SOMAIYA VIDYAVIHAR

K J Somaiya College of Science And Commerce

Somaiya TRUST

Learning Outcomes based Curriculum Framework

(LOCF)

For

S.Y.B.Sc. Geology (Major)

Undergraduate 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.

Board of studies in Geology

	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	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	Ms. Mahalakshmi Ramesh	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	Mr. Robinprince Udhaya Edward	Assistant Professor	K J Somaiya College of Science and Commerce
3	Dr. Anirban Mitra	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.

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 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, 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

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Preamble

Geology, the scientific study of the Earth's structure, processes, and materials, is a discipline of paramount importance that unravels the intricate story of our planet's evolution. From the towering peaks that shape our landscapes to the hidden reservoirs of invaluable resources beneath the surface, geology is the key to understanding the dynamic forces that have sculpted our world. It plays a critical role in addressing environmental challenges, predicting and mitigating natural disasters, and responsibly harnessing Earth's wealth of minerals and energy resources. Inextricably linked to our daily lives, geology serves as a compass guiding humanity towards sustainable practices, as we strive to coexist harmoniously with the ever-changing forces that govern our planet. Embracing the study of geology is an acknowledgment of our interconnectedness with the Earth and a commitment to navigating the complexities of our shared future.

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 bank 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 develop 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.

This Learning Outcome-based Curriculum Framework (LOCF) supports the fundamental principle of providing quality education in India. Our focus is to involve young minds to participate, contribute and add value at each stage in the field of their study. The introduction of Choice Based Credit System (CBCS) has maximized the benefits of the newly designed curriculum in multiple folds.

The LOCF will certainly help teachers to envisage the outcome expected from the learners at the end of the programme. For students, it will be a guide which shows how this curriculum will help them acquire all the skills and knowledge which are essential in their personal and academic growth. Higher education qualifications such as Bachelor'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.

1. Introduction

The B.Sc. Geology programme is developed by keeping in mind interest of learners to explore the field of Geology. The framework helps to maintain the standard of Geology degrees/programmes through periodic programme review within a broad framework of agreed/expected graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcomes. The BSc programme is planned in such a way that it allows flexibility and innovation in programme design, syllabi development, teaching-learning process and quality assessment of students learning levels.

This curriculum framework is developed on the principles of student centric learning pedagogy. The platform intents to empower graduates with the skills required for pursuing Geology-related careers, higher education in Geology and allied subjects. Various graduate attributes are emphasised in this framework such as critical thinking, basic psychology, scientific reasoning, moral ethical reasoning, etc. While designing this framework, an important aspect considered was the measurable teaching-learning outcome to ensure employability of the graduates. Implementation of modern pedagogical tools and concepts such as flip-class, hybrid learning, MOOCs and other e-learning platforms are suggested through this framework. The framework also focuses on issues relevant to India and also of the rest of the world;

Every course is designed in such a way that students get decent exposure to each topic by keeping an equilibrium between these topics and thus creating interest to pursue further education in the field of Geology. It encompasses fundamental principles in Geology, laying a robust groundwork for students and enabling them to delve deeper into the subject. The curriculum covers a wide array of topics, including petrology, mineralogy, structural geology, geochemistry, palaeontology, geohydrology, coal and petroleum geology, volcanology, remote sensing, GIS, and

its applications, as well as economic geology. Additionally, semester III and IV include specialized courses on geohazards (such as earthquakes and flooding) and their mitigation, cartography, field geology, terrain mapping, and watershed management. Semester V introduces elements of geochemistry, remote sensing, GIS, exploration geology, statistics in geology, and oceanography. Semester VI delves into vital subjects such as Earth and Climate, environmental geology, the evolution of life through time, mathematics in geosciences, and geophysical exploration, addressing the increasing relevance of these topics in the contemporary context.

The practical sessions will help the students to gain sufficient skills in chemical analysis, preparations, solvent extraction, chromatography, as well as quantitative analysis. Students are also encouraged to improve their scientific writing skills through various assignments. The research-based project work in the curriculum ensures team building attitude within students and utilise every aspect of the team members in the success of any project. The project evaluation method is designed in such a way that it helps in creating a strong background for the research, skills to generate systematic reports and create effective presentation.

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, and leadership readiness along with specific learning course outcomes at the starting of each course. The Learning Outcomes based Curriculum Framework (LOCF) for B.Sc. with Geology will certainly be a valuable document in the arena of outcome-based curriculum design.

2.1 Nature and extent of B.Sc. Geology

Degree programme in Geology is designed to include cutting edge and core topics from Core and Applied branches of Geology in a perfect balance. The scope of individual topics varies with the nature of specific branch of geology that is being taught. In our endeavour to improve the employability of graduates of geology programme, the curriculum offers courses that provide skills which are highly sought after in the industry like remote sensing & GIS, hydrology, field geology and terrain mapping, watershed management, economic geology, exploration geology, among others. The B.Sc. geology programme is of three years duration. Each year is divided

into two semesters. The total numbers of semester are six. The teaching and learning in the B.Sc. geology programme will involve theory classes (lectures) and practical. The curriculum will be taught through formal lectures with the aid of power-point presentations, audio and video tools and other teaching aids can be used as and when required. Wherever possible RBPT approach will be adopted to make the process of learning more learner-centric. ICT-based teaching-learning tools will be incorporated through which even the mundane aspects could be made more interesting and relevant.

2.2 Programme Education Objectives (PEOs)

The overall aims of bachelor's degree programme in geology are to:

1. Create a great learning environment for students to inculcate deep interests in geology.
2. Provide choice-based learning to students.
3. Empower students by providing appropriate tools of analysis to address issues and problems in the field of geology
4. Help students to develop the ability to use their knowledge and skills to handle the specific theoretical and applied problems in geology
5. Encourage students to pursue advanced studies related to geology by creating a strong and profound base of fundamental concepts.
6. Assist students to develop an array of industry-ready skills which are helpful in creating employment and business opportunities.

3. Graduate Attributes in Geology

Attributes expected from the graduates of B.Sc. Geology Programme are:

GA 1: Comprehensive knowledge and understanding of various concepts and theoretical principles in the field of geology and its different sub-fields.

GA 2: Excel in critically evaluating geological problems, devising innovative solutions, and making informed decisions based on geological evidence.

GA 3: Solid understanding of geotechnical instruments, laboratory techniques, and software tools commonly used in geological research and exploration.

GA 4: Possess a holistic understanding of the interconnectedness of geology with other scientific disciplines, fostering a multidisciplinary approach to problem-solving.

GA 5: Proficient in conducting field studies, collecting geological samples, and interpreting geological features in various natural environments.

GA 6: Conscious of the environmental impact of geological activities, and they strive to integrate sustainable practices into their work.

GA 7: Work effectively in multidisciplinary teams, collaborating with professionals from various backgrounds to address complex geological challenges.

GA 8: Skilled in collecting, managing, and analysing geological data using statistical methods and modelling techniques to extract meaningful patterns and trends.

GA 9: Adhere to ethical standards in geological research, exploration, and resource management and understand the importance of responsible conduct in their professional endeavours.

GA 10: Applying the scientific method to investigate geological phenomena, conduct field studies, and analyse data to draw meaningful conclusions.

4. Qualification descriptors

Undergraduate degree programmes of either 3 or 4-year duration, with multiple entry and exit points and re-entry options, with appropriate certifications such as:

- A 'UG certificate' is awarded to students who opt to exit after completing 1 year (2 semesters) of study in the chosen fields of study with having secured 44 credits and in addition, they complete one vocational course of 4 credits during the summer vacation of the first year. These students are allowed to re-enter the degree programme within three years and complete the degree programme within the stipulated maximum period of seven years.
- A 'UG diploma' is awarded to students who opt to exit after 2 years (4 semesters) of study with having secured 88 credits and in addition, they complete one vocational course of 4 credits during the summer vacation of the second year. These students are allowed to re-enter within a period of three years and complete the degree programme within the maximum period of seven years.
- A Bachelor's degree is awarded after a 3-year (6 semesters) programme of study in major discipline with having secured 132 credits and minimum credit requirements as follows

Sr. No.	Category of Courses	Minimum credit requirements
1	Major Core Course	48
2	Minor Stream Course	20
3	Discipline Specific Elective Course	06
4	Ability Enhancement Course	08
5	Skill Enhancement Course	06
6	Value Education Course	04
7	Vocational Skill Course	08
8	Indian Knowledge System	02

9	Co-curricular Course	20
10	Open Elective Course	10
Total		132

- After completing the requirements of a three-year Bachelor's degree, candidates who meet the minimum CGPA of 7.5 shall be allowed to continue studies in the fourth year of undergraduate program to pursue and complete Bachelor's degree with honours/research (subject to change).
- A 4-year Bachelor's degree (honours) is awarded after eight semesters programme of study with having secured 176 credits and minimum credit requirements as follows:

Sr. No.	Category of Courses	Minimum credit requirements
1	Major Core Course	76
2	Minor Stream Course	24
3	Discipline Specific Elective Course	14
4	Ability Enhancement Course	08
5	Skill Enhancement Course	06
6	Value Education Course	04
7	Vocational Skill Course	08
8	Indian Knowledge System	02
9	Co-curricular Course	24
10	Open Elective Course	10
Total		176

- They should do a research project or dissertation under the guidance of a faculty member of the University/College. The research project/dissertation will be in the major discipline. The students who secure 176 credits, including 12 credits from a research project/dissertation, are awarded UG Degree with Research.

  The 4-year bachelor's degree programme is considered a preferred option since it would provide the opportunity to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per the choices of the student.

Upon successful completion of the programme, students receive B.Sc. degree in the Geology. B.Sc. Geology graduates of this department are expected to demonstrate the extensive knowledge of various concepts of geology and its application, thus contributing in research, development, teaching, government and public sectors. This programme will establish a foundation for student to further pursue higher studies in geology. The list below provides a synoptic overview of possible employment areas provided by an undergraduate training in geology.

The list below provides a synoptic overview of possible career paths provided by an undergraduate training 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 B.Sc. Geology graduate:

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. Academician.
9. Environment analyst
10. Project fellow
11. Entrepreneur
12. Civil services
13. Competitive exams

Higher Education options for B.Sc. Geology graduate:

1. M.Sc. / M.Sc. Tech/ M.Tech. in Geology/ Applied Geology/ Geophysics/ Petroleum Geology/Mineral Exploration/Geo-Informatics
2. Integrated M.Sc.-Ph.D. in Geology
3. PG Diploma in advanced remote sensing and GIS,

4. Courses in management
5. B.Ed.

The learners who complete three years of full-time study of an undergraduate programme of study will be awarded a Bachelor's degree in Geology.

5. Programme Specific Outcomes (PSOs)

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

PSO I: Discuss the fundamental concepts in core (e.g., mineralogy, petrography, structural geology, palaeontology, geochemistry, etc.) and applied (economic geology, mineral exploration, geohazard mitigation, remote sensing and GIS, etc.) branches of Geology.

PSO II: Relate Cutting-edge Knowledge acquired in different fields of geology such as mineral physics, isotope and trace element geochemistry, thermodynamics, field geology, ore-forming processes, geohazard mitigation etc. to develop state of the art technologies to safeguard or for improving human life.

PSO III: Use analytical skills, problem solving skills requiring applications of geological principles.

PSO IV: Identify, differentiate and characterize various geological materials using laboratory and instrumentation techniques.

PSO V: Apply good laboratory practices and safety principles and create awareness about environmental issues.

PSO VI: Justify the central role of geology in society and have preparedness in lifelong learning of technological change.

5.1 Course Mapping

Semester	PSO / Course	I	II	III	IV	V	VI
III	MJ I	√	√	√	√	√	√
	MJ II	√	√	√	√	√	√
	SEC	√	√	√	√	√	√
	VSC	√	√	√	√	√	√
	AEC						
	CC;NCC;SP;FP						
	OE						
	IKS	√			√	√	√
IV	MJ I	√	√	√	√	√	√
	MJ II	√	√	√	√	√	√
	SEC	√	√	√	√	√	√
	VSC	√	√	√	√	√	√
	AEC						
	CC;NCC;SP;FP						
	OE						

6. Structure of B.Sc. Geology programme

The curriculum frame work is designed around the choice-based credit system (CBCS). The programme consists of three years UG having six semesters (two semesters per year) or four years UG (Honours) having eight semesters (two semesters per year).

Credit Distribution for Eight Semester is as follows:

Semester	MJ	DSE	SEC	VSC	MN	AEC	VEC	IKS	CC	FP	INT/ APT	OE	Total
I	6	-	-	-	6	4	2	-	2	-	-	2	22
II	6	-	-	-	6	3	2	1	2	-	-	2	22
III	6	-	3	2	4	1	-	1	2	-	-	3	22
IV	6	-	3	2	4	-	-	-	2	2	-	3	22
V	12	-	-	-	-	-	-	-	-	2	8	-	22
VI	12	6	-	4	-	-	-	-	-	-	-	-	22

BSc with Honours – 22 credits in Sem VII and VIII

BSc with Research – 22 credits in Sem VII and VIII

To acquire a degree in B.Sc. geology a learner must study

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) Students may be allowed to change major within the broad discipline at the end of the second semester by giving her/him sufficient time to explore interdisciplinary courses during the first year.

c) There are twenty four Major Core courses (MJ), two each, in semesters I to IV; and four each in semesters V and VIII.

d) Each Major Core Courses is compulsory.

e) Each Major Core Course from semester I to VI is comprised of 2 credits for theory i.e. 30 hours; 2 lectures of each 1 hr per week and 1 credit for practical of two hours per week in every semester.

f) Each Major Core Course from semester VII and VIII is comprised of 2 credits for theory i.e. 30 hours; 2 lectures of each 1 hr per week and 1.5 credit for practical of three hours per week in every semester.

g) 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. Minor Stream Course (MN):

a) A course is chosen by a candidate from interdisciplinary stream as a minor course. Minor stream course helps a student to gain a broader understanding beyond the major discipline.

b) Students who take a sufficient number of courses in interdisciplinary area of study other than the chosen major will qualify for a minor in that discipline.

c) Students who take a sufficient number of courses in interdisciplinary area of study other than the chosen major will qualify for a minor in that discipline.

d) Students who take a sufficient number of courses in interdisciplinary area of study other than the chosen major will qualify for a minor in that discipline.

e) Students who take a sufficient number of courses in interdisciplinary area of study other than the chosen major will qualify for a minor in that discipline.

f) Each Minor stream Courses is compulsory.

3. Ability Enhancement Courses (AEC)

a) The courses aim at enabling the students to acquire and demonstrate the core linguistic skills, including critical reading and expository and academic writing skills, that help students articulate their arguments and present their thinking clearly and coherently and recognize the importance of language as a mediator of knowledge and identity.

b) Students are required to achieve competency in a Modern Indian Language (MIL) and in the English language with special emphasis on language and communication skills.

c) There are five AE courses in spread over three semesters (I to III).

d) Each student is supposed to take two AE in semester I - English language and Modern Indian language of 2 credits each.

e) There are two AE in semester 2 - English language of two credits and Modern Indian language of 1 credit.

f) There is one AE in semester 3 - Modern Indian language of 1 credit.

4. Value Education Courses (VEC)

a) The course seeks to equip students with the ability to apply the acquired knowledge, skills, attitudes and values required to take appropriate actions for mitigating the effects of environmental degradation, climate change, and pollution, effective waste management, conservation of biological diversity, management of biological resources, forest and wildlife conservation, and sustainable development and living.

b) The VA courses offered are:

VA 1- Environmental Science I (2 credits) (Semester I),

VA II- Environmental Science II (2 credits) (Semester II).

5. Co-Curricular courses (CC):

a) They are designed to provide skill-based knowledge and contain both lab/hands on training/field work.
b) The main purpose of these courses is to provide life skills in hands-on mode to increase employability.
c) There are two CC each in semester I to III – NCC (compulsory 1 credit course) and Other one from Music/Sports training program/Yoga/ Study Circle
d) There are three CC each in semester IV – NCC (compulsory 1 credit course), second one from Music/Sports training program/Yoga/ Study Circle of 1 credit and third one is Field project of 2 credits.
e) There are two CC semester V – Internship/ Apprenticeship (8 credit) and Field project (2 credit)

6. Open Elective (OE)

a) They are designed to provide multidisciplinary education.
b) Students can opt for one interdisciplinary Open Elective Course (OE) in each of the semester I and II of two credit each.
c) Students can opt for one interdisciplinary Open Elective Course (OE) in each of the semester III and IV of three credit each.
d) Open courses are offered in cognate disciplines by different departments in the college.

7. Indian Knowledge System (IKS)

a) They are designed to recognizes the rich heritage of ancient and eternal Indian knowledge and thought as a guiding principle.

b) Students can opt for one General IKS in semester I – Indian cultural Heritage of one credit.
c) There is one IKS based on major subject in semester III of 1 credit.

8. Skill Enhancement Course (SEC):

a) They are designed to provide skill-based knowledge pertaining to the Major course to the learner.
b) The main purpose of these courses is to provide life skills in hands on mode to increase employability.
c) There are two skill enhancement courses offered. Each student is supposed to take one SEC in each semester III and IV of 3 credit each (2 credit theory and 1 credit practical).

9. Discipline Specific Elective Courses (DSE):

a) Elective courses offered under the major course subject of study.
b) There are two discipline specific elective courses (DSE), offered in semesters VI of 2 credits theory and 1 credit practical.
c) There is one discipline specific elective course (DSE), offered in semesters VII and VIII each of 2 credits theory and 2 credit practical.
d) There is one advance level disciplinary course – Research Methodology of 4 credits offered in semester VII.

10. Vocational Skill Course (VSC)

a) Vocational courses are designed to provide practical, hands-on training, competencies, and proficiency to students, ultimately enhancing their skills and employability.

b) These courses are tailored to prepare individuals for specific careers and industries.
c) There are two VSC offered one each in semester III to IV, each one is of two credts.
d) There is one VSC offered in semester VI of 4 credits.

11. On Job Training (OJT)

a) On Job training of 4 credits is offered in semester VIII to enhance the specific skills and competencies required for a particular job
b) OJT bridges the gap between theory and practical application, promoting a deeper understanding of concepts.

12. Internship/ Apprenticeship

a) Internship/ Apprenticeship have a prominent role in linking higher education with the requirements of industry and the world of work. Students are offered internship/ apprenticeship embedded degree program to fulfil the objective of improving employability and forming robust industry academia linkage.
b) Internship/Apprenticeship of 8 credits is offered in semester V.
c) Field based learning /project should provide opportunities for students to understand the different socio-economic contexts. It aims at giving the students exposure to development related issues in rural and urban settings.
d) Two field projects each 2 credits are offered one in each semester IV and V.

6.1 Content

Sr. No	Semester	Course number	Course Code	Course title
1	III	MJ I	24US3GEMJIPSP	Principles of Stratigraphy and Paleontology
2		MJ II	24US3GEMJ2ECY	Elements of Crystallography
3		MJ P	24US3GEMJP	Based on MJ I and MJ II
4		SEC	24US3GESECGHM	Geological Hazard Management
5		SEC(P)	24US3GESECGHMP	Geological Hazard Management Practical
6		IKS	24US3GEIKSGAR	Geoarchaeology
7		VSC	24US3GEVSCCAR	Cartography
8		AEC		
9		CC:NCC, SP:FP		
10		OE		
11	IV	MJ I	24US4GEMJIODM	Optical and Descriptive Mineralogy
12		MJ II	24US4GEMJ2GHY	Geohydrology

13		MJ P	23US2GEMJIP	Based on MJ I and MJ II
14		SEC	24US4GESECGTM	Field Geology and Terrain Mapping
15		SEC(P)	24US4GESECP	Field Geology and Terrain Mapping Practical
16		IKS	24US4GEIKSCGI	Civilisation and Geology in India
17		VSC	24US4GEVSCWSM	Watershed Management
18		AEC		
19		CC:NCC, SP:FP		
20		OE		

6.2 Credit distribution for S.Y.B.Sc. Geology

Semester	Course number	Course title	Credits		
			Theory	Practical	Total
III	MJ I	Principles of Stratigraphy and Paleontology	2	1	3
	MJ II	Elements of Crystallography	2	1	3
	MN I		2	1	3
	MN II		-	1	1
	SEC	Geological Hazard Management	2	1	3
	VSC	Cartography	-	2	2
	IKS	Geoarchaeology	1	-	1
	AEC		1	-	1
	CC:NCC, SP:FP		2	-	2
	OE		3	-	3
	Total				**22**
IV	MJ I	Optical and Descriptive Mineralogy	2	1	3

	MJ II	Geohydrology	2	1	3
	MN I		2	1	3
	MN II		-	1	1
	SEC	Field Geology and Terrain Mapping	2	1	3
	VSC	Watershed Management	-	2	2
	IKS		-	-	-
	AEC		-	-	-
	CC:NCC, SP:FP		2 + 2FP	-	4
	OE		3	-	3
	Total				**22**

6.3 Semester Schedule

Semester	Major Core Courses (MJ)	Minor Stream Courses (MN)	Ability Enhancement Courses (AEC)	Value Education Course (VEC)	Indian Knowledge System (IKS)	Co-Curricular Course (CC)	Open Elective (OE)
III	I] MJ I Principles of Stratigraphy and Paleontology 2] MJ II Elements of Crystallography 3] MJ SEC Geological Hazard Management 4) MJ VSC Cartography	I) MN I Chemistry 2) MN II (Practical) Chemistry 3) MN I Physics 4) MN II (Practical) Physics	Modern Indian Language		MJ IKS Geoarchaeology		
IV	] MJ I Optical and Descriptive Mineralogy 2] MJ II Geohydrology 3] MJ SEC Field Geology and Terrain Mapping 4) MJ VSC Watershed Management	I) MN I Chemistry 2) MN II (Practical) Chemistry 3) MN I Physics 4) MN II (Practical) Physics				2 +2FP	

6.4 Course Learning Objectives

The meticulously designed three-year undergraduate Geology program is tailored to immerse students in the forefront of geological advancements. The structured syllabus is meticulously crafted to elucidate intricate geological concepts and fundamentals, fostering a profound understanding and a genuine passion for the subject. The overarching objective is to facilitate vertical growth in students' proficiency, ensuring the development of advanced skills in geological analysis and critical thinking. Our pedagogical approach is grounded in the belief that students can attain these objectives through a synergistic blend of in-depth literature review and dynamic class lectures. This is further complemented by targeted feedback on their written assignments, project/research papers, presentations, discussions, and debates. Our commitment lies in providing a learning environment that empowers students to cultivate compelling arguments, underpinned by robust evidence, all deeply rooted in an immersive training in specialized geological techniques and methodologies. Essentially, our intention transcends traditional teaching methods, aiming to create an atmosphere where students not only master the intricacies of Geology but also emerge as proficient analytical thinkers adept in employing advanced geological methodologies to substantiate their arguments.

7. Detailed B.Sc. Geology Syllabus

S. Y. B.Sc. Syllabus with effect from the Academic year 2024–2025

Syllabus - S. Y. B.Sc. Geology

Course No.	Course Title	Course Code	Credits	Periods (1 Hr)	Module	Lectures/ module (1 hr)	Examination		
							Internal Marks	External Marks	Total Marks
SEMESTER III									
Major Core courses THEORY									
I	Principles of Stratigraphy and Palaeontology	24US3GEMJIPSP	2	30	2	15	20	30	50
II	Elements of Crystallography	24US3GEMJ2ECY	2	30	2	15	20	30	50
SEC	Geological Hazard Management	24US3GESECGHM	2	30	2	15	20	30	50
IKS	Geoarchaeology	24US3GEIKSGAR	1	15	1	15	25		25
Core courses PRACTICAL									
MJ P	Based on MJ I and MJ II	24US3GEMJP	2	60			50		50
SEC P	Geological Hazard Management Practical	24US3GESECP	1	30			25		25
VSC	Cartography	24US3GEVSCP	2	60			50		50
SEMESTER II									
Major Core courses THEORY									
I	Optical and Descriptive Mineralogy	24US4GEMJIODM	2	30	2	15	20	30	50
II	Geohydrology	24US4GEMJ2GHY	2	30	2	15	20	30	50

SEC	Field Geology and Terrain Mapping	24US4GESECGTM	2	30	2	15	20	30	50
Core courses PRACTICAL									
MJ P	Based on MJ I and MJ II	24US4GEMJP	2	60			50		50
SEC P	Field Geology and Terrain Mapping Practical	24US4GESECP	1	30			25		25
VSC	Watershed Management	24US4GEVSCP	2	60			50		50

S.Y. B. Sc. (Geology) SEMESTER I

Major Core Course- I

COURSE TITLE: Principles of Stratigraphy and Palaeontology

COURSE CODE: 24US3GEMJIPSP [CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Apply principles of stratigraphic analysis effectively, including classification of unconformities and stratigraphic units. 2. Employ advanced techniques such as chemostratigraphy and magnetostratigraphy to refine interpretations of geological history. 3. Explain the processes of fossilization and factors influencing preservation potential, along with the significance of fossils in understanding past environments. 4. Classify and discuss the taxonomic characteristics of invertebrate groups such as trilobites, brachiopods, lamellibranchs, gastropods, cephalopods, and graptolites, and analyze their utility in paleoenvironmental reconstructions.		
Module 1	Stratigraphy	[15L]
Learning Objectives: • Comprehend geological time scales, stratigraphic principles, and advanced techniques in stratigraphy. • Understand the significance of unconformities and the interplay between lithostratigraphy, chronostratigraphy, and biostratigraphy.		
Learning Outcome: • Apply principles of stratigraphic analysis effectively, including classification of unconformities and stratigraphic units.		

• Employ advanced techniques such as chemostratigraphy and magnetostratigraphy to refine interpretations of geological history.		
1.1	Geological Time Scale, Principles of stratigraphic analysis Unconformity: importance of unconformities, Classification and evidence of unconformities	7 L
1.2	Development of stratigraphic concepts: importance of stratigraphy. Stratigraphic classification and nomenclature, Fundamentals of lithostratigraphy, chronostratigraphy, and biostratigraphy, their units. Inter- relationship between lithostratigraphic, chronostratigraphic and biostratigraphic units. Brief introduction to chemostratigraphy (oxygen and carbon), magnetostratigraphy and seismic stratigraphy	8 L
References • Kumar R. (1996), Fundamentals of Historical Geology and Stratigraphy of India, 4th ed.,New Age International Limited • Weller J.M. (1960), Stratigraphic Principles and Practice, Harper		
Module II	**Introduction to Paleontology**	**[15L]**
Learning Objectives: • Understand the definition, scope, and applications of paleontology, including the processes of fossilization and preservation potential of organisms. • Gain insight into the taxonomy, environmental factors, geological distribution, and utility of key invertebrate groups in paleoenvironmental reconstructions.		
Learning Outcome:		

<table>
<tr><td colspan="3">

- Explain the processes of fossilization and factors influencing preservation potential, along with the significance of fossils in understanding past environments.
- Classify and discuss the taxonomic characteristics of invertebrate groups such as trilobites, brachiopods, lamellibranchs, gastropods, cephalopods, and graptolites, and analyze their utility in paleoenvironmental reconstructions.

</td></tr>
<tr><td>2.1</td><td>Definition and scope of Paleontology. Processes of fossilization, preservation potential of organisms. Applications of fossils, Taxonomy, Mass Extinctions.</td><td>7 L</td></tr>
<tr><td>2.2</td><td>Introduction to invertebrate group: Trilobites, Brachiopods, Lamellibranchs, Gastropods, Cephalopods, Graptolites: environmental factors and geological distribution of the various groups and their utility in palaeoenvironmental reconstructions.</td><td>8 L</td></tr>
<tr><td colspan="3">

References:

- Clarkson, E. N.K.(2012)Invertebrate Paleontology and evolution 4th Edition by Blackwell Publishing
- Jones, R.W. (2011). Applications of Palaeontology - Techniques and Case Studies
- Foote, M. & Miller, A. I. (2006). Principles of Paleontology
- Dasgupta, A.,(2005), Introduction to Palaeontology, (1st Edition), World Press
- Clarkson E. (1993), Invertebrate Paleontology and Evolution, Chapman and Hall
- Raup, D. M., Stanley, S.M., Freeman, W. H. (1971). Principles of Paleontology

</td></tr>
</table>

Question paper Template

S.Y.B.Sc. (Geology) SEMESTER III

Core course - I

COURSE TITLE: Principles of Stratigraphy and Palaeontology

COURSE CODE: 24US3GEMJIPSP [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

S.Y. B. Sc. (Geology) SEMESTER III

Major Core Course- II

COURSE TITLE: Elements of Crystallography

COURSE CODE: 24US3GEMJ2ECY [CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Describe crystal lattice structures, symmetry operations, and use crystallographic notation to represent crystallographic planes effectively. 2. Analyze the effects of crystal growth processes and defects on material properties, demonstrating an understanding of their significance in practical applications. 3. Identify crystal forms and apply appropriate nomenclature conventions to describe them accurately. 4. Analyze point group symmetry principles to derive the 32 crystal classes, utilizing Hermann-Mauguin symbols and stereographic projections effectively.

Module 1	Elements of Crystallography	[15L]

Learning Objectives:

- Understand the fundamental principles of crystallography, including crystal lattice, symmetry operations, and crystallographic notation.
- Explore crystal growth mechanisms and defects, and their impact on material properties.

Learning Outcome:

- Describe crystal lattice structures, symmetry operations, and use crystallographic notation to represent crystallographic planes effectively.

• Analyze the effects of crystal growth processes and defects on material properties, demonstrating an understanding of their significance in practical applications. L		
1.1	Lattice: Crystal Lattice, Unit Cells, its parameters and Bravis lattice. Crystal symmetry: Rotation, reflection, center and rotoinversion of symmetry.	8 L
1.2	Crystallographic Axes, classification of crystal, Crystallographic notation for planes, Axial ratio, Stereographic projection. Crystal growth and Crystal defects.	7 L

References:

- Ram S. Sharma and Anurag Sharma (2013) Crystallography and Mineralogy - Concepts and Methods. Text Book Series, Geological Society of India, Bangalore
- R.N. Hota (2012) Practical approach to Mineralogy and Crystallography, CBS Publications & Distributions.
- Klein, C., Dutrow, B. (2008). The 23rd edition of the manual of mineral science: (after James D. Dana). India: Wiley.

Module II	Thirty Two Crystal Classes and its Possible Forms	[15L]

Learning Objectives:

- Understand crystal forms, their nomenclature, and the principles of point group symmetry.
- Explore the derivation of the 32 crystal classes, including the Herman-Mauguin symbol and stereographic projection techniques.

Learning Outcome:

- Identify crystal forms and apply appropriate nomenclature conventions to describe them accurately.

• Analyze point group symmetry principles to derive the 32 crystal classes, utilizing Hermann-Mauguin symbols and stereographic projections effectively.		
2.1	Crystal Forms and their nomenclature. Point group symmetry and derivation of 32 classes.	8 L
2.2	Herman mauguin symbol and stereographic projection derivation for 32 possible classes.	7 L

References:

- Flint, Y., (1975) Essential of crystallography, Mir Publishers.
- Rutley, F. (2012). Rutley's Elements of Mineralogy. Netherlands: Springer Netherlands.
- Klein, C., Philpotts, A. (2017). Earth Materials: Introduction to Mineralogy and Petrology. United Kingdom: Cambridge University Press.

Question paper Template

S.Y.B.Sc. (Geology) SEMESTER III

Core course - II

COURSE TITLE: Elements of Crystallography

COURSE CODE: 24US3GEMJ2ECY [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

S.Y.B.Sc. (Geology

Semester III - Practical I

Course: I and II

Course Code: 24US3GEMJP [Credits: 02]

Major Core Course I	Principles of Stratigraphy and Palaeontology Practical

Learning Objectives

Students will demonstrate proficiency in various aspects of paleontology, including identifying and explaining preservation methods, recognizing different fossil types, analyzing mass extinction events, interpreting stratigraphic data, and understanding the interplay between stratigraphy and paleontology.

Learning Outcomes

After the successful completion of the Course, the learner will be able to:

- Demonstrate proficiency in paleontological principles, including fossil preservation, identification, mass extinctions, stratigraphy, and their interrelation.
- Develop practical fieldwork skills, enhancing their understanding of paleontology's real-world applications.

List of Practical

- Ways of Preservation of Fossils: Moulds and Casts; Familiarity of moulds and casts of different fossil specimens.
- Basic knowledge of different types of invertebrate fossils.
- Basic knowledge of functional morphology
- Marking the mass extinction events: Disappearance and appearance of fossil groups.

- Recognition of the types of unconformity planes and understanding the laws of stratigraphy.
- Chronological reconstruction of geological events in a given cross-section.
- How to collect stratigraphic data
- Interrelationship of stratigraphy and paleontology.

Major Core Course II	Elements of Crystallography Practical

Learning Objectives

To develop a comprehensive understanding of crystallography, including the symmetry elements, stereographic projections, and crystal forms belonging to the seven crystal systems.

Learning Outcomes

After the successful completion of the Course, the learner will be able to:

- Develop a comprehensive understanding of crystallography, encompassing the identification and explanation of symmetry elements, the construction of stereographic projections, and the classification and description of crystal forms within the seven crystal systems.

List of Practical

- Symmetry elements of 32 classes of symmetry
- Stereographic projections of Symmetry elements of 32 classes of symmetry
- Study of all possible forms of crystals belonging to 7 systems:
    - Cubic system
    - Tetragonal system
    - Hexagonal system
    - Trigonal system
    - Orthorohmbic system
    - Monoclinic system
    - Triclinic system.

S.Y. B. Sc. (Geology) SEMESTER III

Core course – Skill Enhancement Course

COURSE TITLE: Geological Hazard Management

COURSE CODE: 24US3GESECGHM [CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Identify and describe the various types of geohazards, such as earthquakes, volcanic eruptions, and tsunamis, along with their distinct characteristics. 2. Analyze the causes and historical case studies of geohazards, and propose effective mitigation measures to minimize their impact on human life and infrastructure. 3. Identify factors contributing to natural hazards such as cyclones, floods, and landslides, and propose effective prediction and mitigation strategies. 4. Analyze the implications of climate change and sea-level rise on the frequency and intensity of natural hazards, and suggest adaptive measures to minimize their impact.

Module 1	Endogenous Hazards	[15L]

Learning Objectives:

- Understand the definition and types of geohazards, including earthquakes, volcanoes, and tsunamis.
- Explore the causes, characteristics, and mitigation strategies associated with these geohazards.

Learning Outcome:

- Identify and describe the various types of geohazards, such as earthquakes, volcanic eruptions, and tsunamis, along with their distinct characteristics.

• Analyze the causes and historical case studies of geohazards, and propose effective mitigation measures to minimize their impact on human life and infrastructure.		
1.1	Definition of Geohazards, types of geohazards in brief: earthquakes, landslides, tsunamis, floods, cyclone and volcanic eruptions. Earthquake: causes, types of seismic waves, magnitude and frequency, building design to prevent collapse, case histories in the past.	7 L
1.2	Volcano: Magma and lava, explosivity, types of lava eruption and their related hazards, hazards linked to volcanic ashes, poisonous gases and mudflow, case histories in the past, monitoring and predictions. Tsunami: Definition, causes, case histories, prediction, precaution.	8 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.		
Module II	**Exogenous Hazards**	**[15L]**
Learning Objectives: • Understand the characteristics and impacts of cyclones, floods, landslides, and climate change. • Explore prediction methods and precautionary measures associated with natural hazards and climate change.		
Learning Outcome: • Identify factors contributing to natural hazards such as cyclones, floods, and landslides, and propose effective prediction and mitigation strategies.		

• Analyze the implications of climate change and sea-level rise on the frequency and intensity of natural hazards, and suggest adaptive measures to minimize their impact.		
2.1	Cyclones, past case histories, prediction and precaution. Flood: stream behaviour, natural and anthropogenic causes, case studies, prediction, prevention.	7 L
2.2	Landslides: Landslides: types and their brief introduction, factors controlling downslope movement, recent landslides in Indian scenario. Climate change, global warming, sea-level change.	8 L

References:

- Edward A Keller and Robert H Blodgett. 2008. Natural hazards. Pearson Prentice Hall, 488p.
- Bell, F. G. (2003). Geological Hazards: Their Assessment, Avoidance and Mitigation. United Kingdom: Taylor & Francis.

Question paper Template

S.Y.B.Sc. (Geology) SEMESTER III

Core course – Skill Enhancement Course

COURSE TITLE: Geological Hazard Management

COURSE CODE: 24US3GESECGHM [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

S.Y.B.Sc. (Geology)

Semester III - Practical III

Course: Skill Enhancement Course Practical

Course Title: Geological Hazard Management Practical

Course Code: 24US3GESECP [Credits: 01]

Major Core Course II	Geological Hazard Management Practical

Learning Objectives

To develop practical skills and theoretical understanding in geohazards assessment and mitigation, focusing on seismic hazard interpretation, slope stability prediction, flood discharge calculation, earthquake epicenter location, and landslide case study analysis.

Learning Outcomes

After the successful completion of the Course, the learner will be able to:

- Demonstrate proficiency in interpreting seismic hazard maps, predicting slope stability, calculating flood discharge, locating earthquake epicenters, and analyzing landslide case studies, enabling effective assessment and management of geohazards.

List of Practical

- Interpretation of seismic hazard maps.
- Basic methods of slope stability prediction
- Flood discharge calculation
- Locating earthquake epicentres
- Case study example landslide

S.Y. B. Sc. (Geology) SEMESTER III

Core Course- VSC

COURSE TITLE: Cartography

COURSE CODE: 24US3GEVSCCAR [CREDITS - 02]

Course Learning Outcomes		
Learning Objective: To familiarize students with the fundamental components of maps and their significance in cartography.		
Learning Outcome: Students will be able to identify, explain, and apply essential map elements, including the title, legend, scale, compass rose, and grid system, in map design and interpretation.		
Sr. No	Experiment	No of Hours (60)
1	Understanding Map Elements	5
2	Sketching a Topographic Map	5
3	Drawing a Map from Memory	5
4	Mapping the Classroom	7
5	Creating a Thematic Map	5
6	Introduction to GIS Software	5
7	Map Symbolization and Legend Design	5
8	Coordinate Systems and Projections	8
9	Choropleth mapping	5
10	Georeferencing and Digitizing Maps	10

References

- Slocum, T. A., McMaster, R. B., Kessler, F. C., Howard, H. (2022). Thematic Cartography and Geovisualization, Fourth Edition. United States: CRC Press.

- Anthamatten, P. (2020). How to Make Maps: An Introduction to Theory and Practice of Cartography. United Kingdom: Taylor & Francis.
- Peterson, G. N. (2009). GIS Cartography: A Guide to Effective Map Design. United States: CRC Press.
- Crampton, J. W. (2011). Mapping: A Critical Introduction to Cartography and GIS. Germany: Wiley.
- Thrower, N. J. W. (2008). Maps and Civilization: Cartography in Culture and Society, Third Edition. Ukraine: University of Chicago Press.

S.Y. B. Sc. (Geology) SEMESTER III

Indian Knowledge System

COURSE TITLE: Geoarchaeology

COURSE CODE: 24US3GEIKSGAR [CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Analyze the geological timeframes associated with human evolution and evaluate how climatic conditions have influenced early human settlements. 2. Apply knowledge of topography, geomorphology, sedimentology, stratigraphy, soils, hydrology, caves, and rock shelters to interpret the geological context of human settlements in India, considering the influence of glaciers and rivers.

Module 1	Fundamentals of Geoarchaeology	[15L]

Learning Objectives:

- Understand the geological chronology of human evolution and the impact of climate on early human settlements.
- Study topography, geomorphology, sediments, stratigraphy, soils, hydrologic systems, caves, and rock shelters to analyze human settlements in an Indian context, considering the influence of glaciers and rivers.

Learning Outcome:

- Analyze the geological timeframes associated with human evolution and evaluate how climatic conditions have influenced early human settlements.
- Apply knowledge of topography, geomorphology, sedimentology, stratigraphy, soils, hydrology, caves, and rock shelters to interpret the geological context of human settlements in India, considering the influence of glaciers and rivers.

1.1	Geological chronology of human evolution and control of climate on early settlements. Study of topography, geomorphology, sediments, stratigraphy, soils, hydrologic systems, caves and rock shelters to understand human settlements in an Indian context.	10 L
1.2	Influence of glaciers and rivers.	5 L

References

- Tiwari, N., Singh, V. and Mehra, S.B. eds., 2023, March. Quaternary Geoarchaeology of India. Geological Society of London.
- Thacker, P., 2008. Practical and Theoretical Geoarchaeology. Paul Goldberg and Richard I. Macphail, 2006, Blackwell Publishing, Oxford
- Agrawal, D.P., 1979. Essays in Indian protohistory. History and archaeology series, 5
- Sankalia, H.D., 1974. The prehistory and protohistory of India and Pakistan.
- Valdiya, K. (2016). Prehistoric River Saraswati, Western India: Geological Appraisal and Social Aspects. Germany: Springer International Publishing.
- Valdiya, K. S. (2002). Saraswati: The River that Disappeared. India: Universities Press.

Evaluation Pattern:
Internal Evaluation: 20M

Pattern of evaluation	Marks/Paper	Credits
Objective- MCQ, Short answer test, Assignments, Internal Evaluation Google form Moodle Objective-MCQ Short answer test	20	2

External evaluation:

	Total Marks	Credit
Paper I	50	2
Paper II	50	2
SEC	50	2

Evaluation Pattern: Practical's

	Total Marks	Credit	Minimum Passing Marks
Practical I (P I& II)	50	2	20
Practical 2 (SEC)	25	2	10
Practical 3 (VSC)	50	2	20

S.Y. B. Sc. (Geology) SEMESTER IV

Major Core Course- I

COURSE TITLE: Optical and Descriptive Mineralogy

COURSE CODE: 24US4GEMJIODM [CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Identify and describe the physical, chemical, and mechanical properties of minerals, applying classification principles based on origin and composition. 2. Analyze the structures and characteristics of rock-forming silicate minerals, forming a foundational understanding of mineral science. 3. Identify petrological microscope parts and operational modes for mineral analysis. 4. Analyze mineral optical characteristics like color, pleochroism, cleavage, and twinning under different lighting conditions.		
Module 1	Descriptive Mineralogy	[15L]
Learning Objectives: • Understand the scope and classification of minerals, including their physical, chemical, and mechanical properties. • Explore the elementary concepts of rock-forming silicate minerals and their structures.		
Learning Outcome: • Identify and describe the physical, chemical, and mechanical properties of minerals, applying classification principles based on origin and composition. • Analyze the structures and characteristics of rock-forming silicate minerals, forming a foundational understanding of mineral science.		

1.1	Mineral Science: Perspective, scope. Mineral: Definition, Significance Physical properties of Mineral: Properties based on interaction with light: colour, lusture, streak, play of colors, Chatoyancy and Asterism, Luminescence. Miscellaneous properties: Odor, taste, feel. Magnetic, Radioactive, Chemical,	8 L
1.2	Electrical Mechanical Properties: cleavage, parting, fracture, hardness, tenacity. Mass-related properties (density and specific gravity) Classification of minerals: based on origin and chemical composition Elementary idea of Rock-forming silicate minerals and their structures	7 L

References

- Nesse, William D.. Introduction to Mineralogy. United Kingdom: Oxford University Press, 2017.
- Rutley, Frank. Rutley's Elements of Mineralogy. Netherlands: Springer Netherlands, 2012.
- Mineralogy - Dexter Perkins, 3rd Edition (2012), PHI Learning PLtd, New Delhi
- Putnis, A.. An Introduction to Mineral Sciences. United Kingdom, Cambridge University Press, 1992.

Module II	Optical Mineralogy	[15L]

Learning Objectives:

- Understand petrological microscope components, types, and operation.
- Explore mineral optical properties under plane-polarized and cross-polarized light.

Learning Outcome:

- Identify petrological microscope parts and operational modes for mineral analysis.

• Analyze mineral optical characteristics like color, pleochroism, cleavage, and twinning under different lighting conditions.		
2.1	Petrological microscope: Their parts and components, types, and working mode.	5 L
2.2	Optical properties of minerals: under plane polarized light: (color, pleochroism, relief, twinkling, cleavage & cleavage angle). under cross nicol: (isotropism / anisotropic, interference colours, extinction & extinction angle, twinning).	10 L

References

- Nesse, William D.. Introduction to Optical Mineralogy. United Kingdom: Oxford University Press, 2013.
- Klein, Cornelis., Dutrow, Barbara. The 23rd edition of the manual of mineral science: (after James D. Dana). India: Wiley, 2008.

Question paper Template

S.Y.B.Sc. (Geology) SEMESTER IV

Core course - I

COURSE TITLE: Optical and Descriptive Mineralogy

COURSE CODE: 24US4GEMJIODM [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

S.Y. B. Sc. (Geology) SEMESTER III

Major Core Course- II

COURSE TITLE: Geohydrology

COURSE CODE: 24US4GEMJ2GHY [CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Describe the components and interactions of the hydrologic cycle, and assess the water balance within a given system. 2. Analyze groundwater occurrence, aquifer characteristics, and groundwater flow mechanisms, including factors influencing flow rates, directions, and the formation of drawdown and cones of depression. 3. Apply knowledge of well construction, saline water intrusion, and groundwater quality to design effective groundwater management strategies. 4. Utilize artificial recharge methods and groundwater exploration techniques to assess and sustainably manage groundwater resources.		
Module 1	Introduction to Geohydrology	[15L]
Learning Objectives: • Understand the hydrologic cycle and its processes, including precipitation, evapotranspiration, runoff, infiltration, and water balance. • Explore the occurrence and flow of groundwater, including water-bearing properties of rocks, aquifer types, groundwater flow mechanisms, and related concepts.		
Learning Outcome: • Describe the components and interactions of the hydrologic cycle, and assess the water balance within a given system.		

• Analyze groundwater occurrence, aquifer characteristics, and groundwater flow mechanisms, including factors influencing flow rates, directions, and the formation of drawdown and cones of depression.		
1.1	Hydrologic Cycle and Processes: Precipitation, Evapotranspiration, Runoff, Infilteration, Water Balance.	5 L
1.2	Occurrance of Groundwater: Water bearing properties of rocks, Zones of Aeration and Saturation, Types of Aquifers, Geological formations as Aquifers.	5 L
1.3	Groundwater Flow: Types of Flow, Permeability, Hydraulic Conductivity, Darcy's Law, Anisotropic Aquifers, Groundwater flow rates and directions, Concept of drawdown and cone of depression.	5 L
References: • Fetter, C. W. (2018, April 23). Applied Hydrogeology. Waveland Press • Hölting, B., Coldewey, W. G. (2018). Hydrogeology. Germany: Springer Berlin Heidelberg. • Delleur, J. W. (2010). The Handbook of Groundwater Engineering. CRC Press. • Subramanya, K. (2008). Engineering Hydrology. United States: Tata McGraw-Hill.		
Module II	**Practical and Applied Geohydrology**	**[15L]**
Learning Objectives: • Understand well construction, saline water intrusion, groundwater quality, artificial recharge methods, groundwater exploration techniques, and hydrogeochemical provinces. • Explore principles, techniques, and applications related to groundwater management and assessment.		

Learning Outcome: • Apply knowledge of well construction, saline water intrusion, and groundwater quality to design effective groundwater management strategies. • Utilize artificial recharge methods and groundwater exploration techniques to assess and sustainably manage groundwater resources.		
2.1	Well Construction and Designing, Saline water intrusion - Ghyben-Herzberg Relation, Groundwater quality and Contamination	4 L
2.2	Artificial Recharge: Spreading methods, Induced Recharge, Recharge well, Subsurface dams, waste water recharge, recharge by urban storm runoff	4 L
2.3	Groundwater Exploration: Geologic and Hydrologic methods, Surface Geophysical Methods, Hydrogeologic Well logging, Geophysical Well logging, Tracer techniques.	4 L
2.4	Groundwater and hydrogeochemical provinces of India	3 L
References: • Raghunath, H. M. (2006). Hydrology : Principles, Analysis And Design. India: New Age International (P) Limited. • Todd, D. K., Mays, L. W. (2005). Groundwater Hydrology. India: Wiley. • Karanth, K. R. (1987). Ground Water Assessment, Development, and Management. India: Tata McGraw-Hill Publishing Company.		

Question paper Template

S.Y.B.Sc. (Geology) SEMESTER IV

Core course - II

COURSE TITLE: Geohydrology

COURSE CODE: 24US4GEMJ2GHY [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

S.Y.B.Sc. (Geology)

Semester IV - Practical I

Course: I and II

Course Code: 24US3GEMJP [Credits: 02]

Major Core Course I	Optical and Descriptive Mineralogy Practical

Learning Objectives:

To familiarize students with the parts and functions of a petrological microscope, introduce them to physical properties of minerals, and develop their skills in the identification of common rock-forming minerals both in hand specimen and under the petrological microscope.

Learning Outcomes:

After the successful completion of the Course, the learner will be able to:

- Master the operation of a petrological microscope and identify its components, facilitating mineral and rock analysis.
- Develop proficiency in identifying common rock-forming minerals in hand specimens and under the petrological microscope, advancing their mineralogical and petrological skills.

List of Practical

- Parts and functions of petrological microscope
- Introduction of physical properties of minerals and Identification of common rock-forming minerals in hand specimen
- Identification of common rock forming minerals under petrological microscope.

Major Core Course II	Geohydrology Practical

Learning Objectives:

To equip students with practical skills and theoretical knowledge in hydrogeological analysis and groundwater assessment through a series of laboratory and field exercises.
Learning Outcomes: After the successful completion of the Course, the learner will be able to: • Master hydrogeological techniques such as groundwater flow determination, saltwater intrusion mapping, and resistivity surveys, enhancing practical skills in groundwater assessment. • Demonstrate advanced analytical abilities in hydrogeological analysis, including rainfall calculation, aquifer correlation, well log interpretation, flow net construction, and numerical problem-solving, improving their understanding of groundwater dynamics.
List of Practical • Determination of Groundwater Flow direction • Determine mean rainfall of an area by Thiessen Polygon method and Arithmetic mean • Preparation of free-flow profile • Flow net • Flownet with flow refraction • Mapping Salt water Intrusion • Aquifer Correlation using Stiff Diagram • Well Logging • Resistivity Survey • Numerical Problems

S.Y. B. Sc. (Geology) SEMESTER IV

Core course – Skill Enhancement Course

COURSE TITLE: Field Geology and Terrain Mapping

COURSE CODE: 24US4GESECGTM [CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Demonstrate competence in utilizing field equipment safely during geological fieldwork. 2. Apply observational skills to accurately record geological data, facilitating detailed analysis and interpretation. 3. Demonstrate proficiency in recording geological data accurately and utilizing techniques such as sampling and photography effectively. 4. Apply knowledge of topographic forms and geological surveying methods to produce high-quality topographic maps, geological illustrations, and maps for analysis and interpretation.

Module 1	Field Geology Essentials	[15L]

Learning Objectives:

- Learn field equipment handling and safety measures for geological fieldwork.
- Develop skills in observing and recording geological data, including rock features and paleontological information and reading toposheets and creating base maps.

Learning Outcome:

- Demonstrate competence in utilizing field equipment safely during geological fieldwork.

• Apply observational skills to accurately record geological data, facilitating detailed analysis and interpretation including toposheets and creating base maps.		
1.1	Field Equipments and Safety: Hammer, Chisel, Hand lens, Brunton / Clinometer, GPS, Measuring Tape, Classification and Colour Charts, Field Notebook, Maps, Safety Equipments. Toposheet Reading, Concept of Base Maps	8 L
1.2	Field Observation: Recording Paleontological information, Recording features of sedimentary rocks and making graphical logs, Recording features of Igneous Rocks and Metamorphic Rocks	7 L
References: • Lahee, F. H. (1961). Field Geology. Japan: McGraw-Hill Book Company.		
Module II	**Geological Field Techniques**	**[15L]**
Learning Objectives: • Learn techniques for recording structural data, sampling, photography, and understanding topographic features. • Develop skills in creating topographic maps, conducting geological surveying, and producing geological illustrations and maps.		
Learning Outcome: • Demonstrate proficiency in recording geological data accurately and utilizing techniques such as sampling and photography effectively. • Apply knowledge of topographic forms and geological surveying methods to produce high-quality topographic maps, geological illustrations, and maps for analysis and interpretation.		

2.1	Recording Structural Information, Sampling, Photography, Understanding Topographic Forms, Making Topographic maps and Profile sections.	8 L
2.2	Geologic Surveying, subsurface geologic surveying, Modes of Geologic Illustration, Making a Geological Map.	7 L

References:

- Coe, A. L. (2011). Geological Field Techniques. John Wiley & Sons.

Question paper Template

S.Y.B.Sc. (Geology) SEMESTER IV

Core course – Skill Enhancement Course

COURSE TITLE: Field Geology and Terrain Mapping

COURSE CODE: 24US4GESECGTM [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

S.Y.B.Sc. (Geology)

Semester IV - Practical III

Course: Skill Enhancement Course

Course Title: Field Geology and Terrain Mapping Practical

Course Code: 24US4GESECP [Credits: 01]

Major Core Course II	Principles of Stratigraphy and Palaeontology Practical

Learning Objectives

To provide students with practical skills and theoretical knowledge in geospatial data collection, field mapping techniques, rock identification, structural geology analysis, thematic map compilation, and sampling methods.

Learning Outcomes

After the successful completion of the Course, the learner will be able to:

- Develop practical skills in geospatial data collection and field mapping using Brunton compasses, clinometers, GPS devices, and Google Maps, facilitating accurate fieldwork planning and execution.
- Demonstrate proficiency in geological analysis, including rock and structural identification, thematic map compilation, and sampling techniques, enhancing their ability to interpret geological features and conduct geological research.

List of Practical

- Use of Brunton, Clinometer and GPS
- Use of google maps in field planning
- Triangulation exercises
- Identification of rocks, identification of primary and secondary structures and their application
- Use of rock symbols and structural symbols

- Thematic Map Compilations
- Sampling techniques

S.Y. B. Sc. (Geology) SEMESTER III

Core Course- VSC

COURSE TITLE: Watershed Management

COURSE CODE: 24US4GEVSCWSM [CREDITS - 02]

Course Learning Outcomes		
Learning Objectives: • Understand watershed management principles, including the hydrological cycle, land use planning, and water quality parameters. • Explore water management strategies and monitoring techniques relevant to watershed management. • Understand soil erosion processes, erosion control, sedimentation, biodiversity conservation, integrated watershed planning, and multidisciplinary approaches. • Explore effective watershed management techniques.		
Learning Outcome After the successful completion of the Course, the learner will be able to: • Analyze watershed components and processes to develop effective water management strategies. • Apply water quality parameters and management techniques for sustainable water resource utilization within watersheds. • Implement erosion control measures and biodiversity conservation strategies to mitigate soil erosion and sedimentation. • Apply integrated watershed planning and multidisciplinary approaches for sustainable watershed management.		
Sr. No	Topics	No of Hours (60)
1	Introduction to Watershed Management	6

2	Watershed Hydrology	7
3	Soil and Water Conservation Techniques	8
4	Vegetative Measures in Watershed Management	6
5	Water Harvesting Techniques	7
6	Watershed Management Planning	10
7	Soil Testing and Analysis	8
8	Watershed Management Structures	8

References

- DAS, M. M., SAIKIA, M. D. (2012). WATERSHED MANAGEMENT. India: PHI Learning.
- Heathcote, I. W. (2009). Integrated watershed management: principles and practice. United Kingdom: Wiley.
- Randhir, T. (2006). Watershed Management. United Kingdom: IWA Publishing.
- France, R. L. (2006). Introduction to watershed management : understanding and managing the impacts of sprawl. United States: Rowman & Littlefield.
- Rajora, R. (1998). Integrated Watershed Management: A Field Manual for Equitable, Productive and Sustainable Development. India: Rawat Publications.
- Murty, J. V. S. (1994). Watershed Management. India: New Age International.

Evaluation Pattern:
Internal Evaluation: 20M

Pattern of evaluation	Marks/Paper	Credits
Objective- MCQ, Short answer test, Assignments, Internal Evaluation Google form Moodle Objective-MCQ Short answer test	20	2

External evaluation:

	Total Marks	Credit
Paper I	50	2
Paper II	50	2
SEC	50	2

Evaluation Pattern: Practical's

	Total Marks	Credit	Minimum Passing Marks
Practical I (P I& II)	50	2	20
Practical 2 (SEC)	25	2	10
Practical 3 (VSC)	50	2	20

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.

I) 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 to develop 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: Mid Semester Examination (MSE) and End Semester Examination (ESE).
- The Mid Semester Examination shall be conducted by the College at the Mid of each semester (20 M) – Duration: 30 Min.
- The End Semester Examination shall be conducted by the College at the end of each semester. (30M) Duration: 1 hours

  End Semester Examination Paper Pattern

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

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 50 Marks throughout entire semester.
- 50 Marks Evaluation as per the following rubrics

Major Core Course	CIE	Experimental Report	Viva	Total
MJ I	15 M	5 M	5 M	25 M
MJ I	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 'U' designates undergraduate
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 24USIGE. 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 Ability enhancement course code, (AE) alphabets followed by a digit (1/2) followed by 'FOC'- Foundation course, 'EVS'-Environmental science are used.
8. For Value Added course code, (VA) alphabets followed by a digit (1/2) followed by 'FOC'- Foundation course, 'EVS'-Environmental science are used.
9. For Indian Knowledge System course code, (IK) alphabets followed by a digit (1/2) followed by 'ICH'- Indian Cultural Heritage is used.
10. For Co-curricular course code, (CC) alphabets followed by a digit (1/2).
11. For Open Elective course code, (OE) alphabets followed by a digit (1/2).
12. 'P' followed by digit indicates practical course number. (Practical course number will be added for semesters only where there is more than one course.