SOMAIYA VIDYAVIHAR

K J Somaiya College of Science And Commerce

Somaiya TRUST

Learning Outcome based Curriculum Framework

(LOCF)

For

M.Sc. II Geology

Postgraduate Programme

From

Academic year

2024-25

Vision & Mission

Mission:

- Equip the student with knowledge and skills of their chosen vocation,
- Inculcate values.
- Provide them opportunities for all round growth and prepare them for life.

Vision:

- To equip the students with advanced knowledge and skills in their chosen vocation.
- To provide value-based education and opportunities to students.
- To help them to face challenges in life.
- To nurture a scientific attitude, temperament and culture among the students.
- To continually review, develop and renew the approach to build India of the Founder's dream.

Goals and Objectives:

- To build a strong Academia-Industry bridge.
- To provide flexibility in the courses offered and proactively adapt to the changing needs of students and the society.
- To establish a centre for multidisciplinary activities.
- To mould individuals who would nurture the cultural heritage of our country and contribute to the betterment of the society.

SOMAIYA VIDYAVIHAR
K J Somaiya College of Science And Commerce

Somaiya TRUST

Board of Studies in Geology

Undergraduate and Postgraduate

	Name	Designation	Institute/Industry
Head of the Department			
1	Mr. Deepak Kumar Sahu	Chairman	K J Somaiya College of Science and Commerce.
Subject Expert nominated by Vice-Chancellor			
1	Dr Vikram Vishal	Associate Professor	IIT, Bombay
Subject Experts			
1	Dr. Bobby Mathew	Associate Professor	St. Xaviers College, Mumbai
2	Dr. Raymond Duraiswami	Associate Professor	Savitribai Phule Pune University
3	Dr. Pravin Henriques	Associate Professor	St. Xaviers College, Mumbai
4	Dr. Durga P Mohanty	Assistant Professor	Savitribai Phule Pune University
5	Dr. Pankaj Khanna	Assistant Professor	IIT, Gandhinagar
Representative from Industry/Corporate Sector/Allied Area			
1	Mr. Bipin Gedam	Reservoir Geologist	ONGC, Mumbai
Meritorious Alumnus			
1	Mr. Omkar Sagavekar	MSc - I	K J Somaiya College of Science and Commerce.
Faculty of the Specialisation			
1	Dr. Jyoti Sharma	Assistant Professor	K J Somaiya College of Science and Commerce.
2	Dr. Anirban Mitra	Assistant Professor	K J Somaiya College of Science and Commerce.
3	Mr. Robinprince Udhaya Edward	Assistant Professor	K J Somaiya College of Science and Commerce.
4	Dr. Mayashri Rajkakati	Assistant Professor	K J Somaiya College of Science and Commerce.
5	Dr. Vedanta Adak	Assistant Professor	K J Somaiya College of Science and Commerce.

Foreword

Autonomy reflects efforts for excellence in academic performances, capability of self-governance and enhancement in the quality of education. In the year 2012, the UGC and University of Mumbai conferred the Autonomous Status to K J Somaiya College of Science and Commerce. Post this recognition and having several accolades to our credit, we made significant changes to our existing syllabi to reflect the changing business, industrial and social needs. A holistic education that provides opportunities to gain and share knowledge, experiment and develop beyond curriculum, is offered at our College.

An Autonomous college carries a prestigious image for the students and the teachers and we have made a collaborative attempt to maintain a high level of quality in the standard of education that we impart.

Structured feedback obtained from the students, alumni and the experts from the industry and the changes suggested by them were duly incorporated in the syllabi. The Board of Studies constituted for each department meets to carry out in depth discussions about different aspects of the curriculum taking into cognizance the recent trends in the discipline.

The IQAC team has facilitated the conduct of a number of workshops and seminars to equip the faculty with the necessary skill set to frame the syllabi and competencies to deliver the same. Training was also provided to employ innovative evaluation methods pertaining to higher cognitive levels of revised Bloom's taxonomy. This has ensured the attainment of the learning outcomes enlisted in the syllabus. Audits are conducted to critically review the practices undertaken in teaching, learning and evaluation. Innovative learning methodologies such as project-based learning, experiential learning and flip- class learning practiced by a committed fleet of faculty and supported by several hands have been our unique outstanding propositions. All efforts have been

made to nurture the academic ambitions as well as the skills in co-curricular activities of the most important stakeholder i. e. student.

With sincere gratitude, I acknowledge the constant support and guidance extended by Shri Samir Somaiya, President- Somaiya Vidyavihar, and all the esteemed members of the Governing board and Academic council of the College. I also would like to acknowledge the Heads of the Departments and all the faculty members for their meticulous approach, commitment and significant contribution towards this endeavour for academic excellence.

Dr. Pradnya Prabhu
Principal

Acknowledgement

At the outset, I would like to thank our Principal Dr. Pradnya Prabhu for her guidance and support during the curriculum restructuring process. I am also grateful to all the esteemed members of the Board of Studies, for their constructive suggestions and contributions.

Above all, I am deeply indebted to all the young and vibrant colleagues in the Department of Geology for the long and arduous work they have put in during the compiling of the restructured syllabus.

Mr. Deepak Kumar Sahu
Chairperson
Board of Studies in Geology

Table of Contents

Preamble

This Learning Outcome-based Curriculum Framework (LOCF) supports the fundamental principle of providing quality education in India. We endeavour to mould young minds to participate, contribute and add value to every milestone in their path towards academic excellence. The introduction of Choice Based Credit System (CBCS) has maximized the benefits of the newly designed curriculum manifold.

The LOCF will assist teachers to envisage the outcome expected from the learners at the end of the programme. It will help them to strategize their teaching effectively. At the same time, this document will guide the students through the new curriculum and help them acquire all the skills and knowledge sets required for their personal and academic growth. Higher education qualifications such as the Master's degree Programme are awarded on the basis of demonstrated achievement of outcomes and academic standards; and this is the very essence of this curriculum.

Education is one of the most critical yardsticks in any country's development. The new National Education Policy (NEP) 2020 is an essential and comprehensive policy framework that aims to revamp the country's educational system from its foundation and to bring it at par with global standards. The larger aim of this policy is to transform the Indian education system by making it more inclusive, flexible and relevant to the changing needs of the society. Some of the key features of this policy are the introduction of vocational training, elective courses, emphasis on cultural studies, development of global skill sets and the promotion of multilingualism.

The policy seeks to bring about significant changes in the Higher Education structure, such as introducing a four-year undergraduate degree Programme, establishing multidisciplinary education and research universities, pooled credit banks and creating a National research Foundation to promote and support research

activities in various fields. The new education policy enables every student to get quality education irrespective of their socio-economic background, gender or disability. NEP 2020 enables teachers to use a variety of learning techniques and experiments.

In the current fast paced world, simply cascading the knowledge in the classroom is not sufficient especially when the global requirements keep changing. Every learner should be encouraged to exchange ideas and thoughts in a collaborative approach. This leads to developing an environment which is cognitive in nature and not a one-way information flow. Keeping all this in mind, the curriculum under Learning Outcome-based Curriculum Framework (LOCF) is designed.

1. Introduction

The M.Sc. Geology course is meticulously designed to cater to the intellectual curiosity and academic aspirations of learners delving into the intricacies of geological sciences. It offers a flexible framework that upholds the core ethos of geology programs, ensuring regular review within a comprehensive structure of agreed-upon postgraduate attributes, qualification descriptors, program learning outcomes, and course-level objectives. This program is strategically crafted to provide adaptability and innovation in curriculum development, teaching methodologies, and quality assessment, with a focus on updating pedagogy and embracing outcome-based education.

Rooted in student-centric learning principles, this curriculum aims to equip graduates with the competencies essential for careers in geological exploration, environmental consulting, and advanced research in geosciences. It underscores various graduate attributes including critical thinking, scientific reasoning, ethical awareness, and more. Notably, employability is a key consideration, ensuring that measurable teaching-learning outcomes are aligned with industry demands.

The adoption of modern pedagogical tools such as flipped classrooms, hybrid learning models, and online platforms like NPTEL and SWAYAM is encouraged within this framework. Moreover, the curriculum addresses both local and global geological issues, fostering a comprehensive understanding among students.

Each course is thoughtfully structured to provide students with substantial exposure to diverse geological topics while maintaining a balanced coverage to stimulate further exploration. Fundamental concepts spanning mineralogy, petrology, structural geology, and sedimentology are covered to establish a robust foundation

and ignite curiosity. Specialized areas such as hydrogeology and environmental geology are also incorporated to address contemporary challenges.

Practical sessions are designed to impart essential skills in fieldwork, laboratory techniques, and data analysis. Emphasis is placed on enhancing scientific writing abilities through various assignments and research projects. The program culminates with a thesis project or dissertation, enabling students to deepen their understanding and apply their knowledge to real-world geological problems.

Overall, the M.Sc. Geology course offers a dynamic and enriching academic experience, preparing students for diverse career pathways in the ever-evolving field of geological sciences.

2. Learning Outcome based Curriculum Framework

LOCF focuses on curriculum framework, curriculum aims, learning targets and objectives. The curriculum framework also provides examples of effective learning, teaching and assessment practices. As the curriculum development is a collaborative and an on-going enhancement process, the LOCF instructs periodic reviews and revisions of the curriculum in accordance with the ever-changing needs of students, teachers and society.

The framework describes how students are given exposure towards core knowledge of the subject, specialisation, choice based learning and other skill enhancement courses ensuring development of an integrated personality and employability. The template defines expected outcomes for the programme like core competency, communication skills, critical thinking, affective skills, problem-solving, analytical, reasoning, research-skills, teamwork, digital literacy, moral and ethical awareness, leadership readiness along with specific learning course outcomes at the starting of each course. The Learning Outcomes based Curriculum Framework (LOCF) for M.Sc. Geology will certainly be a valuable document in the arena of outcome-based curriculum design.

2.1 Nature and extent of M.Sc. Geology

The M.Sc. Geology program spans two years, divided into two semesters annually. It offers a comprehensive blend of traditional core subjects like mineralogy and petrology with contemporary fields such as hydrogeology and geochemistry, ensuring a well-rounded education. Specialized topics, including environmental geology and GIS, cater to diverse career interests.

To enhance employability, entrepreneurial skills specific to geology are integrated into the curriculum. Instruction emphasizes formal lectures supplemented by multimedia tools and interactive techniques like RBPT. ICT-based teaching methods

add dynamism, ensuring relevance and engagement. The goal is to cultivate versatile geoscientists ready to tackle modern challenges.

2.2 Programme Education Objectives (PEOs)

The objectives of the Master's degree program in Geology are:

1. Develop a comprehensive understanding of core concepts and skills in geology.
2. Establish a robust connection between academia and industry to enhance practical relevance.
3. Develop technical skills in specialized geological disciplines, such as hydrogeology or geomorphology, while gaining expertise in research methodologies and problem-solving approaches specific to these areas.
4. Provide opportunities for internships and research projects to refine scientific capabilities.
5. Apply acquired scientific knowledge to tackle pressing global research challenges.
6. Prepare students for further academic pursuits such as doctoral studies, national eligibility tests, or careers in Geology-related professions.
7. Foster values of global citizenship, empathy for all living beings, and commitment to sustainability.

3. Graduate Attributes in Geology

Attributes expected from graduates of the M.Sc. Geology Program include:

PGA 1: Possess a deep understanding of advanced concepts in mineralogy, structural geology, tectonics, geomorphology, petrology, sedimentary geology, hydrogeology, geophysics, and marine geology.

PGA 2: Integrate knowledge from various geological disciplines to analyze complex geological processes and phenomena, including the interactions between rocks, minerals, structures, and Earth systems.

PGA 3: Demonstrate proficiency in utilizing advanced geological techniques and tools, such as geological mapping, geochemical analysis, remote sensing, GIS (Geographic Information Systems), and geophysical surveys..

PGA 4: Develop advanced research skills, including the ability to formulate research questions, design and conduct geological investigations, collect and analyze geological data, and present research findings effectively.

PGA 5: Acquire extensive experience in conducting geological fieldwork, including the ability to identify and interpret geological features, map geological formations, and collect geological samples in diverse field settings.

PGA 6: Apply geological principles to solve complex problems effectively.

PGA 7: Communicate geological concepts clearly to diverse audiences.

PGA 8: Uphold ethical standards and professional integrity in the practice of geology, including adherence to safety protocols, environmental regulations, and ethical guidelines in geological research, exploration, and resource management.

4. Qualification descriptors

Upon successful completion of the program, students are awarded a Master's degree in Geology. M.Sc. Geology graduates of this department acquire comprehensive knowledge across various foundational and specialized branches within the field of geology, accompanied by the development of practical skills in their chosen area of specialization. Graduates are expected to demonstrate a profound understanding of geological concepts and their practical applications.

With their acquired expertise, M.Sc. Geology graduates are well-equipped to contribute to diverse sectors including research and development, academia, governmental agencies, and the public sector. This program provides a robust platform for students to further their studies in geology, whether through pursuing doctoral research or engaging in field-based investigations within the discipline.

The list below provides a synoptic overview of possible career paths provided by an undergraduate Student in Geology:

1. Academics
2. Research
3. Mining industry
4. Mineral Exploration companies
5. GIS-based companies
6. Remote sensing industry
7. Hydrogeology
8. Geohazard mitigation industry
9. Oil and Gas sector
10. Coal sector
11. Energy sector
12. Civil construction companies

13. Environmental monitoring and analysis
14. Climate change related industry

Job Roles for Geology Postgraduate:

After graduation one can seek a professional career as:

1. Field Geologist
2. Laboratory Geologist
3. Geochemist
4. Geophysical surveyor
5. GIS analyst
6. Remote sensing analyst
7. Data analyst (Geological data)
8. Academist
9. Environment analyst
10. Project fellow
11. Entrepreneur
12. Civil services
13. Competitive exams

Higher Education options for geology Postgraduate:

1. Ph.D. in Geology
2. PG Diploma in advanced remote sensing and GIS,
3. Courses in management

The learners who complete two years of full-time study of an postgraduate programme of study will be awarded a Master's degree in Geology.

5. Programme Specific Outcomes (PSOs)

After the successful completion of modules in different courses of M.Sc. Geology, the learner will be able to:

PSO 1: Demonstrate an advanced understanding of key concepts and theories in various subfields of geology.

PSO 2: Possess proficient fieldwork skills, including the ability to conduct geological field studies, analyze geological formations, and interpret geological features in diverse geological settings.

PSO 3: Excel in designing, executing, and presenting geological research projects.

PSO 4: Integrate specialized knowledge from diverse areas of geology, to address complex geological problems and challenges.

PSO 5: Acquire proficiency in utilizing advanced geological techniques and tools, to investigate geological phenomena and processes.

PSO 6: Demonstrate critical thinking skills and the ability to apply geological principles and methods to analyze and solve complex geological problems

PSO 7: Develop effective written and oral communication skills, including the ability to communicate geological concepts, research findings, and interpretations to diverse audiences, including peers, professionals, and the public.

PSO 8: Uphold ethical standards and professional integrity in the practice of geology, including adherence to safety protocols, environmental regulations, and ethical guidelines in geological research, exploration, and resource management.

5.1 Course Mapping

Semester	PSO	I	II	III	IV	V	VI	VII	VIII
	Course								
I	MJ I	√		√	√	√	√	√	√
	MJ II	√	√	√	√	√	√	√	√
	MJ III	√	√		√	√	√	√	
	MJ IV	√		√	√	√	√	√	√
	DSE I	√	√	√	√	√	√	√	√
	DSE II	√	√	√	√	√	√	√	√
	DSE III	√	√	√	√	√	√	√	√
	RM			√			√	√	√
II	MJ I	√	√	√	√	√	√	√	√
	MJ II	√	√	√	√	√	√	√	√
	MJ III	√	√		√	√	√	√	√
	MJ IV	√	√	√	√	√	√	√	√
	DSE I	√	√	√	√	√	√	√	√
	DSE II	√	√	√	√	√	√	√	√
	DSE III	√	√	√	√	√	√	√	√
	OJT	√	√	√	√	√	√	√	√
III	MJ I	√	√	√	√	√	√	√	√
	MJ II	√	√	√	√	√	√	√	√
	MJ III	√	√		√	√	√	√	√
	MJ IV	√	√	√	√	√	√	√	√
	DSE I	√	√	√	√	√	√	√	√
	DSE II	√	√	√	√	√	√	√	√
	DSE III	√	√	√	√	√	√	√	√
IV	MJ I	√	√		√	√	√	√	√
	MJ II	√	√		√	√	√	√	√

	MJ III	√	√	√	√	√	√	√	√
	MJ IV	√		√	√	√	√	√	√
	RP	√	√	√	√	√	√	√	√

RM : Research Methodology Course

RP: Research Project

OJT: On Job Training.

6. Structure of M.Sc. Geology programme

The programme consists of two years (two semesters per year). The syllabus is drafted such that all significant theoretical subjects are covered in the initial three semesters with an emphasis on on-the-job training and research project/ internship/ apprenticeship work in industry or certified laboratories.

Sem	Major	DSE	RM/OJT/ RIA	Total
1	14	4	RM 4	22
2	14	4	OJT 4	22
3	16	6	-	22
4	8	-	RIA 14	22

• In semester I, the learner will have four major core courses on General Geology, one discipline specific elective and one common minor course on Research Methodology.

• In Semester II, the learner will have four major core courses on Advanced Geology, one discipline specific elective and will have to engage in an on-the-job training for 21 days.

• In Semester III the subject specialisation begins, the learner has four courses in and two discipline specific elective courses

• In Semester IV the learner has four courses in, and will have to complete one long Research Project and submit a dissertation at the end of the semester.

• Dissertation should be appreciable, original and of good quality. Assessment of dissertation will be based on an open viva for defence.

1. Major Core Courses (MJ):

a) A course which is required to be opted by a candidate as a major core course. The course designed under this category aims to cover the basics that a student is expected to imbibe in that particular subject or discipline.

b) There are sixteen Major Core courses (MJ), four each, in semesters I II, III and IV

c) Each Major Core Courses is compulsory.

d) Each Major Core Course consists of 2 credits for theory i.e. 30 hours; 2 lectures of each 1 hr per week and 1.5 credit per practical of two hours per week per course in every semester.

e) The purpose of fixing major core papers is to ensure that the institution follows a minimum common curriculum so as to adhere to common minimum standards with other universities/institutions.

2. Discipline Specific Elective (DSE) :

a) A course is chosen by the candidate from the same stream as an elective out of the three courses offered. Elective course helps the student to gain a broader understanding of the specialization in the major discipline.

b) There is one DSE course each in semester I, II and two in semester III. The credits assigned are 2 credits for theory ie. 30 hours; 2 lectures of 1 hr each per week and 2 credits for practical of four hours per week in semester 1 and 2. In semester 3, there are 2 credits for theory per course and 1 credit each for the practical.

3. Research Methodology (RM)

a) This is a mandatory Minor that all post graduate students of science have to take.

b) Students are required to achieve understanding of the various nuances of research, how to formulate a research problem, plan the work and execute it effectively. Scientific writing and other skills relevant to research are taught here.

c) This course carries 4 credits (60 - hours in class teaching)

4. On Job Training (OJT)

a) On Job training or Internships are introduced as per the guidelines of the National Education Policy (NEP) 2020, which emphasizes the importance of research and internships in undergraduate education. The internships will be mandatory for students in three-year and four-year degree programs, with a duration of 60 to 120 hours.

b) This seeks to equip students with the ability to gain relevant soft skills such as teamwork, problem-solving, work ethics, adaptability, communication, and time management.

c) This training carries 4 credits. 1 credit corresponds to 30 hours of engagement in a semester.

5. **Internship (INT):**

a) One of the fundamental principles guiding the development of our education system as per NEP 2020 is the fostering of 'outstanding research as a corequisite for outstanding education and development'. with this perspective Research project / Dissertation is a mandatory component of the masters program

b) Here the learner is assigned a research problem related to their field of specialization either within the department or at a premier institute of the country. The learner has to complete their research and present their dissertation at the end of the period.

c) Internship is introduced in semester IV of M.Sc course, having 14 credits. 1 credit of internship corresponds to 30 hours of engagement in a semester.

6.1 Course Content

Sr. No	Semester	Course number	Course Code	Course title
1	I	MJ I	23PSIGEMJIAMO	Advanced Mineralogy and Crystal Optics
2		MJ II	23PSIGEMJ2SGT	Structural Geology and Tectonics
3		MJ III	23PSIGEMJ3TGM	Tectonic Geomorphology
4		MJ IV	23PSIGEMJ4IGP	Igneous Petrology

5		MJ P	23PSIGEMJP1 23PSIGEMJP2	Practical based on each Major Course- [MJ1+MJ2=P1, MJ3+MJ4=P2]
6		DSE1	23PSIGEDSERME	Rock Mechanics and Rock Engineering
7		DSE2	23PSIGEDSEAGC	Analytical Geochemistry
8		DSE3	23PSIGEDSEVCG	Volcanology
9		DSEP	23PSIGEDSERMEP 23PSIGEDSEAGCP 23PSIGEDSEVCGP	Practical based on the DSE course
10		RM	24PSIGERM	Research Methodology
11	II	MJ I	23PS2GEMJ1SMG	Sedimentary Geology
12		MJ II	23PS2GEMJ2MMP	Metamorphic Petrology
13		MJ III	23PS2GEMJ3MEE	Mineral Exploration and Mineral Economics
14		MJ IV	23PS2GEMJ4PAL	Paleontology
15		MJ P	23PS2GEMJP1 23PS2GEMJP2	Practicals based on each major course
16		DSE I	23PS2GEDSEAPL	Applications of Paleontology
17		DSE 2	23PS2GEDSECPG	Coal and Petroleum Geology

18		DSE 3	23PS2GEDSESTI	Stratigraphy
19		DSE P	23PS2GEDSEAPLP 23PS2GEDSECPGP 23PS2GEDSESTIP	Practicals based on each DSE course
20		OJT	23PS2GEOJT	On Job Training
21	III	MJ I	24PS3GEMJIHGY	Hydrogeology
22		MJ II	24PS3GEMJIIGPY	Geophysics
23		MJ III	24PS3GEMJIIIRSG	Remote Sensing and GIS
24		MJ IV	24PS3GEMJIVMAG	Marine Geology
25		MJ P	24PS3GEMJPI 24PS3GEMJP2 24PS3GEMJP3 24PS3GEMJP4	Practicals based on each major course
26		DSE 1	24PS3GEDSEGDY	Geodynamics
27		DSE 2	24PS3GEDSEGST	Geostatistics
28		DSE 3	24PS3GEDSESGE	Soil Geology
29		DSE P	24PS3GEDSEGDYP 24PS3GEDSEGSTP 24PS3GEDSESGEP	Practicals based on any one DSE course
30	IV	MJ I	24PS4GEMJIEVG	Environmental Geology
31		MJ II	24PS4GEMJIIEAC	Earth and Climate

32		MJ III	24PS4GEMJIIINHM	Natural Hazards and Mitigation
33		MJ IV	24PS4GEMJIVITG	Instrumentation Techniques in Geology
34		RP/INT/A	24PS4GERIA	Research Project/Internship/ Apprenticeship

6.2 Credit distribution for M.Sc. Geology

Semester	Course number	Course title	Credits		
			Theory	Practical	Total
I	MJ I	Advanced Mineralogy and Crystal Optics	2	1.5	3.5
	MJ II	Structural Geology and Tectonics	2	1.5	3.5
	MJ III	Tectonic Geomorphology	2	1.5	3.5
	MJ IV	Igneous Petrology	2	1.5	3.5
	DSE	Student will choose any one DSE	2	2	4
	RM	Research Methodology	4	-	4
	Total				**22**

II	MJ I	Sedimentary Geology	2	1.5	3.5
	MJ II	Metamorphic Petrology	2	1.5	3.5
	MJ III	Mineral Exploration and Mineral Economics	2	1.5	3.5
	MJ IV	Paleontology	2	1.5	3.5
	DSE	Student will choose one DSE	2	2	4
	OJT	On Job Training	4	-	4
	Total				**22**
III	MJ I	Hydrogeology	2	2	4
	MJ II	Geophysics	2	2	4
	MJ III	Remote Sensing and GIS	2	2	4
	MJ IV	Marine Geology	2	2	4
	DSEI	Student will choose one DSE	2	1	3
	DSEII	Student will choose one DSE	2	1	3
	Total				**22**
IV	MJ I	Environmental Geology	2	-	2
	MJ II	Earth and Climate	2	-	2

	MJ III	Natural Hazards and Mitigation	2	-	2
	MJ IV	Instrumentation Techniques in Geology	2	-	2
	RIA	Research Project/ Internship/ Apprenticeship	14	-	14
	Total				**22**

6.3 Semester Schedule

Semester	Major Core Courses (MJ)	DSE [Any one per semester]	RM/ OJT/ Internship CC
I	Advanced Mineralogy and Crystal Optics	Rock Mechanics and Rock Engineering	RM -
		Analytical Geochemistry	
		Volcanology	
	Structural Geology and Tectonics		
	Tectonic Geomorphology		

	Igneous Petrology		
II	Sedimentary Geology	Applications of Paleontology	- OJT
	Metamorphic Petrology	Coal and Petroleum Geology	
	Mineral Exploration and Mineral Economics	Stratigraphy	
	Paleontology		
III	Hydrogeology	Geodynamics	-
	Geophysics	Geostatistics	
	Remote Sensing and GIS	Soil Geology	
	Marine Geology		
IV	Environmental Geology	-	- Research Internship
	Earth and Climate		
	Natural Hazards and Mitigation		
	Instrumentation Techniques in Geology		

6.4 Course Learning Objectives

The MSc Geology program is designed to achieve several key learning objectives. Over the course of two years, students will gain a comprehensive understanding of fundamental geological concepts. Through lectures, fieldwork, and laboratory exercises, they will develop analytical and critical thinking skills necessary for solving geological problems effectively. Practical proficiency will be enhanced as students apply their knowledge to real-world scenarios. Additionally, the program aims to cultivate effective communication skills, both written and oral, enabling students to articulate geological findings convincingly. Continuous improvement will be supported through constructive feedback provided throughout the program. Moreover, students will be encouraged to consider the ethical and societal implications of geological practice, fostering a sense of responsibility within the field.

7. Detailed M.Sc. Geology Syllabus

M.Sc. Syllabus with effect from the Academic year 2024–2025

Syllabus - M.Sc II Geology

Course No.	Course Title	Course Code	Credits	Periods (1 Hr)	Module	Lectures per module (1 hr)	Examination		
							Internal Marks	External Marks	Total Marks
SEMESTER III									
Core Courses THEORY									
I	Hydrogeology	24PS3GEMJIHGY	2	30	2	15	20	30	50
II	Geophysics	24PS3GEMJIIGPY	2	30	2	15	20	30	50
III	Remote Sensing and GIS	24PS3GEMJIIIRSG	2	30	2	15	20	30	50
IV	Marine Geology	24PS3GEMJIVMAG	2	30	2	15	20	30	50
Core Courses PRACTICAL									
		24PS3GEMJP1	4	120			40	60	100
		24PS3GEMJP2	4	120			40	60	100
Discipline Specific Elective DSE [Any one]									
DSE1	Geodynamics	24PS3GEDSEGDY	2	30	2	15	20	30	50
DSE2	Geostatistics	24PS3GEDSEGST	2	30	2	15	20	30	50
DSE3	Soil Geology	24PS3GEDSESGE	2	30	2	15	20	30	50
DSE Practical									
	Practical based on chosen DSE course	24PS3GEDSEGDYP 24PS3GEDSEGSTP	1	30			10	15	25

		24PS3GEDSESGEP							
SEMESTER IV									
Core Courses THEORY									
I	Environmental Geology	24PS4GEMJIEVG	2	30	2	15	20	30	50
II	Earth and Climate	24PS4GEMJIIEAC	2	30	2	15	20	30	50
III	Natural Hazards and Mitigation	24PS4GEMJIIINHM	2	30	2	15	20	30	50
IV	Instrumentation Techniques in Geology	24PS4GEMJIVITG	2	30	2	15	20	30	50
Research Project / Internship / Apprenticeship									
RIA	Research Project/Internship/ Apprenticeship	24PS4GERIA	14	420			350		350

MSc GEOLOGY SEMESTER III

Major Core Course- I

COURSE TITLE: Hydrogeology

COURSE CODE: 24PS3GEMJIHGY

[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to - 1. Understand the hydrogeologic cycle and groundwater distribution within aquifer systems 2. Develop skills in analyzing groundwater properties and conducting testing methods like flownet analyses. 3. Analyze groundwater properties and quality, and apply relevant exploration techniques. 4. Utilize methods for effective assessment and management of groundwater resources, including addressing salinity, contamination, and saltwater intrusion.

Module I	Fundamental Concepts in Hydrogeology	[15L]

Learning objectives

The module is intended to -

- Introduce hydrogeology principles, covering the hydrogeologic cycle, aquifer formation, and groundwater properties.
- Familiarize with groundwater occurrence, movement, and testing methods, including flownet analyses.

Learning outcomes

After the successful completion of the module, the learner will be able to -

- Understand the hydrogeologic cycle and groundwater distribution within aquifer systems
- Develop skills in analyzing groundwater properties and conducting testing methods like flownet analyses.

Subtopic	Title	15L
1.1	Introduction to Hydrogeology: The hydrogeologic cycle, Vertical Distribution of Groundwater, Formation of aquifer systems and types, Properties of rocks and groundwater.	8 L
1.2	Occurrence and movement of groundwater, flownet analyses, Groundwater testing Methods.	6 L

- Hölting, B., Coldewey, W. G. (2018). Hydrogeology. Germany: Springer Berlin Heidelberg.
- Patra, H. P., Adhikari, S. K., Kunar, S. (2016). Groundwater Prospecting and Management. Senegal: Springer Nature Singapore.
- Delleur, J. W. (2010, December 12). The Handbook of Groundwater Engineering. CRC Press.
- Fetter, C.W., (1994): Applied Hydrogeology MacMillan Pub. Comp. New York.

Module II	Groundwater Exploration and Groundwater Quality	[15L]

Learning objectives

The module is intended to –

- Understand groundwater chemistry, quality analysis, and exploration techniques.
- Explore methods for assessing groundwater resources and addressing issues like salinity, contamination, and saltwater intrusion.

Learning outcomes

After the successful completion of the module, the learner will be able to -

- Analyze groundwater properties and quality, and apply relevant exploration techniques.
- Utilize methods for effective assessment and management of groundwater resources, including addressing salinity, contamination, and saltwater intrusion

Subtopic	Title	15L
2.1	Chemical properties of groundwater: Groundwater chemistry and quality analysis salinity,Salt Water intrusion, water logging and causes of water table declination. Groundwater contamination. Groundwater resources of India.	8 L
2.2	Groundwater Exploration: Groundwater exploration by geologic, hydro geologic, remote sensing and geophysical methods. Well hydraulics, tube well drilling techniques, designing, and development.	7 L

- D.K. Todd (1995): Groundwater Hydrology, John Wiley and Sons.
- K. R. Karanth (1989): Hydrogeology, Tata McGraw Hill Publ.
- Ragunath, H.M., (1992): Groundwater Wiley Eastern Ltd. New Delhi.
- S.N. Davies and R.J.N. De Wiest (1966): Hydrogeology, John Wiley and Sons, New York.

Question paper Template

M. Sc. (Geology) SEMESTER III

Major Core Course- I

COURSE TITLE: Hydrogeology

COURSE CODE: 24PS3GEMJ1HGY

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

MSc Geology Semester III

Major Core Course- II

COURSE TITLE: Geophysics

COURSE CODE: 24PS3GEMJ2GPY

[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to: 1. Grasp the fundamentals of gravity methods for geological mapping and resource exploration. 2. Comprehend seismic techniques for identifying and characterizing subsurface resources. 3. Master the fundamentals of resistivity, electromagnetic, magnetic, and radiometric methods for subsurface investigation 4. Apply knowledge of geophysical borehole logging principles and techniques to interpret subsurface geological features.

Module I	Introduction to Rock Mechanics and Rheology	[15L]

Learning objectives

The module is intended to –

- Understand various geophysical methods used in solid earth research and exploration.
- Learn the principles and applications of gravity and seismic methods in geological studies

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Grasp the fundamentals of gravity methods for geological mapping and resource exploration.
- Comprehend seismic techniques for identifying and characterizing subsurface resources.

Subtopic	Title	15L
1.1	Brief idea of various geophysical methods used in geophysical prospecting and solid earth research.	2 L
1.2	Gravity method : rock densities, gravity formulas, shape of the earth, Isostasy, gravity anomaly and it's types, corrections, Application of gravity methods in regional geological mapping and hydrocarbon, mineral and ground water exploration, gravimeters.	6 L
1.3	Seismic methods : Seismic waves and their propagaion, theory of elasticity, seismic reflection and refraction methods, focal mechanism and fault plane solution, seismotectonics and internal structure of the eath, reservoir induced seismicity, Application of seismic reflection and refraction in exploration programs.	7

References

- Lowrie, William., Fichtner, Andreas. Fundamentals of Geophysics. India: Cambridge University Press, 2020
- Kearey, Philip., Brooks, Michael., Hill, Ian. An Introduction to Geophysical Exploration. Germany: Wiley, 2013.
- Reynolds, John M.. An Introduction to Applied and Environmental Geophysics. Germany: Wiley, 2011.

Module II	Geophysical Exploration: Electrical, Magnetic, Radiometric Methods	15L

Learning objectives

The module is intended to –

- Gain familiarity with electrical, magnetic, radiometric, and borehole logging methods used in geophysical exploration.
- Understand the principles, instrumentation, and interpretation techniques associated with each geophysical method.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Master the fundamentals of resistivity, electromagnetic, magnetic, and radiometric methods for subsurface investigation
- Apply knowledge of geophysical borehole logging principles and techniques to interpret subsurface geological features.

Subtopic	Title	15L
2.1	Electrical method : Basic electrical quantities, Resistivity and resistivity survey, Electrical profiling and sounding, 2-layer and 3-layer cases, Electromagnetic field techniques and interpretation, Magnetotelluric method, Induced Polarisation and Self potential	5 L
2.2	Magnetic Method : Fundamental principles of magnetic prospecting, Earth's magnetism, Instruments, field measurements and interpretation Introduction to airborne magnetic survey	2 L

2.3	Radiometric methods : Fundamental of radioactivity and detection of radiation, units of radioactivity, radioactive minerals, Instruments used in radiometric survey	3 L
2.4	Geophysical borehole logging : Introduction to drilling, Principles of well logging, types of logging	3 L
2.5	Case studies related to each exploration techniques	2 L

References

- Burger, Henry Robert., Sheehan, Anne F.., Jones, Craig H.. Introduction to Applied Geophysics: Exploring the Shallow Subsurface. United Kingdom: W.W. Norton, 2006.
- Telford, W. M.., Geldart, L. P.., Sheriff, R. E.. Applied Geophysics. N.p.: Cambridge University Press, 1990
- Dobrin, Milton Burnett., Savit, Carl H.. Introduction to Geophysical Prospecting. United Kingdom: McGraw-Hill Book Company, 1988.

Question paper Template

MSc Geology Semester III

Major Core Course- II

COURSE TITLE: Geophysics

COURSE CODE: 24PS3GEMJ2GPY

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

MSc Geology Semester III

Major Core Course- III

COURSE TITLE: Remote Sensing and GIS

COURSE CODE 24PS3GEMJ3RSG

[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to – • Understand the fundamental principles of electromagnetic radiation and its interactions relevant to remote sensing. • Identify and evaluate various remote sensing sensors and their capabilities, along with interpreting aerial photographs using photogrammetric techniques. • Understand the principles of thermal infrared radiation, RADAR systems, GIS components, and spatial referencing methods. • Identify the applications and assess the capabilities of thermal infrared and RADAR remote sensing, as well as GIS, in various fields, considering their advantages and limitations.

Module I	Fundamentals of Remote Sensing	15 L
Learning objectives The module is intended to – • Introduce the principles of remote sensing, encompassing electromagnetic radiation, energy-matter interactions, and spectral reflectance. • Familiarize students with remote sensing sensors, resolutions, aerial photography, and photogrammetric principles.		
Learning outcomes		

After the successful completion of the module, the learner will be able to -

- Understand the fundamental principles of electromagnetic radiation and its interactions relevant to remote sensing.
- Identify and evaluate various remote sensing sensors and their capabilities, along with interpreting aerial photographs using photogrammetric techniques.

Subtopic	Title	15L
1.1	Introduction to Remote Sensing Principles of Electromagnetic Radiation: Wave/particle model of electromagnetic (EM) energy; Laws and principles of electromagnetic radiation; EM spectrum; EM wavelength regions and their applications; Scattering, absorption and reflection of EM radiation; Atmospheric window; energy-matter interactions; Spectral reflectance curves.	6 L
1.2	Sensors and Resolutions: Types of sensors; Spatial, spectral, temporal and radiometric resolution of sesnors	2 L
1.3	Aerial Photography: Aerial platforms; cameras, filters and films; Photogrammetry principles; Geometry of aerial photographs; Scale determination; Photogrammetric measurements; Elements of photointerpretation; Interpretation of aerial photographs.	7 L

References

- Emery, W., Camps, A. (2017). Introduction to Satellite Remote Sensing: Atmosphere, Ocean, Land and Cryosphere Applications. Netherlands: Elsevier Science.

- Jensen, J. (2015). Introductory Digital Image Processing: A Remote Sensing Perspective. United Kingdom: Pearson Education.
- Lillesand, T., Kiefer, R. W., Chipman, J. (2015). Remote Sensing and Image Interpretation. United Kingdom: Wiley.
- Jensen, J. (2013). Remote Sensing of the Environment: An Earth Resource Perspective: Pearson New International Edition. United Kingdom: Pearson Education
- Gupta, R. P. (2013). Remote Sensing Geology. Germany: Springer Berlin Heidelberg.
- Prost, G. L. (2001). Remote Sensing for Geologists: A Guide to Image Interpretation. Netherlands: Taylor & Francis.

Module II	Advanced Remote Sensing and Fundamentals of GIS	15L

Learning objectives

The module is intended to –

- Introduce thermal infrared and RADAR remote sensing principles, along with GIS fundamentals and spatial referencing techniques.
- Familiarize students with the components, advantages, and limitations of these remote sensing and GIS technologies.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Understand the principles of thermal infrared radiation, RADAR systems, GIS components, and spatial referencing methods.
- Identify the applications and assess the capabilities of thermal infrared and RADAR remote sensing, as well as GIS, in various fields, considering their advantages and limitations.

Subtopic	Title	15L

2.1	Thermal Infrared Remote Sensing: Thermal infrared radiation principles; Kinetic heat and temperature; Thermal radiation laws; Emissivity; Thermal properties of terrain; Thermal infrared detectors; Applications, advantages and limitations of thermal infrared remote sensing.	3 L
2.2	Active microwave (RADAR) remote sensing: RADAR system components; RADAR nomeclature; Advantages and limitations of RADAR; RADAR operations; Polarization; RADAR image geometry; RADAR resolutions; RADAR relief displacement: Foreshortening, layover and shadow; Synthetic aperture radar systems; Fundamental RADAR equation	4 L
2.3	Introduction to Geographic Information System: Introduction and definitions; Technology and concepts; Components of GIS; Primary features of GIS; Capabilities of GIS; Advantages and limitations of GIS; Introduction to commonly used GIS software.	3 L
2.4	Spatial Referencing: Coordinate systems: Geographic and projected; Map Projections; Types of map projections and their characteristics; Datum and its nomenclature; Geometry of datum; Regional and geocentric datum; UTM zones; Basics of GPS.	3 L
2.5	GIS Data: Method of data capture; Nature and source of data; Geographic data models; Fields and entities; Raster and Vector data formats; Advantages and limitations of vector and raster data;	2 L

References

- Elangovan, K. (2023). GIS: Fundamentals, Applications and Implementations. India: NIPA.
- Wegmann, M., Schwalb-Willmann, J., Dech, S. (2020). An Introduction to Spatial Data Analysis: Remote Sensing and GIS with Open Source Software. United Kingdom: Pelagic Publishing
- McHaffie, P., Hwang, S., Follett, C. (2018). GIS: An Introduction to Mapping Technologies. United Kingdom: CRC Press.
- Woodhouse, I. H. (2017). Introduction to Microwave Remote Sensing. United States: CRC Press.
- Jensen, J. R., Jensen, R. R. (2013). Introductory Geographic Information Systems. United Kingdom: Pearson

Question paper Template

M. Sc. (Geology) SEMESTER III

Major Core Course- III

COURSE TITLE: Remote Sensing and GIS

COURSE CODE: 24PS3GEMJ3RSG

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

MSc Geology Semester III

Major Core Course- IV

COURSE TITLE: Marine Geology

COURSE CODE: 24PS3GEMJ4MAG

[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to - • Analyze the significance of key oceanic expeditions and their contributions to marine geology. • Evaluate evidence for plate tectonics and classify marine sediments based on sources, composition, and distribution. • Analyze ocean floor features and circulation patterns, explaining their origins and effects. • Evaluate marine mineral resources' potential and their implications for economic and environmental sustainability.

Module I	Evolutions, Expeditions and Marine Sediments	15L

Learning objectives

The module is intended to –

- Explore the history, scope, and methods of marine geological investigations, emphasizing oceanic expeditions and ocean floor exploration
- Understand the evolution of oceans through plate tectonics, focusing on mid-oceanic ridges, plate boundaries, and sea-floor spreading.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Analyze the significance of key oceanic expeditions and their contributions to marine geology.
- Evaluate evidence for plate tectonics and classify marine sediments based on sources, composition, and distribution.

Subtopic	Title	15 L
1.1	History of Marine Geology, Scope and Applications of Marine Geological Investigations. Oceanic expeditions: Challenger expedition, Deep Sea drilling Project, Ocean drilling Programme, Joint Global Flux Studies (JGOFS), Integrated Ocean Drilling Programme (IODP). Methods of exploring the ocean floor.	7 L
1.2	Evolution of Oceans: Evidence for plate tectonics; Plate boundaries; Mid- oceanic ridges an mantle convection; Sea floor spreading	4 L
1.3	Marine sediments, Classification of sediments; Neritic deposits; Pelagic deposits; sources and composition, sediment types and distribution.	4 L

References

- Pinet, P. R. (2011). Invitation to Oceanography. United States: Jones & Bartlett Learning.
- Stewart, R. H. (2009). Introduction to Physical Oceanography. United States: University Press of Florida.
- Keen, M. J. (2017). An Introduction to Marine Geology. Netherlands: Elsevier Science.
- Kennett, J. P. (1982). Marine geology. United Kingdom: Prentice-Hall.

Module II	Ocean Terrain, Circulation, and Resources	15L

Learning objectives

The module is intended to –

- Understand ocean floor topography, continental margins, oceanic ridges, basins, and forces driving ocean circulation.
- Explore marine mineral resources, both surface and subsurface, and their significance.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Analyze ocean floor features and circulation patterns, explaining their origins and effects.
- Evaluate marine mineral resources' potential and their implications for economic and environmental sustainability.

Subtopic	Title	15L
2.1	Ocean Floor topography-- Continental margins: continental shelf and slope, its origin, continental rise; Submarine canyon and their origin, Oceanic ridges: Ridges, fracture zones; Ocean basins: Abyssal plains, Abyssal hills, Seamounts and guyots, Marginal trenches	6 L
2.2	Surface, intermediate and deep ocean circulation; forces that produce and effects circulation patterns in world oceans; Important phenomena associated with surface circulation; Formation and movement of deep and bottom waters.	6 L
2.3	Marine mineral resources: Surface marine resource; Subsurface marine resource	3 L

Reference

- Condie, K. C. (1997). Plate tectonics and crustal evolution. Boston: Elsevier Science & Technology Books.
- Talley, L. D. (2011). Descriptive Physical Oceanography: An Introduction. Netherlands: Elsevier Science.
- Garrison, T. (2005). Oceanography: An Invitation to Marine Science. United States: Thomson Brooks/Cole.
- Garrison, T. (2004). Essentials of Oceanography. United Kingdom: Brooks/Cole
- Gross, M. G., Gross, E. R. (1996). Oceanography, a view of earth. United Kingdom: Prentice Hall.

Question paper Template

M. Sc. (Geology) SEMESTER III

Major Core Course- IV

COURSE TITLE: Marine Geology

COURSE CODE: 24PS3GEMJ4MAG

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

MSc Geology Semester III

Practical

24PS3GEMJP1

Core Course I	Hydrogeology Practical

Learning Objectives

To provide students with practical skills and theoretical understanding in groundwater flow analysis, chemical quality data interpretation, aquifer test data analysis, and problem-solving related to groundwater recharge and mapping techniques.

Learning Outcomes

After completion of this practical, learner will be able to

1. Proficiently construct and interpret groundwater flow nets and analyze chemical quality data, facilitating effective groundwater flow pattern analysis and water quality assessment.
2. Demonstrate competence in aquifer test data analysis and problem-solving related to groundwater recharge and map interpretation, enhancing their practical skills in hydrogeology.

1. Groundwater flow net construction and interpretations;
2. Graphical plotting and interpretation of chemical quality data of waters;
3. Analysis of aquifer test data;
4. Problem-solving on groundwater recharge, groundwater volume, balance, Maps related to groundwater recharge,
5. Resistivity,
6. Map on Groundwater Provinces,
7. Groundwater Recharge problems

Core course II	Geophysics Practical

Learning Objectives

To provide students with practical skills and theoretical understanding in various geophysical methods including gravity studies, seismic exploration, earthquake location determination, resistivity surveying, and interpretation of geophysical prospecting maps

Learning Outcomes

After completion of this practical, learner will be able to

1. Proficiently solve numerical problems in gravity anomalies, seismic studies, earthquake location, and resistivity surveying, enhancing their understanding of geophysical principles.
2. Develop competence in interpreting maps related to gravity, electrical, and seismic prospecting, fostering analytical skills in geophysical exploration.

1. Numerical problems related to gravity of the earth, isostasy and gravity anomaly.
2. Numerical problems related to refraction and reflection seismology.
3. Determination of location of an earthquake on the surface.
4. Seismic velocity and internal structure of the earth.
5. Problems related to focal plane solution.
6. Problems related to induced polarization and resistivity surveying.
7. Maps related with gravity, electrical and seismic prospecting.

MSc Geology Semester III

Practical

24PS3GEMJP2

Core course III	Remote Sensing and GIS Practical

Learning objectives

To provide students with practical skills and theoretical knowledge in remote sensing techniques, including image interpretation, digital image processing, georeferencing, classification methods, terrain analysis, and change detection.

Learning Outcomes

After the successful completion of the Practical, the learner will be able to

1. Master remote sensing techniques including image interpretation, digital image processing, georeferencing, classification methods, and indices calculation, enhancing their skills in spatial analysis and feature extraction.
2. Develop proficiency in terrain analysis, brightness temperature calculation, change detection, and supervised classification, facilitating their ability to analyze and interpret remote sensing data for various applications.

1. Stereo image and visual image interpretation
2. Understanding Digital Images
3. Georeferencing
4. Colour Composites
5. Indices
6. Unsupervised Classification
7. Supervised Classification
8. Terrain Analysis
9. Brightness Temperature and Land Surface Temperature
10. Change Detection

Core course IV	Marine Geology Practical

Learning Objectives:

To provide students with practical skills and theoretical understanding in oceanography, focusing on ocean floor topography, currents and gyres, salinity-density relationship, beach profiles, sand budgets, and numerical problems on tidal and wave phenomena.

Learning Outcomes:

After the successful completion of the Practical, the learner will be able to

1. Understand ocean floor topography, ocean currents, and gyres, and their influence on global climate systems.
2. Analyze the relationship between salinity, density, and water column stratification, interpret beach profiles and sand budgets, and solve numerical problems related to tidal and wave phenomena.

1. Ocean floor topography
2. Formation and distribution of Ocean Currents and Gyres
3. Relationship between salinity, density, and water column stratification
4. Problems on beach profile and sand budget
5. Numerical problems on tidal range, tidal period, wave period frequency, wave speed etc.

MSc Geology Semester III

Discipline Specific Elective - I

COURSE TITLE: Geodynamics

COURSE CODE: 24PS3GEDSGDY

[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to – 1. Analyze the Earth's layers, isostasy, and lithospheric flexure, explaining their roles in plate tectonics. 2. Evaluate plate geometry, isochrons, and plate velocities, and discuss the forces responsible for plate movements, including their life cycle. 3. Analyze the correlation between earthquakes and plate boundaries, explaining how seismic activity provides insight into plate movements. 4. Evaluate the concept of Earth's magnetic field reversal and its implications for understanding plate motion through paleomagnetic evidence, including the interpretation of paleomagnetic poles and polar wander paths.

Module I	Plate Tectonics	15L

Learning objectives

The module is intended to

1. Understand the Earth's structure, including its layers, isostasy, and plate tectonics theory.
2. Explore plate geometry, isochrons, plate velocities, and forces driving plate movements.

Learning outcomes

After the successful completion of the module, the learner will be able to –

1. Analyze the Earth's layers, isostasy, and lithospheric flexure, explaining their roles in plate tectonics.
2. Evaluate plate geometry, isochrons, and plate velocities, and discuss the forces responsible for plate movements, including their life cycle.

Subtopic	Title	15 L
1.1	Earth's layers; Isostasy and lithospheric flexure; Plate geometry, Euler poles, Isochrons and Velocities, Rises, Trenches and Island arcs, Fracture zones;	7 L
1.2	Plates in velocity space: Velocity line, Velocity Plane, Plates in velocity space, Triple junctions. Forces driving plates; Life cycle of a plate.	8 L

References:

- Condie, K.C., 2021. Earth as an evolving planetary system. Academic Press.
- Kearey, P., Klepeis, K.A. and Vine, F.J., 2009. Global tectonics. John Wiley & Sons.

Module II	Earth's Magnetic Field	15L

Learning objectives

The module is intended to –

1. Understand the relationship between earthquakes and plate tectonics, as well as the Earth's magnetic field and its variations.
2. Explore paleomagnetic evidence for plate motion, including paleomagnetic poles, polar wander, and apparent polar wander paths.

Learning outcomes

After the successful completion of the module, the learner will be able to –

1. Analyze the correlation between earthquakes and plate boundaries, explaining how seismic activity provides insight into plate movements.
2. Evaluate the concept of Earth's magnetic field reversal and its implications for understanding plate motion through paleomagnetic evidence, including the interpretation of paleomagnetic poles and polar wander paths.

Subtopic	Title	15 L
2.1	Earthquakes and plates; Earth's magnetic field, Reversal of Earth's Magnetic Field	7 L
2.2	Paleomagnetic poles, Polar wander and Plate motion, Apparent polar wander paths	8 L

References:

- Mussett, A.E. and Khan, M.A., 2000. Looking into the earth: an introduction to geological geophysics. Cambridge University Press
- Cox, A. and Hart, R.B., 1991. Plate tectonics: How it works. John Wiley & Sons.

Question Paper Template

M. Sc. (Geology) SEMESTER III

Department Specific Elective - I

COURSE TITLE: Geodynamics

COURSE CODE: 24PS3GEDS1GDY

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

Practical

24PS3GEDSEGDYP

DSE I	Geodynamics Practical

Learning Objectives

To provide practical experience and theoretical knowledge in plate tectonics, including Euler poles determination, rate of spreading calculations, identification of fracture zones and transform faults, relative velocity vectors, stability and migration of triple point junctions, interpretation of earthquake first motion data, "beach ball" diagrams, and plate tectonic setting interpretation from magnetic profiles.

Learning Outcomes

After the successful completion of the Practical, the learner will be able to

1. Demonstrate proficiency in analyzing plate tectonic data, including determining Euler poles and calculating rates of spreading, enhancing their understanding of plate motion dynamics.
2. Develop skills in interpreting earthquake first motion data and "beach ball" diagrams, aiding in the understanding of fault orientations and plate tectonic settings.

1. Finding Euler poles
2. Calculating the rate of spreading across a mid oceanic ridge
3. Distinguishing inactive fracture zones and transform faults
4. Relative velocity vectors in two dimensions
5. Velocity space diagrams
6. Stability and Migration of triple point junctions
7. Interpretation of First motion data of earthquakes and "beach ball" diagrams
8. Interpretation of Plate tectonic setting from magnetic profiles

MSc Geology Semester III

Discipline Specific Elective - II

COURSE TITLE: Geostatistics

COURSE CODE: 24PS3GEDSEGST

[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to – 1. Grasp fundamental statistical concepts and their relevance to geological research and data interpretation. 2. Apply elementary statistical methods to analyze geological data accurately, ensuring robust and reliable interpretations. 3. Apply T-test, F-test, and Chi-square test to compare and analyze two sets of geological data effectively. 4. Utilize least-squares methods, regression analysis, and spatial analysis techniques like ANOVA, variogram, semivariogram, and kriging to analyze spatial data and model geological phenomena accurately.

Module I	Introduction to Statistics	15L

Learning objectives

The module is intended to –

1. Introduce statistical principles in the context of geology and diverse measurement systems utilized.
2. Familiarize students with elementary statistical concepts, including errors, probability, and significance, applicable to geological analysis.

Learning outcomes

After the successful completion of the module, the learner will be able to –

1. Grasp fundamental statistical concepts and their relevance to geological research and data interpretation.
2. Apply elementary statistical methods to analyze geological data accurately, ensuring robust and reliable interpretations.

Subtopic	Title	15 L
1.1	Introduction: Statistics in Geology and different measuring systems; Elementary statistics: Errors in statistics,	8 L
1.2	Probability, Central Limits theorem, P-values, Significance, Confidence limits	7 L

References

- Marsal, D. and Merriam, D.F., 2014. Statistics for geoscientists. Elsevier.
- Davis, J. C. (2002). Statistics and Data Analysis in Geology (3rd ed.). New York: John Wiley and Sons, Inc

Module II	Application of Statistics in Geology	15 L

Learning objectives

The module is intended to –

1. Explore statistical methods for comparing two sets of data, including T-test, F-test, and Chi-square test.
2. Understand least-squares methods, regression analysis, and spatial analysis techniques such as ANOVA, variogram, semivariogram, and kriging.

Learning outcomes

After the successful completion of the module, the learner will be able to –

1. Apply T-test, F-test, and Chi-square test to compare and analyze two sets of geological data effectively.

2. Utilize least-squares methods, regression analysis, and spatial analysis techniques like ANOVA, variogram, semivariogram, and kriging to analyze spatial data and model geological phenomena accurately.		
Subtopic	**Title**	**15 L**
2.1	Statistics with two set of data: T-test, F-test, Chi-square test; Least-squares methods and regression analysis.	10 L
2.2	Spatial analysis: ANOVA, Variogram and semivariogram, Kriging.	5 L

References

- Shumway, R.H., 1987. Statistics and data analysis in geology.
- Schaum's Outline of Statistics by Spiegel and Stephens. McGraw Hill Education

Question Paper Template

M. Sc. (Geology) SEMESTER III

Department Specific Elective - II

COURSE TITLE: Geostatistics

COURSE CODE: 24PS3GEDSEGST

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

Practical
24PS3GEDSEGSTP

DSE II	Geostatistics Practical

Learning Objectives

To provide practical skills and theoretical knowledge in geostatistical applications, including porosity and permeability analysis, geochemical data significance, exploration drilling optimization, mineral inventory calculation, grade-tonnage relations, and planning cut-off grade.

Learning Outcomes

After the successful completion of the Practical, the learner will be able to

1. Demonstrate proficiency in applying geostatistical techniques for porosity and permeability analysis, enhancing reservoir characterization.
2. Develop competence in calculating significance and interdependency of geochemical data, aiding in geological analysis and resource estimation.

1. Geostatistical applications: use in porosity and permeability analysis
2. Calculation of significance and interdependency of geochemical data
3. Optimisation of exploration drilling
4. Calculation of mineral inventory
5. Establishment of grade-tonnage relations
6. Calculation of planning cut-off grade

MSc Geology Semester IIII

Discipline Specific Elective - III

COURSE TITLE: Soil Geology

COURSE CODE: 24PS3GEDSESGE

[CREDITS - 02]

Course learning outcomes		
After the successful completion of the Course, the learner will be able to – 1. Analyze soil composition, pedogenic processes, and classification systems to interpret soil properties effectively. 2. Apply fabric analysis techniques to understand soil structure, texture, and void characteristics, aiding in soil classification and interpretation. 3. Demonstrate proficiency in recognizing and interpreting paleosols, emphasizing their significance in stratigraphic sequences. 4. Evaluate the importance of calcrete and laterite formations, considering their classification, genesis, and occurrence in Quaternary and ancient sedimentary sequences.		
Module I	Formation, Classification, & Fabric Analysis	15L
Learning objectives The module is intended to – 1. Understand the concept of soil, its components, formation processes, and classification. 2. Explore soil fabric analysis, including size, shape, structure, and voids, and methods of soil conservation.		
Learning outcomes After the successful completion of the module, the learner will be able to –		

1. Analyze soil composition, pedogenic processes, and classification systems to interpret soil properties effectively.
2. Apply fabric analysis techniques to understand soil structure, texture, and void characteristics, aiding in soil classification and interpretation.

Subtopic	Title	15 L
1.1	Concept of soil, components of soil, soil profile; Process of soil formation, pedogenic processes; Classification of soil, mineral and chemical composition of soils, mineral stability during weathering; Soil organic matter form and function; A brief introduction to methods of soil conservation.	7 L
1.2	Fabric analysis - size and shape, concepts of size and shape, grade scale, methods of analysis, presentation of data, analysis and field grading; Concepts of structure fabric: Soil fabric, soil structure, soil texture and field grading units; Peds and pedalilty, size and shape of peds, pedality, primary, secondary and tertiary structures and their interpretation; Voids - concepts, size, shape, arrangement and morphological classification	8 L

References

- Brady, N. C., Weil, R. R. (2014). The Nature and Properties of Soils. United Kingdom: Pearson.
- Gerrard, A. (1992). Soil Geomorphology. Netherlands: Springer Netherlands.
- Govinda Rajan, S. V., Gopala Rao, H. G. (1978). Studies on Soils of India. India: Vikas Publishing House.

Module II	Paleosols, Calcretes, and Laterites: Origins & Significance	[15L]

Learning objectives

The module is intended to –

1. Identify and describe paleosols, understanding their origin, significance, and presence in stratigraphic records.
2. Grasp the characteristics, formation, and importance of calcrete and laterite in geological contexts.

Learning outcomes

After the successful completion of the module, the learner will be able to –

1. Demonstrate proficiency in recognizing and interpreting paleosols, emphasizing their significance in stratigraphic sequences.
2. Evaluate the importance of calcrete and laterite formations, considering their classification, genesis, and occurrence in Quaternary and ancient sedimentary sequences.

Subtopic	Title	15 L
2.1	Paleosols - Field recognition, description, origin and causes; Paleosol in stratigraphic records; Significance of paleosol study	9 L
2.2	Calcrete - definition, classification, calcrete formation, pedogenic calcrete soil profile, macro features in calcretes, micromorphology (petrography), calcretes from Quaternary and ancient sedimentary sequences; significance of calcretes; Laterite - characteristics, genesis, Indian occurrences.	6 L

References

- Hunt, C. B. (1972). Geology of Soils; Their Evolution, Classification, and Uses. United States: W. H. Freeman.
- Wright;, V. Paul and Tucker, M.E. (1991) Calcretes. Blackwell Scientific Publicaton.

Question Paper Template

M. Sc. (Geology) SEMESTER III

Department Specific Elective - III

COURSE TITLE: Soil Geology

COURSE CODE: 24PS3GEDSESGE

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

Practical

24PS3GEDSESGEP

DSE III	Soil Geology Practical

Learning Objectives

To equip students with practical skills in soil analysis, including determination of soil texture, classification, pH, moisture content, organic content, and bulk density.

Learning Outcomes

After the successful completion of the practical, the learner will be able to

1. Master soil analysis techniques, including texture determination, classification, pH measurement, moisture content analysis, organic content determination, and bulk density measurement.
2. Develop skills in soil characterization, enabling assessment of soil properties for agricultural and environmental purposes

1. Determination of Soil texture
2. Classification of Soil
3. Study of pH of Soil
4. Moisture content of soil
5. Determination of Soil organic content.
6. Determination of bulk density

MSc Geology Semester IV

Major Core Course - I

COURSE TITLE: Environmental Geology

COURSE CODE: 24PS4GEMJIEVG

[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to – 1. Analyze soil processes and land use impacts, understanding their environmental implications. 2. Evaluate the influence of human activities on water and air quality, soil contamination, and environmental degradation, identifying strategies for mitigation and conservation 3. Analyze environmental issues' impacts on ecosystems and communities. 4. Evaluate the role of environmental laws and impact assessment through case studies.

Module I	Fundamentals of Environmental Geology	15L

Learning objectives

The module is intended to –

- Grasp the fundamentals of environmental geology, soil formation, types, degradation, and changing land use patterns
- Explore the impact of human activities on environmental changes, including geodiversity, biodiversity, element mobility, and pollution.

Learning outcomes

After the successful completion of the module, the learner will be able to –

1. Analyze soil processes and land use impacts, understanding their environmental implications.
2. Evaluate the influence of human activities on water and air quality, soil contamination, and environmental degradation, identifying strategies for mitigation and conservation

Subtopic	Title	15L
1.1	Concept and definition of Environmental Geology. Processes of soil formation, types of soils, soil degradation and changing land use pattern. Environmental changes due to influence of human-dominated environment over nature-dominated system. Concept of Geodiversity and biodiversity. Mobility of elements	8 L
1.2	Impact assessment of water availability, quality and contamination of surface water and groundwater. Atmosphere and air pollution. Soil contamination due to urbanization, industrialization and mining.	7 L

References

- Valdiya, K. S. (2013). Environmental Geology: Ecology Resource and Hazard Management. India: McGraw-Hill Education LLC.
- Strahler, A. N., & Strahler, A. H. 1973. Environmental geoscience: interaction between natural systems and man. Santa Barbara, Calif: Hamilton Pub. Co.
- Keller, E. A. 2011. Introduction to Environmental Geology. 9th ed. Person Prentice Hall

Module II	Geoenvironmental Hazards	15L

Learning objectives

The module is intended to

- Understand causes and impacts of deforestation, land degradation, urban flooding, acid mine drainage, global warming, and acid rain.
- Familiarize with environmental laws and impact assessment principles.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Analyze environmental issues' impacts on ecosystems and communities.
- Evaluate the role of environmental laws and impact assessment through case studies.

Subtopic	Title	15L
2.1	Deforestation and land degradation. Urban Flooding, Urban Island Heat effect, Acid Mine Drainage, Global Warming, Acid Rain Basic tenets of environmental laws. Environmental Impact Assessment	8 L
2.2	Case Studies - Dam Failure, Urban Flooding, Joshimath land subsidence.	7 L

References

- Voigt, H. r., Knodel, K., Knödel, K., Lange, G. (2007). Environmental Geology: Handbook of Field Methods and Case Studies. Germany: Springer Berlin Heidelberg.
- Montgomery, C. W. (2018). Environmental Geology. United Kingdom: McGraw-Hill Education.
- Lundgren, L. (1999). Environmental Geology. United Kingdom: Prentice Hall.

Question paper Template

M. Sc. (Geology) SEMESTER II

Major Core Course - I

COURSE TITLE: Environmental Geology

COURSE CODE: 24PS4GEMJIEVG

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

MSc Geology Semester II

Major Core Course - II

COURSE TITLE: Earth and Climate

COURSE CODE: 24PS4GEMJ2EAC

[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to – 1. Analyze atmospheric components and processes shaping weather. 2. Evaluate atmospheric circulation's influence on global climate patterns. 3. Analyze climate system dynamics and their impact on climate variability. 4. Evaluate the role of orbital cyclicity and classification systems in understanding global and regional climatic changes, with a focus on India.

Module I	Types and factors of metamorphism	15L

Learning objectives

The module is intended to –

- Understand atmosphere composition, processes like adiabatic lapse rate, and heat budget.
- Explore atmospheric circulation, pressure belts, wind systems, and climate phenomena interactions.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Analyze atmospheric components and processes shaping weather.
- Evaluate atmospheric circulation's influence on global climate patterns.

Subtopic	Title	15 L

1.1	Atmosphere : The role, structure, and composition of atmosphere, Adiabatic Lapse rate, Latent heat of condensation.	7 L
1.2	Insolation and heat budget: Temperature distribution on earth, Heat budget, Net Radiation and Latitudinal energy balance	8 L
1.3	The temperature of the atmosphere: Process of heat energy transfer, Heating and cooling of atmosphere, Temperature belts of the world, Factors affecting Temperature patterns on the globe.	
1.4	Atmospheric circulation: Air pressure and atmospheric circulation, Atmospheric Pressure Belts and Wind Systems, Factors Affecting Wind movement - Coriolis Force Types of Winds: Permanent, Secondary & Local Winds.	
1.5	Atmospheric interaction: Atmosphere and ocean interaction and its effect on climate, Monsoons and jet streams; Temperate and tropical cyclones; Types and distribution of precipitation, El Nino | ENSO | La Nina | Indian Ocean Dipole (IOD).	

References

- Lutgens, F., Tarbuck, E., and Tasa, D., 2009. The Atmosphere: An Introduction to Meteorology. Pearson Publisher
- Aguado, E., and Burt, J., 2009. Understanding weather. Pearson Prentice Hall

Module II	Climate System and Climate Change	15 L

Learning objectives

The module is intended to

- Understand climate system components, controlling factors, and response mechanisms.
- Explore orbital cyclicity, glacial-interglacial cycles, and climate classification systems.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Analyze climate system dynamics and their impact on climate variability.
- Evaluate the role of orbital cyclicity and classification systems in understanding global and regional climatic changes, with a focus on India.

Subtopic	Title	15L
2.1	Climate system: Components of the climate system. Climate controlling factors. Climate forcing, Climate system response, response rates and interactions within the climate system. Feedbacks in climate system	5 L
2.2	Orbital Cyclicity and climate change: Milankovitch cycles and variability in the climate. Glacial-interglacial stages. The Last Glacial maximum (LGM). Pleistocene Glacial-Interglacial cycles. Younger Dryas. Marine isotope stages.	5 L
2.3	Climate classification: Koppen's, Thornthwaite's and Trewartha's classification of world climates; Global climatic change and role and response of man in climatic changes, Importance of Indian perspective. Climatic regions of India. Air Masses and Fronts	5 L

References

- Rohli, R.V., and Vega, A.J., 2007. Climatology. Jones and Barlatt.
- Rudiman, W.F., 2001. Earth's climate: past and future. Edition 2, Freeman Publisher.

Question paper Template

M. Sc. (Geology) SEMESTER IV

Major Core Course- II

COURSE TITLE: Earth and Climate

COURSE CODE: 24PS4GEMJ2EAC

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

MSc Geology Semester IV

Major Core Course - III

COURSE TITLE: Natural Hazards and Mitigation

COURSE CODE: 24PS4GEMJ3NHM

[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to – 1. Analyze the causes and characteristics of different natural hazards, assessing their potential impacts on communities and environments. 2. Evaluate mitigation strategies for earthquakes, volcanoes, landslides, and tsunamis, aiming to minimize risks and enhance resilience to these hazards. 3. Analyze the causes and effects of cyclones, floods, glacial outbursts, and flash floods, considering their impacts on communities and environments. 4. Evaluate mitigation and prediction measures for these disasters, drawing from case studies in India to understand their practical applications and effectiveness.

Module I	Geological Hazards	15L
Learning objectives The module is intended to – • Understand various types of natural hazards including earthquakes, volcanoes, landslides, tsunamis, cyclones, floods, glacial outbursts, and flash floods. • Explore the causes, characteristics, and mitigation strategies for earthquakes, volcanoes, landslides, and tsunamis.		
Learning outcomes		

After the successful completion of the module, the learner will be able to –

- Analyze the causes and characteristics of different natural hazards, assessing their potential impacts on communities and environments.
- Evaluate mitigation strategies for earthquakes, volcanoes, landslides, and tsunamis, aiming to minimize risks and enhance resilience to these hazards.

Subtopic	Title	15L
1.1	Natural hazards and it's types: Earthquakes, Volcanoes, landslides, tsunamis, cyclones, floods, glacial outburst and flash floods; Earthquakes: Causes and types of earthquakes, Measurement of earthquake magnitude, Earthquake mitigation	8 L
1.2	Volcanoes: causes and types, explosivity of volcanoes, long term and short term hazards of volcanoes, mitigation; Landslides: types, factors responsible, mitigation; Tsunamis: causes, characteristics and mitigation	7 L

References:

- Edward A Keller and Robert H Blodgett. 2008. Natural hazards. Pearson Prentice Hall,
- Geohazards: Analysis, Modelling and Forecasting. (2023). Germany: Springer Nature Singapore

Module II	Climatic Hazards	15L

Learning objectives

The module is intended to

- Understand the causes, characteristics, and impacts of cyclones, floods, glacial outbursts, and flash floods.

- Explore mitigation strategies and prediction techniques for these natural disasters.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Analyze the causes and effects of cyclones, floods, glacial outbursts, and flash floods, considering their impacts on communities and environments.
- Evaluate mitigation and prediction measures for these disasters, drawing from case studies in India to understand their practical applications and effectiveness.

Subtopic	Title	15L
2.1	Cyclones: causes, characteristics, mitigation and prediction; Floods: stream behaviour, causes, characteristics, effects, prediction and mitigation; Glacial outburst and flash floods: causes, types, effects and mitigation	9 L
2.2	Cases studies of natural disasters from India.	6 L

References

- Geohazards: Analysis, Modelling and Forecasting. (2023). Germany: Springer Nature Singapore
- Donald Hyndman and David Hyndman. 2009. Natural hazards and disasters. Brooks/Cole. 555p

Question Paper Template

M. Sc. (Geology) SEMESTER V

Major Core Course- III

COURSE TITLE: Natural Hazards and Mitigation

COURSE CODE: 24PS4GEMJ3NHM

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

MSc Geology Semester IV

Major Core Course - IV

COURSE TITLE: Instrumentation Techniques in Geology

COURSE CODE: 24PS4GEMJ4ITG

[CREDITS - 02]

Course learning outcomes
After the successful completion of the Course, the learner will be able to – 1. Analyze fundamental principles in analytical geochemistry, applying them to detection and sampling. 2. Evaluate various analytical techniques such as flame photometry, EPMA, AAS, ICP-OES, and mass spectrometry, understanding their principles and applications. 3. Analyze the significance of instruments like clinometer, spectrometer, and petrological microscope in geological and paleontological research. 4. Evaluate the effectiveness of instruments like scanning electron microscopy and testing machines in conducting accurate analyses, enhancing understanding of geological and paleontological data.

Module I	Instrumentation Techniques used in Petrology and Geochemistry	15L

Learning objectives

The module is intended to –

- Grasp basic concepts in analytical geochemistry, including detection limits and sampling strategies.

- Explore classical and rapid methods of chemical analysis, petro-mineralogical techniques, and optical and mass spectrometry principles.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Analyze fundamental principles in analytical geochemistry, applying them to detection and sampling.
- Evaluate various analytical techniques such as flame photometry, EPMA, AAS, ICP-OES, and mass spectrometry, understanding their principles and applications.

Subtopic	Title	15L
1.1	Basic concepts in analytical geochemistry, Detection limits, Sampling strategy. Classical and rapid methods of chemical analysis – Flame photometry, EDTA. Petro-mineralogical analysis - EPMA, EBSD, RAMAN	7 L
1.2	Optical spectrometry : Principles and Instrumentation - AAS and ICP-OES Mass spectrometry : Principles and Instrumentation - QICP-MS, LA-ICP-MS, MC-ICP-MS, TIMS, GC-MS	8 L

References

- Potts, P. J.. Handbook of Rock Analysis. United Kingdom: Viridian, 2003.
- Hutchison, D.., JEFFREY, P G. Chemical Methods of Rock Analysis. United Kingdom: Elsevier Science, 2012.
- Goldstein, J. I., Newbury, D. E., Michael, J. R., Ritchie, N. W.M., Scott, J. H. J., Joy, D. C., 2018. Scanning Electron Microscopy and X-Ray Microanalysis, Springer New York, NY,

Module II	Instrumentation Techniques used in other Disciplines of Geology	15L

Learning objectives

The module is intended to

- Understand instruments in Structural Geology, Engineering Geology, Remote Sensing, Petrological Microscopy, and Paleontology
- Learn about their functionalities and applications in respective fields.

Learning outcomes

After the successful completion of the module, the learner will be able to –

- Analyze the significance of instruments like clinometer, spectrometer, and petrological microscope in geological and paleontological research.
- Evaluate the effectiveness of instruments like scanning electron microscopy and testing machines in conducting accurate analyses, enhancing understanding of geological and paleontological data.

Subtopic	Title	15 L
2.1	nstruments used in Structural Geology and Engineering Geology : Clinometer and Brunton compass, hand held GPS, Laboratory jaw crusher, Brazilian test Apparatus, Point load strength testing machine and Soil triaxial testing machine	8 L
2.2	Instruments used in Remote sensing: Spectrometer and Infrared sensor Petrolgical microscope: Transmitted and reflected microscopy. Instruments used in Paleontology :	7 L

	Scanning electron micrscopy (SEM), Different maceration methods for micrpaleontological specimen separation.	

References

- Rollinson, Hugh R. Using geochemical data: evaluation, presentation, interpretation. Routledge, 2014.
- Field Instrumentation in Geotechnical Engineering: A Symposium Organised by the British Geotechnical Society Held 30th May–1st June 1973. United Kingdom: Elsevier Science, 2013.
- Nesse, William D.. Introduction to optical mineralogy. United Kingdom: Oxford University Press, 1991.
- Marshak, S. and Mitra, G., 1988. Basic methods of structural geology.

Question paper Template

M. Sc. (Geology) SEMESTER IV

Major Core Course- IV

COURSE TITLE: Instrumentation Techniques in Geology

COURSE CODE: 24PS4GEMJ4ITG

[CREDITS - 02]

Module	Remembering / Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total Marks
I	6	3	2	2	2	-	15
II	6	3	2	2	2	-	15
Total marks per question	12	6	4	4	4	-	30
% Weightage	40	20	13.33	13.33	13.33	-	100

8. Teaching learning process

The pedagogic methods adopted, involve direct lectures, tutorial discussions, as well as technology- supported presentations. We believe that education is interactive and all sessions between students and teachers are based upon reciprocity and respect.

1. The lectures (of 1 hr duration) delivered to one whole class at a time systematically deal with the themes of the syllabus. This constitutes the core of the teaching- learning process. The students are provided with bibliographic references and encouraged to go through at least some readings so that they could be more interactive and ask more relevant questions in the class. This also helps obtain knowledge beyond the boundaries of the syllabi.
2. Wherever needed, teachers use audio-video based technology devices (e. g. power point, YouTube videos) to make their presentations more effective. Some courses require that students see a documentary or feature film and course themes are structured so that discussions of these will further nuance the critical engagement of students with ideas introduced in their textual materials.
3. Remedial coaching, bridge courses are adopted to enhance the scope of learning for the learners. Remedial sessions are conducted to offer assistance on certain advanced topics. Bridge courses facilitate the development of a concrete basis for the topics to be learnt in the coming academic year.

9. Assessment Methods

Evaluation Pattern: Theory

- Assessments are divided into two parts: Continuous Internal Evaluation (CIE) and End Semester Examination (ESE).
- The CIE is taken at regular intervals in the form of Seminar presentations, MCQ based tests, Paper Summary writing etc.
- The End Semester Examination shall be conducted by the College at the end of each semester. (30M) Duration: 1.5 hours
  End Semester Examination Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	24 M	15 M
2	II	24 M	15 M

Each question will have six sub questions a, b, c, d, e, f and out of which any three should be answered.

Evaluation pattern: Practical

- Continuous Assessment for 25 Marks [P1+P2] throughout the entire semester.
- 50 Marks End Semester Evaluation as per the following rubrics [25 marks P1+25 marks P2}

Major Core Course	CIE	Experimental Report	Viva	Total
MJ 1	15 M	5 M	5 M	25 M
MJ 2	15 M	5 M	5 M	25 M

10. Programme and Course Code Format

The course is coded according to following criteria:

1. First two numbers in each course code indicates year of implementation of syllabus (24- year of implementation is 2024-25)
2. Third letter 'P' designates postgraduate
3. Fourth letter 'S' designate Science discipline and the digit followed is for semester number (S1 – 1st Semester)
4. Letter 'GE' is for Geology discipline (GE-Geology). This forms the programme code 23PS1GE. For the further course codes programme code is amended as follows
5. To represent Major Core Course (MJ) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
6. To represent Minor Stream Course (MN) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
7. For Discipline Specific Elective Course Code, (DSE) alphabets followed by a digit (1/2/3) followed by three letters specifying the course title are used.
8. 'P' followed by digit indicates practical course number. (Practical course number will be added for semesters only where there is more than one course.