensing?
9. Explain the concept of Digital Elevation Model (DEM) and its applications?
10. What is the Geographic Resources Analysis Support System (GRASS)?
11. Define raster data handling in GIS?
12. What is hydrogeological modeling using GIS?

**PART – B**

Answer any ***five*** questions.
Each question carries **Eight** marks.

13. Explain the differences between supervised and unsupervised image classification methods?
14. Discuss the challenges and issues related to hyperspectral remote sensing?
15. Describe the radiation science basics involved in thermal remote sensing?
16. What are the interactions between radar and surface materials in microwave remote sensing?
17. Explain the concepts of spatial analysis and map algebra in GIS?
18. Describe the process of drainage mapping and morphometric analysis?
19. Discuss the integration of Remote Sensing and GIS for water quality monitoring?

**PART – C**

Answer ***any two questions***.
Each question carries **ten** marks.

20. Provide a detailed overview of the applications and significance of microwave remote sensing in various fields?
21. Discuss the history and development of remote sensing technology, highlighting key advancements and their impact on GIS applications?
22. Explain hyperspectral remote sensing, spectral signatures, and BRDF in the Visible, NIR, and SWIR regions. Compare multispectral, hyperspectral, and thermal image data.
23. Describe the role of DEM in hydrological modeling and the integration of Remote Sensing and GIS for urban resource mapping and risk management.

**2 x 10 = 20 Marks**

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**Ninth Semester Integrated M.Sc. Geology Degree Examination**
**GLO9IE02(E02c) – QUATERNARY GEOLOGY AND PALEOCLIMATE**

Time: 2 Hours Maximum Marks: 60

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer any ***nine*** questions.
Each question carries **Two** mark.

1. Define the Quaternary period and discuss its significance.
2. What is the role of oxygen isotope stratigraphy in Quaternary studies?
3. Name two methods of Quaternary dating and briefly explain them.
4. What are the key applications of geomorphology in natural hazard assessment?
5. What is the significance of pollen and phytoliths in Quaternary stratigraphy?
6. Describe the types of continental records used in Quaternary stratigraphy.
7. What is the role of the Milankovitch cycles in paleoclimatology?
8. Define the concept of Paleoclimatic reconstruction
9. How do glacial and interglacial cycles affect plant and animal life during the Quaternary?
10. What is the impact of anthropogenic activity on global climate?
11. What is magnetostratigraphy and how is it used in Quaternary studies?

**PART – B**

Answer any ***four*** questions.
Each question carries **Eight** marks.

12. Discuss the methods of Quaternary dating with examples of their applications.
13. Explain the importance of pollen, spores, and phytoliths in reconstructing Quaternary environments.
14. Discuss the Quaternary stratigraphy of India with key examples.
15. Explain the concept of global energy budget and its influence on climate.
16. Describe the different types of Quaternary records and their significance in stratigraphy.
17. Discuss the effects of Milankovitch cycles and plate tectonics on global climate patterns.

**PART – C**

Answer ***any one*** question.
Each question carries **ten** marks.

18. Explain the role of geomorphic, neotectonic, and active tectonics in natural hazard assessment, with examples of their applications.

19. Discuss the evolution of man and Stone Age culture in relation to the Quaternary period.

**1 x 10 = 10 Marks**

**Ninth Semester Integrated M.Sc. Geology Degree Examination**
**GLO9IE03(E03a) – MARINE GEOLOGY AND OCEANOGRAPHY**

Time: 2 Hours Maximum Marks: 60

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer any ***nine*** questions.
Each question carries **Two** mark.

1. What was the contribution of the Challenger Expedition to marine geological studies?
2. Define hypsometry and its significance in studying sea bottom topography.
3. What are eustatic changes in sea level, and how can they be evidenced?
4. Describe the physical properties of seawater, including thermocline and pycnocline.
5. What is the significance of the Oxygen Minimum Layer in the ocean?
6. What is the Coriolis effect, and how does it influence ocean currents?
7. Define thermohaline circulation and its role in ocean dynamics.
8. What is the El Niño Southern Oscillation (ENSO), and how does it affect weather patterns?
9. Explain the role of jet streams in weather systems.
10. What are the major types of coastal protection structures?
11. Define coastal geomorphology and classify different types of coasts.

**PART – B**

Answer any ***four*** questions.
Each question carries **Eight** marks.

12. Discuss the history of marine geological studies, focusing on the contributions of the Challenger Expedition and the JOIDES Resolution.
13. Explain the chemical properties of seawater, including key dissolved gases and elements present.
14. Discuss the distribution and classification of marine sediments and their relation to the CCD (Calcite Compensation Depth).
15. Discuss the role of coastal processes such as waves, currents, and tides in shaping coastal landscapes.
16. Discuss the general circulation of the atmosphere and how it affects ocean currents.
17. Explain the general weather systems of India, particularly the monsoon system.

**PART – C**

Answer ***any one*** question.
Each question carries **ten** marks.

18. Discuss coastal erosion and the various methods of coastal protection, including seawalls, jetties, and groins.
19. Explain the coupled ocean-atmosphere system, focusing on the relationship between the ocean and atmosphere in influencing climate and weather.

**1 x 10 = 10 Marks**

**Tenth Semester Integrated M.Sc. Geology Degree Examination**
**GLO10IB23 – GEOCHEMISTRY AND ISOTOPE GEOLOGY**

Time: 2.5 Hours Maximum Marks: 80

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer any ***ten*** questions.
Each question carries **Two** mark.

1. What are the different processes of nucleosynthesis?
2. Define meteorites and chondrites, and explain the significance of chondritic ratios.
3. How does the distribution of elements in the solar system vary with respect to distance from the Sun?
4. What is the geochemical classification of elements?
5. Explain the basic concept of thermodynamics in geochemistry.
6. What is the Clapeyron equation and its significance in phase changes?
7. Define molarity and molality in the context of aqueous geochemistry.
8. What is the solubility product, and how does it relate to solubility?
9. Explain the concept of pH and its role in aqueous geochemistry.
10. What is the significance of CO2-H2O interaction in weathering processes?
11. Describe the concept of radioactive decay and its relation to half-life.
12. What is the isochron method of dating?

**PART – B**

Answer any ***five*** questions.
Each question carries **Eight** marks.

13. Discuss the origin of the solar system and how the distribution of elements varies with distance from the Sun.
14. Explain the thermodynamic control on the distribution of chemical species between coexisting phases.
15. Describe the different methods of geochemical and cosmochemical classification of elements.
16. Explain the concept of kinetic and metastability in thermodynamics.
17. Discuss the principles and applications of the isochron method and fission track dating.
18. Describe the process of radioactivity discovery and the significance of stable and radiogenic isotopes in geochemistry.
19. Explain the interpretation of ages obtained from methods like 40Ar-39Ar and U-Th disequilibrium dating.

## PART – C

Answer ***any two questions***.
Each question carries **ten** marks.

20. Discuss the different methods of radiometric dating (e.g., U-Th-Pb, K-Ar, Rb-Sr) and their geological significance in understanding the evolution of the ocean, crust, and mantle.
21. Explain the principles of isotope fractionation, focusing on oxygen, carbon, and nitrogen isotopes, and their application in paleoclimatology and biological processes.
22. Discuss the role of stable isotopes (O, H, C, N, S) in ore geology, mineral exploration, and petroleum exploration.
23. Describe the use of stable isotope geothermometry and geobarometry in understanding geological processes.

**2 x 10 = 20 Marks**

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**Tenth Semester Integrated M.Sc. Geology Degree Examination**
**GLO10IE04(E04a) – GEOTECHNICAL ENGINEERING**

Time: 2 Hours Maximum Marks: 60

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer any ***nine*** questions.
Each question carries **Two** mark.

1. What is the role of the CBR test in foundation design?
2. Explain the difference between intrusive and non-intrusive site investigation methods.
3. What is seismic tomography, and how is it used in geophysical investigations?
4. Describe the methods of drilling used in borehole investigations.
5. What is the purpose of backfilling excavations and boreholes after sampling?
6. Explain the difference between disturbed and undisturbed soil samples.
7. What is the Standard Penetration Test (SPT), and why is it important in borehole testing?
8. What is the purpose of permeability and packer tests in geotechnical investigations?
9. Define the effective and total stress in soils.
10. What are the main types of samplers used in soil sampling?
11. Explain the importance of soil classification in geotechnical engineering.

**PART – B**

Answer any ***four*** questions.
Each question carries **Eight** marks.

12. Discuss the role of aerial photographs and remote sensing in site reconnaissance and planning.
13. Describe the different drilling used in borehole investigations, and explain the associated sampling methods.
14. Explain the process and importance of in situ testing in boreholes, including methods like pressure meter tests, pumping tests, and borehole geophysics.
15. Discuss the various soil tests used to determine mechanical properties, including the triaxial test and shear box test.
16. Describe the different types of foundations (shallow and deep) and the factors affecting their bearing capacity.
17. Discuss the methods and significance of slope stability analysis in geotechnical engineering.

**PART – C**

Answer ***any one*** question.
Each question carries **ten** marks.

18. Discuss the various site investigation methods used in geotechnical engineering, including both intrusive (borehole drilling) and non-intrusive (geophysical) techniques. Highlight their advantages, limitations, and applications.
19. Explain the process of soil testing, including the classification of soils and tests such as particle size distribution, consolidation, and Atterberg limits. How do these tests influence the design of foundations?

**1 x 10 = 10 Marks**

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**Tenth Semester Integrated M.Sc. Geology Degree Examination**
**GLO10IE05(E05c) – CLIMATOLOGY**

Time: 2 Hours Maximum Marks: 60

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer any ***nine*** questions.
Each question carries **Two** mark.

1. What are latitudes and longitudes, and how are they used in determining location?
2. Explain the concepts of Earth's rotation and revolution.
3. What is the role of the atmosphere in supporting life on Earth?
4. Describe the structure and composition of the Earth's atmosphere.
5. What are the main climatic types in Koppen's classification?
6. Define global warming and its possible effects on the Earth's climate.
7. What is the lapse rate in meteorology?
8. Explain the concept of atmospheric stability.
9. What is the Coriolis force, and how does it affect wind movement?
10. What are permanent, secondary, and local winds? Provide examples.
11. What are jet streams, and why are they important in weather patterns?

**PART – B**

Answer any ***four*** questions.
Each question carries **Eight** marks.

12. Discuss the global distribution of climatic types, highlighting both Koppen's and Thornthwaite's classification systems.
13. Explain how atmospheric pressure belts and wind systems influence weather patterns around the globe.
14. Describe the types of winds and the factors that affect their movement.
15. Discuss the different types of temperature inversions and their impacts on weather.
16. Explain the different types of clouds and the conditions under which each forms.
17. Discuss the role of latent heat of condensation in weather processes and its significance in atmospheric dynamics.

**PART – C**

Answer ***any one*** question.
Each question carries **ten** marks.

18. Explain the phenomenon of smog, detailing the differences between photochemical smog and sulfurous smog, and their impacts on health and environment.

19. Discuss the heat budget of the Earth, including insolation and the distribution of temperature across the planet. How does this affect global weather patterns?

**1 x 10 = 10 Marks**

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# MODEL QUESTION PAPERS FOR OPEN COURSES

**Fifth Semester Integrated M.Sc. Geology Degree Examination**
**GLO5ID01 - GEOSCIENCE AND ENVIRONMENT**

Time : 2 Hours Maximum Marks : 60

*(Draw neat sketches, wherever necessary)*

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**PART – A**

Answer ***all*** questions.

Each question carries **Two** mark.

**Ceiling -20 Marks**

1. What is palaeontology?
2. Define mud streams.
3. Describe the agents of weathering.
4. What is *Nuee ardente*?
5. Distinguish *Tuff* and *Ignimbrite*
6. What are the zones of groundwater?
7. What is perched water level?
8. Define solifluction.
9. What is open well and bore well?
10. What is glacier?
11. What is intensity and magnitude of earthquake?
12. What is ozone depletion?

**PART – B**

Answer ***all*** questions.

Each question carries **Five** marks.

**Ceiling -30 Marks**

13. Explain different types of weathering
14. Write a short note on structure of the Earth and its major discontinuities
15. What is Landslide? Explain different types of landslides.
16. What is waste disposal? What are the different methods for waste disposal?
17. Discuss about the greenhouse gases and its effects on climate change.
18. Briefly write about hydrological cycle with help of a diagram.
19. Discuss different types of moraines.

**PART - C**

Answer any ***one*** questions.

Each question carries **Ten** marks.

20. Write about land, air and water pollution and its causes and effects.
21. What are Volcanoes? Explain the types, components, distribution and products of volcanoes.

**2 x 10 = 20 Marks**