ROYAL GLOBAL UNIVERSITY
GUWAHATI

ROYAL SCHOOL OF ENVIRONMENTAL AND EARTH SCIENCES (RSEES)

DEPARTMENT OF GEOLOGY

COURSE STRUCTURE & SYLLABUS

B.Sc. (Hons.) Geology

w.e.f. 2022-23

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1. Preamble

The role of higher education is very important in securing employment and/or providing further access to higher education comparable to the best available in the world class institutions. The improvement in the quality of higher education, therefore, deserves to be given highest priority to enable the young generation of students to acquire skill, training and knowledge in order to enhance their thinking, comprehension and application abilities and prepare them to compete, succeed and excel globally.

Sustained initiatives are required to reform the present higher education system for improving and upgrading the academic resources and learning environments by raising the quality of teaching and standards of achievements in learning outcomes across all undergraduate programs in science, humanities, commerce and professional streams of higher education.

The Assam Royal Global University is offering and continuously upgrading its undergraduate programmes in accordance with the Learning Outcomes-based Curriculum Framework (LOCF) which makes it student-centric, interactive and outcome-oriented with well-defined aims, objectives and goals to achieve. The LOCF has been formulated for the courses as far as the Qualification Descriptors, Program Outcomes (PO) and the Course Outcomes (CO) are concerned and the course structure and detailed contents of the courses regarding the various components like the class room teaching (theory), laboratory (experiments), tutorials, and industrial / field visits and projects are designed and planned to achieve the stated Learning Objectives (LO).

Outcome based learning is the principal end of pedagogical transactions in higher education in today's world in the light of exponential changes brought about in science and technology, and the prevalent utilitarian world view of the society. Geology as a discipline falls within the special category of science with a multidisciplinary approach.

2. Learning Outcomes-based Approach to Curricular Planning

Outcome based learning is the principal end of pedagogical transactions in higher education in today's world in the light of exponential changes brought about in science and technology, and the prevalent utilitarian world view of the society. Geology as a discipline falls within the special category of science with a multidisciplinary approach.

The basic premise of learning outcomes-based approach to curriculum planning and development is that higher education qualifications such as a Bachelor's Degree (Hons.) programmes are earned and awarded on the basis of the following factors--(a) achievement of outcomes, demonstrated in terms of knowledge, understanding, skills, attitudes and values and (b) academic standards expected out of the graduates of a programme of study.

The expected learning outcomes are used as reference points to formulate graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes which in turn will help in curriculum planning and development, and in the design, delivery, and review of academic programmes.

In the Solar System amongst the terrestrial planet the Earth is the only living planet which has Lithosphere, oxygenated Atmosphere, Hydrosphere and the Biosphere. There is seamless interaction among these spheres. The Earth has hot interior and this very heat acts as the fuel to run the Earth engine. To understand how our planet works, at depth and at the surface, the ideas and principles of Biology, Chemistry, Physics, Mathematics and Geography are integrated in the exciting and stimulating studies which make up Earth Sciences. It is a fastmoving, diversifying, multidisciplinary field that ranges from understanding the Earths origin in the solar system, the evolution of hydrosphere and atmosphere as well as the earth's materials at the atomic level, through the geological processes that drive volcanoes and earthquakes, surface processes that shape landscapes and create the geological record, biological processes that build diversity and bring extinction, up to planetary-scale systems, such as plate tectonics, climate and the origins of life and ecosystems. The Earth

Science takes you very close to the nature as this is basically a filed Science. The geology program integrates field trips with classroom learning to give you the hands-on experience you need to succeed. These opportunities develop your technical skills using measuring instruments and laboratory equipment.

An outcome-based approach moves away from the emphasis on what is to be taught to what is actually learnt. This approach provides greater flexibility to the teachers to develop and the students to adopt different pedagogical strategies in an interactive and participatory ecosystem. The idea is to integrate social needs and teaching practices in a manner that is responsive to the need of the community. The Assam Royal Global University has addressed this aspect since its inception through the CBCS curricula adopted by the university in 2017. This approach is further consolidated through identifying further relevant and common outcomes beneficial to the student community and by developing such outcomes that not only match the specific needs of the students but also expands their outlook and values. Moreover, this curriculum keeps into perspective the fact that the focus is not just on domain knowledge or outcomes only but on processes and approaches to be employed in pedagogical transactions. This is important in order to ensure the efficacy of the curriculum adopted.

2.1. Nature and extent of UG program in Geology

The UG program in Geology builds on the basic Geosciences if taught at the +2 level in all the schools in the country. Ideally, the +2 senior secondary school education should aim and achieve a sound grounding in understanding the basic concepts in Geosciences with sufficient content of topics from modern Geology and contemporary areas of exciting developments in geosciences to ignite the young minds. The curricula and syllabi are framed and implemented in such a way that the basic connection between theory and experiment and its importance in understanding Geology is apparent to the student. This is very critical in developing a scientific temperament and urge to innovate, create and discover in Geology. Unfortunately, the condition of our school system in most parts of the country lacks the facilities to achieve the above goal and it is incumbent upon the college/university system to fill the gaps in the knowledge creation of our young minds created by the lack of infrastructural and academic resources of our school system and strengthen their understanding in all the subjects through the UG programs specially in Geology and other science subjects.

The undergraduate program in Geology is presently being offered though the courses designed for granting B.Sc (Honours) Geology. The course is of three-year duration spread over six semesters after the higher secondary (+2) level Science course.

Sl. No.	Semester	Mandatory Credits to be Secured for the Award
1	1st	26
2	2nd	26
3	3rd	23
4	4th	21
5	5th	25
6	6th	25
Total Credits		**146**

2.2. Aims of UG program in Geology

The aims and objectives of our UG educational program in Geology is structured to:

- Create the facilities and environment in all the educational institutions to introduce and consolidate the knowledge acquired at +2 level and to motivate and inspire the students to create deep interest in

Geology, to develop broad and balanced knowledge and understanding of geological concepts, principles and theories of stratigraphy, geological mapping, exploration of natural resources and understand Earth evolution.

- Learn, design and perform experiments in the labs to demonstrate the concepts, principles and theories learned in the classrooms.
- Develop the ability to apply the knowledge acquired in the classroom and laboratories to specific problems in theoretical and applied Geology.
- Expose the student to the vast scope of Geosciences as a theoretical and experimental science with applications in solving most of the geogenic problems in nature spanning from disaster management, watershed management, water pollution, oil exploration and mining, etc.
- Emphasize the need for integrating Geosciences as one of the most important branch of science for pursuing the interdisciplinary and multidisciplinary higher education and/or research in interdisciplinary and multidisciplinary areas.
- To emphasize the importance of Geology as the most important discipline for sustaining the existing industries and establishing new ones to create job opportunities at all levels of employment.

3. Graduate Attributes in Geology

Some of the characteristic attributes of a graduate in Geology are:

GA 1: Disciplinary Knowledge:

a) Develop a systematic understanding of both core areas and advanced topics in the study of the Earth, its materials and structure, its history over 4600 million years, and the processes that have controlled its evolution as a planet by viewing Earth from new and challenging perspectives of time, space, process and pattern.
b) Stimulate students to see Geology as a vital component of our culture, where science develops as informed curiosity about the Earth and Society's environment, promoting human development and sustainability through the search for energy sources, raw materials, water supplies, sites for safe waste disposal, and the mitigation of natural hazards.
c) Develop skills in gathering and interpreting the geological and geophysical data used to gain this understanding and thereby equip students with the foundations for their professional careers or additional study.
d) Provide an excellent preparation for a career in professional practice in industrial or environmental Earth Sciences, research in Geosciences, and specialist areas of other physical and natural sciences.

GA 2: Communication Skills:

a) Skills to communicate in written, numerical, graphical and verbal forms, in ways that are appropriate to different audiences and indifferent situations, ranging from scientific and industry reports, to group and individual oral presentations, and from blogs and outreach articles, to news articles and essays.
b) Use group discussions and joint seminar presentations to research and present work collaboratively; and develop oral presentation and participation skills during seminars and group-work, and in written form through online e-learning tools, dissertations and essays.

GA 3: Critical Thinking:

a) Acquire an understanding of the concept in geology and related disciplines and an ability to understand, integrate, and extend it so that all fundamental geological concepts are accessible.
b) Acquire, digest and critically evaluate scholarly arguments, the assumptions behind them, and their theoretical and empirical components.

GA 4: Problem Solving:

a) Skills to recognise and articulate a problem and then apply appropriate conceptual frameworks and methods to solve it.
b) Emphasis is placed on larger, integrated problem-solving exercises, during which students are taught how to process complex data sets using a diverse range of skills and knowledge. This provides the foundation for student-led independent, but academically directed, project work.

GA 5: Analytical Reasoning:

a) Competency in both field and laboratory skills, and in data analysis, interpretation and presentation that permit the successful pursuit of pure or applied problems in geology.

GA 6: Research-Related Skills:

a) Develop a research design, which has an appropriate problem related to earth sciences but may incorporate some scientific methods, ability to plan and write a research paper.

b) Ability to process and interpret large, complex, datasets, to hypothesis set and test, and to function as a numerate, literate scientist able to prove insight and guidance related to real-world problems and issues.

GA 7: Digital Literacy:

a) ability of advanced Word skills and advanced GIS, statistics, databases, spreadsheets, digital drawing through online workbooks and workshops

b) ability to use digital resources for presentations

GA 8: Moral and Ethical Values:

a) The degree to which every student engages with these themes will vary but it is important that all think especially about ethical issues

b) Avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights, and adopting objectives, unbiased and truthful actions in all aspects of work.

GA 9: Global Competency:

a) After completing course in Geology, the student is expected to be fully knowledgeable about the subject and not only from the point of view of examination.

b) He/she will be ready to accept challenges and stand in competition at a national and global level.

GA 10: Life-long Learning:

a) ability to blend academic and practical skills

b) ability to transfer such skills to other domains of one's life and work

4. Qualification descriptors for B. Sc. (Honours) Geology

The qualification descriptors for a B.Sc. (Honours) Geology Program may include the following. The graduates should be able to:

- Demonstrate a coherent and systematic knowledge and understanding of the field of Geology making intelligible Geoscientific research frontiers and theoretical developments in this field in the global context. This would also include the student's ability to collect, analyse, synthesise, summarise and inter-relate diverse processes and facts, to formulate and test hypotheses and reach conclusions.
- Demonstrate the ability to identify and differentiate rocks, minerals, fossils, other Earth materials and Earth structures in the field, as hand specimens and using laboratory techniques including microscopy and spectroscopic analysis. Skill to observe and record original field and laboratory data and then apply these to evaluate and resolve geological and geotechnical problems.
- Demonstrate skills in areas related to one's specialization area and current developments in the academic field of Geology, including a critical understanding of the latest developments in the area of specialization, and an ability to use modern established techniques of analyses and enquiry within the field of specialization.
- Demonstrate comprehensive knowledge about materials, including current research, scholarly, and/or professional literature, relating to essential and advanced learning areas pertaining to various subfields in Geology, and techniques and skills required for identifying problems and issues in their area of specialization.
- Demonstrate the ability to assemble and analyse incomplete and varied observational data and develop testable hypotheses, predictions or explanations from them. Skills to recognise associations between geological observations and then integrate them into their 3D and 4D (space-time) frameworks.

- Demonstrate the ability to share the results of academic and disciplinary learning through different forms of communication such as essays, dissertations, reports, findings, notes, etc. on different platforms of communication such as the classroom, conferences, seminars, workshops, the media and the internet.
- Address one's own learning needs relating to current and emerging areas of study in Geology, making use of research, development and professional materials as appropriate, including those related to new frontiers of knowledge in science.
- Ability to devise and carry out an independent field-based project, including the formulation and testing of hypotheses whilst in the process of carrying out the project. The integration of field-based, experimental and theoretical principles needed for the Earth Sciences.
- Demonstrate subject-related and transferable skills that are relevant to some of the Geology related jobs and employment opportunities in the public and private sector.

5. Program Outcomes in B.Sc. (Honours) Geology

Upon satisfactory completion of B.Sc. (Honours) degree in Geology, the graduates will be able to achieve the following:

PO 1: Disciplinary Knowledge of Geology

- Ability to attain extensive and coherent knowledge and understanding of the academic field of Geology as a whole and its applications, and links to related disciplinary areas/subjects of study.

PO 2: Communication Skills

- Communicate the results of studies undertaken in the academic field of Geology accurately in a range of different contexts using the established and emerging concepts, constructs and techniques.

PO 3: Critical Thinking

- Develop skills in creative and critical thinking, analytical methods and integration of knowledge in multiple branches and will be able to formulate a scientific problem and strategies to solve it.

PO 4: Problem Solving

- Demonstrate the ability to use skills in Geology and its related areas of technology for formulating and tackling geosciences-related problems and identifying and applying appropriate geological principles and methodologies to solve a wide range of problems associated with geosciences.

PO 5: Analytical Reasoning

- Apply one's knowledge and understandings relating to Geology and skills to new/unfamiliar contexts and to identify and analyse problems and issues and seek solutions to real-life problems.

PO 6: Research-Related Skills

- Ability to identify research gaps, formulate research questions and ascertain relevant sources to find substantive explanations.

PO 7: Digital Literacy

- Ability to use digital sources for critical reading, data analysis, problem solving and presentations.

PO 8: Values: Moral, Ethical, Literary

- Ability to interrogate one's own ethical values, and to be aware of ethical issues.
- Ability to transfer such skills to other domains of one's life and work.

PO 9: Global Competency

- Demonstrate skills in identifying information needs, collection of relevant quantitative and/or qualitative geostatistical data drawing on a wide range of sources from the field and labs around the world, analyses and interpretation of data using methodologies as appropriate to the subject of Geology in the area of his/her specialization.

PO 10: Life-long Learning

- Graduate will acquire values and attitudes towards understanding complex environmental- economic-social challenges, and participating actively in solving current geological problems.

6. Program Specific Outcomes in B.Sc. (Honours) Geology

Upon completion of this programme the student will be able to:

PSO 1	**Academic competence:** (i) Understand fundamental concepts, principles and processes underlying the field of Geology, its different subfields and its linkage with related disciplinary areas/subjects. (ii) Demonstrate an understanding of a wide range of geological processes (e.g., genesis of rocks and formation of geological structures, formation of minerals and their alteration, effects of human activities at meso-microscale.) (iii) Undertake field tour in any part of India with respect to lithology, structure and stratigraphy and produce geological maps.
PSO 2	**Personal and Professional Competence:** (i) Carry out field mapping in any part of India with respect to lithology, structure and stratigraphy and produce geological maps. (ii) Analyse geological data and samples procured during field work. (iii) Formulate ideas, execute scientific writing and authentic reporting, geological maps, effective presentation and communication skills.
PSO 3	**Research Competence:** (i) Apply skills developed towards comprehension of geological conditions to address issues and find solutions in case of ground water, mineral and fossil fuel exploration and geo hazards. (ii) Integrate informatics and statistical skills to explore and authenticate field and laboratory data for experimental purpose.

7. Teaching Learning Process

Teaching and learning in this programme involve a wide spectrum of activities. It includes-

- Lecture classes which are delivered through slideshow as well as video presentations.
- Tutorial classes where a closer interaction between the students and the teacher is present as each student gets individual attention.
- Mentor-Mentee
- Project-based learning (very small projects like 1-day field-based projects, so as to increase their practical skills and knowledge).
- Group discussion, Student presentations, Seminars
- Home assignments, Quizzes and class tests
- Interactive sessions with invited experts from various fields of Geology
- Industrial Tour and/or Field visit

8. Evaluation System

Methods	Weightage
Continuous Evaluation	30%
Semester End Examination	70%
Total	**100%**

The Continuous Evaluation component is again re-divided as per the following connotation:

- Class Participation (15%)
- Mid-Term Examination (10%)
- Attendance (5%)

Class Participation (15%): Every student's progress and performance are continuously adjudged throughout the semester in different ways such as Class Tests, Viva, Assignments, Project Work, and Seminars etc. 15% marks are allotted under the head 'Class Participation'.

Mid-Term Examination (10%): This is a written test conducted in the middle of the semester after completion of 30% to 40% of the course. 10% marks are allotted for Mid-Term Examination.

Attendance (5%): Ideally, a student is expected to attend 100% of the classes, but considering various hindrances like illness, accident, etc. a relaxation of maximum 25% is given, which means a student has to maintain an attendance of minimum 75% in each course; failing to do so will lead to debarment of the student from the examination in the said course. 1-5 marks are given to students having more than 75% attendance. Attendance is awarded to a student as per the following connotation:

Percentage of Attendance (%)	Marks
More than 95%	5
More than 90% and up to 95%	4
More than 85% and up to 90%	3
More than 80% and up to 85%	2
More than 75% and up to 80%	1
Up to 75%	0

B.Sc. (Honours) Geology

Program Structure

1st SEMESTER							
Sl. No	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
		Core Courses					
1	GEOL162C101	Physical Geology	3	1	0	4	4
2	GEOL162C112	Structural Geology	2	0	4	4	6
3	GEOL162C113	Mineral Science	2	0	4	4	6
		Skill Enhancement Course (SEC)					
4	GEOL162S111	Field Geology - I	0	0	4	2	4
		Value Added Course (VAC)					
5		Choose any one from common pool of VAC courses	2	0	0	2	2
		Generic Elective Courses (GEC)					
6	GEOL162G101	Essentials of Geology *(pre-requisite: students from PCM only)*	3	0	0	3	3
7	GEOL162G102	Fundamentals of Geology	3	0	0	3	3
		Ability Enhancement Compulsory Courses (AECC)					
8	CEN984A101	Communicative English-I	1	0	0	1	1
9	BHS984A103	Behavioural Science-I	1	0	0	1	1
TOTAL CREDITS (C) = 24 AND TOTAL CONTACT PERIODS (TCP) = 32							
2nd SEMESTER							
Sl. No	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
		Core Courses					
1	GEOL162C211	Igneous Petrology	2	0	4	4	6
2	GEOL162C212	Metamorphic Petrology	2	0	4	4	6
3	GEOL162C213	Geochemistry	2	0	4	4	6
		Skill Enhancement Course (SEC)					
4	GEOL162S211	Field Geology – II	0	0	4	2	4
		Value Added Course (VAC)					
5		Choose any one from common pool of VAC courses	2	0	0	2	2
		Generic Elective Courses (GEC)					
6	GEOL162G201	Rocks and Minerals	3	0	0	3	3
7	GEOL162G202	Earth Sciences	3	0	0	3	3
		Ability Enhancement Compulsory Courses (AECC)					
8	CEN984A201	Communicative English-II	1	0	0	1	1
9	BHS984A203	Behavioural Science-II	1	0	0	1	1
TOTAL CREDITS (C) = 24 AND TOTAL CONTACT PERIODS (TCP) = 32							
3rd SEMESTER							
Sl. No	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
		Core Courses					
1	GEOL162C311	Sedimentology	2	0	4	4	6
2	GEOL162C312	Palaeontology	2	0	4	4	6
		Discipline Specific Electives (DEC) (any one)					
3	GEOL162D311	Geomorphology	2	0	4	4	6
4	GEOL162D302	River Science	4	0	0	4	4
		Ability Enhancement Compulsory Courses (AECC)					
5	CEN984A301	Communicative English-III	1	0	0	1	1

6	BHS984A303	Behavioural Science-III	1	0	0	1	1
		Generic Elective (GE)					
7	GEOL162G301	Physics and Chemistry of Earth	3	0	0	3	3
8	GEOL162G102	Fundamentals of Geology	3	0	0	3	3
		Internship					
9	GEOL162C321	Project	0	0	0	4	0
TOTAL CREDITS (C) = 24 AND TOTAL CONTACT PERIODS (TCP) = 32							
4th SEMESTER							
Sl. No	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
		Core Courses					
1	GEOL162C441	Principles of Stratigraphy	2	0	4	4	6
2	GEOL162C402	Indian Stratigraphy	4	0	0	4	4
		Discipline Specific Electives (DEC) (any one)					
3	GEOL162D401	Earth & Climate	4	0	0	4	4
4	GEOL162D402	Soil Geology	4	0	0	4	4
		Skill Enhancement Course (SEC)					
5	GEOL162S411	Field Geology – III	0	0	4	2	4
		Value Added Course					
6		VAC 3	2	0	0	2	2
		Ability Enhancement Compulsory Courses (AECC)					
7	CEN984A401	Communicative English - IV	1	0	0	1	1
8	BHS984A403	Behavioural Science-IV	1	0	0	1	1
		Generic Elective (GE)					
9	GEOL162G401	Earth Surface Processes	3	0	0	3	3
10	GEOL162G202	Earth Sciences	3	0	0	3	3
TOTAL CREDITS (C) = 24 AND TOTAL CONTACT PERIODS (TCP) = 32							
5th SEMESTER							
Sl. No	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
		Core Courses					
1	GEOL162C541	Hydrogeology	2	0	4	4	6
2	GEOL162C542	Economic Geology	2	0	4	4	6
		Discipline Specific Elective Courses (DSE) (any two)					
3	GEOL162D541	Remote Sensing and GIS	2	0	4	4	6
4	GEOL162D502	Climatology and Oceanography	4	0	0	4	4
5	GEOL162D503	Exploration Geology	4	0	0	4	4
		Value Added Course					
6		VAC 4	2	0	0	2	2
		Ability Enhancement Compulsory Courses (AECC)					
7		Communicative English - V	1	0	0	1	1
8		Environmental Studies & Sustainable Development - I	1	0	0	1	1
		Internship					
9		Internship for 6 weeks which will commence after 4th semester examinations	0	0	0	6	0
TOTAL CREDITS (C) = 26 AND TOTAL CONTACT PERIODS (TCP) = 28							

6th SEMESTER							
Sl. No	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
		Core Courses					
1	GEOL162C641	Engineering Geology	2	0	4	4	6
2	GEOL162C602	Fuel Geology	4	0	0	4	4
		Discipline Specific Elective Courses (DSE) (any three)					
3	GEOL162D601	Evolution of life through time	4	0	0	4	4
4	GEOL162D602	Planetary Geology	4	0	0	4	4
5	GEOL162D603	Analytical Geology	4	0	0	4	4
6	GEOL162D604	Introduction to Geophysics	4	0	0	4	4
		Skill Enhancement Course (SEC)					
7	GEOL162S611	Field Geology – IV	0	0	4	2	4
		Value Added Course					
8		VAC 5	2	0	0	2	2
		Ability Enhancement Compulsory Courses (AECC)					
9	CEN984A601	Communicative English - VI	1	0	0	1	1
10		Environmental Studies & Sustainable Development - II	1	0	0	1	1
TOTAL CREDITS (C) = 26 AND TOTAL CONTACT PERIODS (TCP) = 32							

List of Value-Added Courses (VAC):

Type of Course	Courses
VAC1	Physical Education-Yoga, Sports/Life skills/Fundamental Rights/Time management/Personal Hygiene & Nutrition/Physical fitness & basic survival
VAC2	Positive psychology/Dance/Personal branding & Self-management/Chronological Thinking/India: Land of Diversity
VAC3	Theatre/Functional Languages/Green consumption/Social responsibilities/Leadership & Team development
VAC4	Moral values/Music/Foreign Languages/Wildlife Conservation management/Women empowerment
VAC5	E-Governance/Sign language/Disaster management/Mathematics for Competitive Examinations/Managing Innovation
VAC6	Political Journalism/Intellectual Property Rights/Managing learning disabilities/EXIM Documentation/Machine learning

B. Sc. (Honours) Course in Geology: Semester-I

Paper I Core Course	PHYSICAL GEOLOGY			Subject Code:
	L-T-P-C: 4-0-0-4	Credit Units: 4	Scheme of Evaluation: T	GEOL162C101

Course Objectives: Physical Geology is an introductory course that covers the fundamental principles of geology. It provides an understanding of the Earth's internal and external processes that shape the Earth's surface and subsurface features. This course covers a range of topics, including mineralogy, petrology, plate tectonics, structural geology, and geological time.

Course Outcomes:

1. Remembering: Recall the fundamental concepts of geology, including the rock cycle, plate tectonics, and geological time.
2. Understanding: Explain the processes that form the Earth's surface features and analyze the geological structures and their influence on the formation of natural resources.
3. Applying: Apply the principles of mineralogy and petrology to identify and classify different types of rocks and minerals, interpret geological maps and cross-sections, and solve geological problems.
4. Analyzing: Analyze geological structures and geological data to understand the distribution of rock units and geological structures.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Earth as a Planet** Earth Science & its branches. Origin and evolution of the Universe and Solar System, The Standard Planetary Model. The Terrestrial and Jovian planets. Meteorites, Asteroids and Comets. Mechanical layering of the Earth: lithosphere, asthenosphere, mantle and core. Formation of core, mantle, crust, hydrosphere, and atmosphere. Introduction to rocks – Igneous, Sedimentary and Metamorphic rocks.	12
Unit 2	**Geodynamics** Concept of continental drift, seafloor spreading and plate tectonics. Origin of oceans, continents, mountains and rift valleys. Earthquake and earthquake belts. Volcanoes - types, products and their distribution. Earth's magnetic field; Convection in Earth's core and production of its magnetic field. Geothermal gradient and internal heat of the Earth.	12
Unit 3	**Cosmic abundance of elements** Distribution of elements in solar system and in Earth, Chemical differentiation and composition of the Earth; General concepts about geochemical cycles and mass balance. Introduction to the properties of elements: The periodic table. Geochemical behaviour of selected elements like Si, Al, K, Na etc	12
Unit 4	**Understanding the past from stratigraphic records** Introduction to the concept of time in geological studies: Standard stratigraphic time scale Introduction to geochronological methods and their application in geological studies. History of development in concepts of uniformitarianism, catastrophism and neptunism; Laws of superposition and faunal succession; Unconformity and its types, recognition of unconformity. Introduction to geology and geomorphology of Indian subcontinent.	12
	Total	**48**

Text Books:

1) Introduction to Physical Geology – Thompson & Turk
2) Global Tectonics - Philip Kearey, Keith A. Klepeis, Frederick J. Vine, (3rd edition, 2009), Wiley-Blackwell Publishing

Reference Books:

1) Physical Geology – R. F. Flint and J Skinner, John Wiley and Sons, Inc
2) Essentials of Geology - Stephen Marshak, 4th edition, W. W. Norton & Company

Paper II Core Course	STRUCTURAL GEOLOGY			Subject Code:
	L-T-P-C: 2-0-4-4	Credit Units: 4	Scheme of Evaluation: T + P	GEOL162C112

Course Objectives: Structural geology is a sub-discipline of geology that deals with the study of deformation and deformation-related structures of rocks at various scales. This course aims to provide a fundamental understanding of structural geology, including the analysis of structural data and the interpretation of deformation processes that occur in the Earth's crust.

Course Outcomes:

1. Remembering: Students will be able to recall the basic concepts, terminology, and principles of structural geology.
2. Understanding: Students will be able to comprehend the various types of rock deformation and deformation-related structures, including folds, faults, and joints.
3. Applying: Students will be able to apply their knowledge of structural geology to analyze and interpret geological maps and cross-sections.
4. Analysing: Students will be able to analyse structural data, including the measurement and plotting of various structural elements, such as strike, dip, and plunge.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Structures and Concepts of Rock Deformation** Diastrophic and non-diastrophic structures. Structural elements: planar and linear structures, concept of strike and dip, trend and plunge, rake/pitch. Outcrop patterns of different structures. Concept of rock deformation: Stress – normal and shear stress, stress at a point, Stress ellipsoid and principal stress axes, Mohr's stress circle and various stress types. Strain in rocks, types of strain, Principal strain axes and Strain ellipses. Flinn's diagram.	12
Unit 2	**Ductile and Brittle Structures** Concept of brittle and ductile deformation. Fold morphology; Geometric and genetic classification of folds; Introduction to the mechanics of folding: Buckling, Bending, Flexural slip and flow folding. Description and origin of foliations and lineations. Geometry of pinch and swell and boudin structure. Basic idea of shear zone, faults and joints. Geometric and genetic classification of fractures and faults. Geologic/geomorphic criteria for recognition of faults.	12
Unit 3 Practical	Preparation of a topographic profile Drawing profile sections and interpretation of geological maps of different complexities. Structural contouring and 3-point (bore hole) problems of dip and strike.	12
Unit 4 Practical	Determination of true thickness of strata from a given exposure. Exercises of stereographic projections of mesoscopic structural data (planar, linear, folded) Exercises on plotting and analysis of linear data in Rose diagram.	12
	Total	**48**

Text Books:

1) Structural Geology - Robert J. Twiss & Eldridge M. Moores, (2nd edition, 2007), W. H. Freeman & Co Ltd.
2) Structural Geology - M. P. Billings, 4th edition, Prentice-Hall.

Reference Books:

1) Foundations of Structural Geology - Park, R. G. (2005), Routledge.
2) Structural Geology – Fundamentals and Modern Developments - S. K. Ghosh, (2013), Elsevier Science.
3) Structural Geology of Rocks and Region - G. R. Davis, (1984), John Wiley.
4) Structural Geology – Haakon Fossen, (2010), Cambridge University Press, New York.

Paper III Core Course	MINERAL SCIENCE L-T-P-C: 2-0-4-4 Credit Units: 4 Scheme of Evaluation: (T + P)	Subject Code: GEOL162C113

Course Objectives: Mineral Science is an undergraduate-level course that focuses on the study of minerals and their properties, including crystallography, optical properties, chemical composition, and physical characteristics. The course provides an overview of the formation and classification of minerals, as well as the processes involved in their identification and analysis.

Course outcomes:

1. Remembering: Recall and identify the properties of minerals, their classification, and crystallographic systems.
2. Understanding: Explain the physical and chemical properties of minerals and their significance in geological processes and exploration of mineral resources.
3. Applying: Apply mineralogical knowledge to identify minerals using optical microscopy and X-ray diffraction techniques.
4. Analysing: Analyse mineral assemblages and their distribution in rocks to understand the origin and evolution of geological processes.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Crystallography** Concept of crystal, crystalline and amorphous matter; Crystal structure. Atomic arrangements: unit cell, CCP and HCP; Pauling's rules; Solid Solution, polymorphism, pseudomorphism. Crystal parameters and indices; form and zone; Crystal symmetry, classification of crystals into systems; Lattice theory and 32-point groups; International symbol of point groups.	12
Unit 2	**Rock forming minerals** Minerals - definition, physical and chemical properties; Chemical classification of minerals. Silicate and non-silicate structures. Study of physical properties of minerals of the following group of minerals: Olivine, Pyroxene, Amphibole, Mica, Silica and Feldspar. **Optical Mineralogy** Polarization of light, Polarisers. Functions of petrological microscope. Optical behaviour of minerals: Absorption, Transmission and Double-refraction of light. Theory of light propagation in minerals: Isotropy and Anisotropy; Optic axis. Optical properties of minerals in thin section.	12
Unit 3 Practical	Exercises on stereographic projection of crystal faces. Study of physical properties of minerals in hand specimen: Olivine, Garnet, SilIimanite, Kyanite, Staurolite, Beryl, Tourmaline, Augite, Actinolite, Hornblende, Serpentine, Talc, Muscovite, Biotite, Phlogopite, Quartz, Orthoclase, Plagioclase, Microcline, Nepheline, Sodalite, Zeolite Quartz varieties: Chert, Flint, Chalcedony, Agate, Jasper, Amethyst, Rose quartz, Smoky quartz.	12
Unit 4 Practical	Study of the following silicate minerals under optical microscope: Olivine, Garnet, SilIimanite, Kyanite, Staurolite, Tourmaline, Enstatite, Diopside, Augite, Actinolite, Hypersthene, Hornblende, Serpentine, Muscovite, Biotite, Quartz, Orthoclase, Plagioclase, Microcline, Nepheline, Sodalite, Calcite. Determination of Pleochroic Scheme of minerals. Identification of Plagioclase Feldspars by Michel-Levy method.	12
	Total	**48**

Text Books Suggested:

1) Mineralogy - Dexter Perkins, 3rd edition (2015), Pearson Publication.
2) Rutley's Elements of Mineralogy – H.H. Read; CBS publishers.

Reference books:

1) Introduction to Optical Mineralogy – William D. Nesse, 3rd edition (2004), Oxford University Press.
2) The Manual of Mineral Science (after James D. Dana) - Klein, C., Dutrow, B., Dwight, J., & Klein, C.; (2007) J. Wiley & Sons.

Paper IV SEC	FIELD GEOLOGY - I			Subject Code:
	L-T-P-C: 0-0-4-2	Credit Units: 2	Scheme of Evaluation: (P)	GEOL162S111

Course Objectives: This course is designed to provide students with hands-on experience in geologic field methods and techniques. Topics covered will include geologic mapping, structural geology, stratigraphy, and palaeontology. Students will participate in field trips to local geologic sites and will be required to prepare geologic maps and reports.

Course Outcomes:

1. Remembering: Students will be able to recall and recognize the key concepts, principles, and facts related to geologic field methods and techniques.
2. Understanding: Students will be able to explain the fundamental principles and processes of geologic field methods and techniques, including geologic mapping, structural geology, stratigraphy, and palaeontology.
3. Applying: Students will be able to apply geologic field methods and techniques to collect, record, and interpret geologic data from field sites.
4. Analysing: Students will be able to analyse geologic field data to identify geologic structures, interpret stratigraphic relationships, and reconstruct geologic histories.
5. Evaluating: Students will be able to evaluate the quality and reliability of geologic data collected in the field, and assess the strengths and weaknesses of different field techniques and methods.
6. Creating: Students will be able to design and execute a geologic field project, including developing hypotheses, collecting and analysing data, and presenting findings.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Basic idea of: topographic contours, topographic sheets, indexing of toposheets, lithological and structural maps. Importance of representative factors of the map. Reading contours and topography.	6
Unit 2	Orientation of Topographic sheet in field, marking location in toposheet. Concepts of map reading, Distance, height and pace approximation. Front Bearing and Back Bearing.	6
Unit 3	Basic field measurement techniques: Bedding dip and strike. Use of Clinometer and Brunton compass for structural measurements. Identification of rock types in field; structures and texture of rocks, Use of hand lens.	6
Unit 4	Field Visit – Basic Field Training	6
	Total	**24**

Text Books Suggested:

1) Guide to Field Geology – S. M. Mathur, PHI Publications
2) Field Geology – F. H. Lahee, CBS Publishers and Distributors Pvt Ltd; Sixth Edition (2002)

Reference books:

1) Manual of Field Geology – Robert R. Compton; John Wiley & Sons.
2) Basic Methods of Structural Geology – Stephen Marshak & Gautam Mitra; Pearson Publication.

Paper: GE 1 Generic Elective	ESSENTIALS OF GEOLOGY			Subject Code:
	L-T-P-C: 3-0-0-3	Credit Units: 3	Scheme of Evaluation: (T)	GEOL162G101

Course Objectives: This course introduces students to the fundamental concepts and principles of geology. Topics covered will include the structure and composition of Earth, plate tectonics, Earth's history and geological time scale. Students will develop an understanding of the processes that shape Earth's surface and subsurface, and the role of geology in society and the environment.

Course Outcomes:

1. Remembering: Students will be able to recall and recognize the basic concepts, principles, and terminology of geology.
2. Understanding: Students will be able to explain the fundamental processes and phenomena that shape Earth's surface and subsurface, and the role of geology in society and the environment.
3. Applying: Students will be able to apply geologic principles and concepts to analyze and solve problems related to Earth's structure, composition, and history.
4. Analyzing: Students will be able to analyze geologic data to interpret the physical and chemical properties of Earth materials, and to evaluate the role of these materials in shaping Earth's geologic history.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Introduction to geology, scope, sub-disciplines and relationship with other branches of sciences. Journey of elements from Nebula to Mineral. Evolution of earth through time. Introduction to rocks and their types.	6
Unit 2	Internal constitution of the earth - core, mantle and crust Dynamics of lithosphere: Plate Tectonic Theory Origin of oceans, continents and mountains. Origin of Himalaya.	6
Unit 3	Concept of Mobile belts, cratons and shield. Concepts of rock deformation: Stress and Strain in rocks. Ductile and Brittle Structures: Foliations, Folds, Faults, Joints.	6
Unit 4	Introduction to the Standard stratigraphic time scale, Global Stratotype Section and Point. Laws of superposition and faunal succession. Concept of uniformitarianism. Unconformity and its types, recognition of unconformity.	6
	Total	**24**

Text Books suggested:

1) Textbook of Geology – P. K. Mukherjee; World Press Pvt. Ltd.
2) A Textbook of Geology – G. B. Mahapatra; CBS publishers
3) Principles of Engineering Geology by K.M. Bangar

Reference Books:

1) Klein, C., Dutrow, B., Dwight, J., & Klein, C. (2007). The 23rd Edition of the Manual of Mineral Science (after James D. Dana). J. Wiley & Sons.
2) Introduction to Physical Geology – Thompson & Turk
3) Essentials of Geology - Stephen Marshak, 4th edition, W. W. Norton & Company

Paper: GE 2 Generic Elective	Fundamentals of Geology			Subject Code:
	L-T-P-C: 3-0-0-3	Credit Units: 3	Scheme of Evaluation: (T)	GEOL162G102

Course Objectives: This course introduces students to the fundamental concepts and principles of geology. Topics covered will include the structure and composition of Earth, plate tectonics, Earth's history, minerals and rocks, natural hazards, and the environment. Students will develop an understanding of the processes that shape Earth's surface and subsurface, and the role of geology in society and the environment.

Course Outcomes:

1. Remembering: Students will be able to recall and recognize the basic concepts, principles, and terminology of geology.
2. Understanding: Students will be able to explain the fundamental processes and phenomena that shape Earth's surface and subsurface, and the role of geology in society and the environment.
3. Applying: Students will be able to apply geologic principles and concepts to analyze and solve problems related to Earth's structure, composition, and history.
4. Analyzing: Students will be able to analyze geologic data to interpret the physical and chemical properties of Earth materials, and to evaluate the role of these materials in shaping Earth's geologic history.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Physical Geology** Earth as a planet, Exogenous and Endogenous processes and their associated landforms. Earthquake and Volcanism, Introduction to the interior of the earth.	6
Unit 2	**Minerals and Rocks** Introduction to minerals, Crystallisation of minerals. Brief idea of the mineral groups. Introduction to rocks and their types. Origin of Igneous, Sedimentary and Metamorphic rocks.	6
Unit 3	**Stratigraphy** Introduction to the Standard stratigraphic time scale, Global Stratotype Section and Point. Laws of superposition and faunal succession. Concept of uniformitarianism. Unconformity and its types, recognition of unconformity.	6
Unit 4	**Fossils** Definition of fossil, modes of fossil preservation. Role of fossils in development of geological time scale. Brief introduction to various fossils groups. Introduction to micro-palaeontology.	6
	Total	**24**

Text books:

1) Essentials of Geology - Stephen Marshak, 4th edition, W. W. Norton & Company
2) Principles of Engineering Geology by K.M. Bangar

Reference books:

1) Manual of Mineral Science (after James D. Dana) – Klein, C., Dutrow, B., Dwight, J., & Klein, C. (2007), 23rd Edition.
2) Introduction to Physical Geology – Thompson & Turk
3) A Textbook of Geology – G. B. Mahapatra; CBS publishers.

Paper: AECC 1	Communicative English - I: Developing Oral Communication and Listening L-T-P-C: 1-0-0-1 Credit Units: 1	Subject Code: CEN982A101

Scheme of Evaluation: Theory + Viva-Voce + Extempore Speech
Continuous Evaluation: 30 Marks
Semester End Examination: Component A – Theory (30 Marks)
Component B + C – Viva-Voce + Extempore speech (40 Marks)

Course Objectives:
The objective of the course is to introduce students to oral communication skills in English by engaging them to meaningful discussion and interactive activities.

Course Outcomes:
After the completion of course, students will be expected to:

- Have a knowledge of Communication process, verbal, and non-verbal communication
- Improve the skill of listening processes
- Develop a life skill on oral group communication- group discussion leadership skills, team management.
- Have a basic idea of language styles – oral and written communication.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Basics of Communication- Introduction Communication - definition – meaning – elements - basics of communication - communication process - importance of communication Components of Communication Types/forms of Communication (Oral-written, Formal-Informal (Grapevine), Interpersonal-Intrapersonal, Mass- Group, Verbal-Non Verbal External communication, Organizational Communication- Upward, Downward, horizontal, Diagonal) Non-verbal Communication - Introduction; Body language- Personal Appearance, Postures, Gestures, Eye Contact, Facial expressions Paralinguistic Features-Rate, Pause, Volume, Pitch/Intonation/ Voice/ modulation Proxemics, Haptics, Artifactics, Chronemics	**4**
Unit 2	The Listening Process Types of Listening – Superficial, Appreciative, Focused, Evaluative, Attentive, Emphatic, Listening with a Purpose, Barriers to Communication, Barriers to Listening	**4**
Unit 3	Focus on Oral Group Communication Nature of group communication, Characteristics of successful Group Communication Selection of group discussion-subject knowledge, leadership skills, team management Group Discussion Strategies	**4**
Unit 4	Language Styles- Oral and Written Communication Technical Style, ABC of technical communication- accuracy, using exact words and phrases, brevity, clarity, Objectivity of Technical Writing - Impersonal language, Objectivity in professional speaking.	**4**
	Total	**16**

Text books:

1) Rizvi, M. Ashraf. (2008). Effective Technical Communication (11th reprint). New Delhi: Tata McGraw Hill.

Reference books:

1) Koneru, Aruna.(2017) Professional Communication. New Delhi: Tata McGraw Hill ISBN-13: 978-0070660021
2) Hair, Dan O., Rubenstein, Hannah and Stewart, Rob. (2015). A Pocket Guide to Public Speaking. (5th edition). St. Martin's. ISBN-13:978-1457670404

Paper: AECC 2	Behavioural Science - I L-T-P-C: 1-0-0-1 Credit Units: 1	Subject Code: BHS982A102

Scheme of Evaluation: Theory + Viva-Voce + Extempore Speech
Continuous Evaluation: 30 Marks
Semester End Examination: Component A – Theory (30 Marks)
Component B + C – Viva-Voce + Extempore speech (40 Marks)

Course Objectives:
To increase one's ability to draw conclusions and develop inferences about attitudes and behaviour, when confronted with different situations that are common in modern organizations

Course Outcomes:
After the completion of course, students will be expected to:

- Understand self-identity and identity crisis
- Understand self-esteem.
- Have in depth knowledge of foundation of individual behaviour.
- Develop a life skill on Time management
- Have an idea on barriers of communication.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Understanding Self** Understanding of Self, what is self? Components of Self: self-identity, Identity crisis, Definition self-confidence, self-image, Johari Window, Self Esteem, High and Low Self-esteem, Erikson's model.	**4**
Unit 2	**Foundations of individual behaviour** Personality- structure, determinants, personality traits, Perception- Perceptual Process, Attribution, Errors in perception, Stereotyping, Racial Profiling, Learning- Theories of learning.	**4**
Unit 3	**Managing self** Time management: Introduction – the 80:20, sense of time management, Three secrets of time management, Effective scheduling, Stress management, effects of stress, kinds of stress-sources of stress, Signs of stress, Stress management tips.	**4**
Unit 4	**Behaviour and communication** Behaviour as a barrier to Communication, ways to overcome the barriers, Non-verbal communication-body language (voluntary and involuntary body language) forms of body language, Interpreting body language	**4**
	Total	**16**

Text books:

1) Soft skills by Dr K. Alex, S. Chand.
2) Organisational behaviour by S.P Robbins, Judge, Vohra 18th Ed.

B. Sc. (Honours) Course in Geology: Semester-II

Paper I Core Course	IGNEOUS PETROLOGY			Subject Code:
	L-T-P-C: 2-0-4-4	Credit Units: 4	Scheme of Evaluation: (T + P)	GEOL162C211

Course Objectives: Igneous Petrology is a course designed to provide an understanding of the origin, classification, textures, and mineralogy of igneous rocks. The course will cover the processes that lead to the formation of magmas, their emplacement and crystallization, and the resultant diversity of igneous rocks. The course will also explore the relationship between igneous processes and tectonic settings.

Course outcomes:

1. Remembering: Classify igneous rocks based on their mineralogy and textures.
2. Understanding: Describe the processes involved in the formation of magmas and their subsequent crystallization into igneous rocks. Explain the relationship between igneous processes and tectonic settings.
3. Applying: Analyse and interpret igneous rock suites using microscopic and macroscopic techniques.
4. Analysing: Evaluate the applications of igneous petrology in geologic exploration and mineral resource identification.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Introduction: Heat flow, geothermal gradient, Physical and chemical properties of magmas. Classification of igneous rocks. Textures and structures of igneous rocks. Mode of occurrence of Igneous rocks. Types of magma sources. Magma ascent and eruption. Crystallisation of Magma, Reaction Principle, Magmatic differentiation, Role of volatiles in magmatic differentiation. Plate tectonics and igneous rock formation. Igneous rocks and magma chambers.	12
Unit 2	Granite formation and composition. Continental rifting and flood basalts. Oceanic crust formation and composition. Mid-ocean ridges and seafloor spreading Types of volcanic eruptions. Volcanic hazards and monitoring Petrogenesis of Felsic and Mafic igneous rocks: Granitoids, Basalt, Gabbro, Alkaline rocks, peridotites and kimberlites.	12
Unit 3 Practical	Study of important igneous rocks in hand specimens (textural and mineralogical): granite, granodiorite, diorite, gabbro, anorthosites, ultramafic rocks, basalts, andesites, trachyte, rhyolite, dacite.	12
Unit 4 Practical	Study of important igneous rocks in thin sections (textural and mineralogical): granite, granodiorite, diorite, gabbro, anorthosites, ultramafic rocks, basalts, andesites, trachyte, rhyolite, dacite.	12
	Total	**48**

Text Books Suggested:

1. Principles of igneous and metamorphic petrology – A. Philpotts & J. Ague. (2009). Cambridge University Press.
2. Principles of igneous and metamorphic petrology – J. D. Winter (2014). Pearson

Reference Books:

1) Petrology: the study of igneous, sedimentary, and metamorphic rocks. L. A. Raymond, (2002). McGraw-Hill Science Engineering
2) Igneous and Metamorphic Petrology - Myron G. Best (2001).
3) Principles of Petrology – G. W. Tyrrell. (1926). Springer

Paper II Core Course	METAMORPHIC PETROLOGY			Subject Code:
	L-T-P-C: 2-0-4-4	Credit Units: 4	Scheme of Evaluation: (T + P)	GEOL162C212

Course Objectives: This course provides an in-depth understanding of the origin, classification, and petrological properties of metamorphic rocks. Students will learn about the various metamorphic processes, including the role of fluids and deformation, and how these processes influence mineral assemblages and textures. The course also covers the use of metamorphic petrology in understanding the tectonic and thermal history of a region.

Course outcomes:

1. Remembering: Describe the classification and nomenclature of metamorphic rocks.
2. Understanding: Identify and interpret the mineral assemblages and textures of metamorphic rocks, and explain their significance.
3. Applying: Apply knowledge of metamorphic processes and petrographic techniques to identify and interpret metamorphic rocks and their evolution.
4. Analysing: Analyse the factors that control the metamorphic process, including pressure, temperature, fluids, and deformation.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Metamorphism:** Definition of metamorphism. Factors controlling metamorphism. Types of metamorphism - contact metamorphism, regional metamorphism, fault zone metamorphism, impact metamorphism. Index minerals, Chemographic projections. Metamorphic zones and isograde. Concept of metamorphic facies and grade	12
Unit 2	**Metamorphism and Tectonism & Petrogenesis** Relationship between metamorphism and deformation. Structure and textures of metamorphic rocks. Metamorphic mineral reactions (prograde and retrograde). Migmatites and their origin. Metasomatism and role of fluids in metamorphism. Petrogenesis of metamorphic rock associations- schists, gneisses, khondalites, charnockites, blue schists and eclogites.	12
Unit 3 Practical	**Hand Specimen study (textural and mineralogical) of the following metamorphic rocks:** Low grade metamorphic rocks: serpentinites, albite-epidote-chloritequartz schist, slate, talc-tremolite, calcite-quartz schist. Medium to high grade metamorphic rocks: Gneisses, amphibolite, hornfels, garnetiferous schists, sillimanite-kyanite-bearing rocks, Granulites, eclogite, diopside-forsterite marble. Laboratory exercises in graphic plots for petrochemistry and interpretation of assemblages.	12
Unit 4 Practical	**Microscopic study (textural and mineralogical) of the following metamorphic rocks:** Low grade metamorphic rocks: serpentinites, albite-epidote-chloritequartz schist, slate, talc-tremolite, calcite-quartz schist. Medium to high grade metamorphic rocks: Gneisses, amphibolite, hornfels, garnetiferous schists, sillimanite-kyanite-bearing rocks, Granulites, eclogite, diopside-forsterite marble.	12
	Total	**48**

Text Books Suggested:

1. Principles of igneous and metamorphic petrology – A. Philpotts & J. Ague. (2009). Cambridge University Press.
2. Principles of igneous and metamorphic petrology – J. D. Winter (2014). Pearson

Reference Books:

1) Petrology: the study of igneous, sedimentary, and metamorphic rocks. L. A. Raymond, (2002). McGraw-Hill Science Engineering
2) Igneous and Metamorphic Petrology - Myron G. Best (2001).

Paper III Core Course	GEOCHEMISTRY			Subject Code:
	L-T-P-C: 2-0-4-4	Credit Units: 4	Scheme of Evaluation: (T + P)	GEOL162C213

Course Objectives: Geochemistry is the study of the chemical composition, structure, and processes of the Earth and other planets. This course covers the fundamentals of geochemistry, including the principles of thermodynamics, kinetics, isotope geochemistry, and major and trace element geochemistry.

Course Outcomes:

1. Remembering: Recall the basic concepts of geochemistry, including thermodynamics, kinetics, and isotope geochemistry.
2. Understanding: Understand the principles of major and trace element geochemistry and their applications in geological systems.
3. Applying: Apply geochemical methods to investigate geological processes and solve geological problems.
4. Analysing: Analyse geochemical data using appropriate statistical and graphical techniques.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Concepts of Geochemistry** Introduction to properties of elements: The periodic table, atomic environment of elements, Geochemical classification of elements. Concepts of geochemical cycles and mass balance. Aqueous geochemistry- basic concepts and speciation in solutions, Eh-pH relations Elements of marine chemistry Mineral reactions- diagenesis and hydrothermal reactions. Geochemical behaviour of selected elements like Si, Al, K, Na etc.	12
Unit 2	**Layered structure of Earth and Geochemistry** Chemical differentiation and Composition of the Earth (Continental crust, Oceanic crust, depleted mantle, enriched mantle and core). Conservation of mass, isotopic and elemental fractionation Concept of radioactivity and its application in geochronology The solid Earth – geochemical variability of magma and its products. Composition of the bulk silicate Earth. Meteorites. Cosmic abundance of elements	12
Unit 3 Practical	Types of geochemical data analysis and interpretation of common geochemical plots. Norm calculation of silica saturated igneous rocks. Graphical plots of metamorphic mineral assemblages using chemographic diagrams (ACF and AKF) in greenschist and amphibolite facies	12
Unit 4 Practical	Geochemical variation diagrams and its interpretations (bivariate and trivariate plots to delineate the control of different compositional variables): Harker variation diagram, AFM diagram, MgO diagram.	12
	Total	**48**

Text Books:

1) Geochemistry – W. M. White, (2013), Wiley-Blackwell Publishing.
2) Introduction to Geochemistry: Principles and Applications - Kula C. Misra, (2012), Wiley-Blackwell Publishing.

Reference Books:

1) Principles of Geochemistry - Mason, B., (3rd Edition, 1986), Wiley New York.
2) Essentials of geochemistry - Walther, J. V. (2009), Jones & Bartlett Publishers.
3) Geochemistry in Mineral Exploration – Haweks, H.E., Webb, J. S.
4) Geochemistry: An Introduction - Albarède, F. (2003), Cambridge University Press.
5) Isotopes: Principles and Applications - Faure, Gunter and Teresa M. Mensing (2004), Wiley India Pvt. Ltd.

Paper IV SEC	FIELD GEOLOGY - II			Subject Code:
	L-T-P-C: 0-0-4-2	Credit Units: 2	Scheme of Evaluation: (P)	GEOL162S211

Course Objectives: This course is designed to provide students with hands-on experience in geologic field methods and techniques. Topics covered will include geologic mapping, structural geology, stratigraphy, and palaeontology. Students will participate in field trips to local geologic sites and will be required to prepare geologic maps and reports.

Course Outcomes:

1. Remembering: Students will be able to recall and recognize the key concepts, principles, and facts related to geologic field methods and techniques.
2. Understanding: Students will be able to explain the fundamental principles and processes of geologic field methods and techniques, including geologic mapping, structural geology, stratigraphy, and palaeontology.
3. Applying: Students will be able to apply geologic field methods and techniques to collect, record, and interpret geologic data from field sites.
4. Analysing: Students will be able to analyse geologic field data to identify geologic structures, interpret stratigraphic relationships, and reconstruct geologic histories.
5. Evaluating: Students will be able to evaluate the quality and reliability of geologic data collected in the field, and assess the strengths and weaknesses of different field techniques and methods.
6. Creating: Students will be able to design and execute a geologic field project, including developing hypotheses, collecting and analysing data, and presenting findings.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Geological mapping.	6
Unit 2	Primary (scalars and vectors) and secondary structures (linear and planar)	6
Unit 3	Trend, plunge, Rake/Pitch	6
Unit 4	Stereoplots of linear and planar structures, Orientation analyses	6
	Total	**24**

Text Books Suggested:

1) Guide to Field Geology – S. M. Mathur, PHI Publications
2) Field Geology – F. H. Lahee, CBS Publishers and Distributors Pvt Ltd; Sixth Edition (2002)

Reference books:

1) Manual of Field Geology – Robert R. Compton; John Wiley & Sons.
2) Basic Methods of Structural Geology – Stephen Marshak & Gautam Mitra; Pearson Publication.

Paper: GE 3 Generic Elective	Rocks and Minerals			Subject Code:
	L-T-P-C: 3-0-0-3	Credit Units: 3	Scheme of Evaluation: (T)	GEOL162G201

Course Objectives: This course is designed to provide students with a comprehensive understanding of rocks and minerals, including their classification, properties, formation, and distribution on Earth. The course will cover topics such as mineral identification, crystallography, petrography, and the geological processes that shape rocks and minerals.

Course Outcomes:

1. Remembering: Students will be able to recall the basic concepts and terminology of rocks and minerals, including their classification and properties.
2. Understanding: Students will be able to explain the formation and geological processes that shape rocks and minerals.
3. Applying: Students will be able to apply their knowledge of rocks and minerals to identify different types of minerals and rocks in hand samples and thin sections.
4. Analysing: Students will be able to analyse the textures and structures of rocks and minerals using various techniques, such as petrographic microscopy.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Minerals-Definitions, Physical properties of minerals. Mineral structures Mineralogy of the Earth's crust, mantle and core	6
Unit 2	Principles of optical mineralogy: Polarised light, Double-refraction, Petrographical microscope. Optical behaviour of minerals. Optical classification of minerals: Isotropy and Anisotropy. Uniaxial and Biaxial minerals.	6
Unit 3	Rocks- Definitions and types. Igneous rock- magma generation, differentiation and crystallisation. Sedimentary rocks- processes of formation. Clastic and non-clastic sedimentary rocks.	6
Unit 4	Metamorphic rocks- types of metamorphism. Rock cycle-interactions between plate tectonics and climate systems Age of the earth: Radioactivity and its application in determining the age of the Earth, rocks, minerals and fossils.	6
	Total	**24**

Text Books suggested:

1) Textbook of Geology – P. K. Mukherjee; World Press Pvt. Ltd.
2) A Textbook of Geology – G. B. Mahapatra; CBS publishers

Reference Books:

1) Klein, C., Dutrow, B., Dwight, J., & Klein, C. (2007). The 23rd Edition of the Manual of Mineral Science (after James D. Dana). J. Wiley & Sons.
2) Introduction to Physical Geology – Thompson & Turk
3) Essentials of Geology - Stephen Marshak, 4th edition, W. W. Norton & Company

Paper: GE 4 Generic Elective	EARTH SCIENCES	Subject Code:
	L-T-P-C: 3-0-0-3 Credit Units: 3 Scheme of Evaluation: (T)	GEOL162G202

Course Objectives: This course provides a broad overview of the interdisciplinary field of Earth Sciences, which encompasses geology, meteorology, oceanography, and astronomy. Students will explore the processes that shape the Earth's surface, the dynamics of the Earth's atmosphere and oceans, and the formation and evolution of the solar system. The course will introduce students to the methods and tools used in Earth Science research and the interdisciplinary nature of the field.

Course Outcomes:

1. Remembering: Students will recall and identify the major components and processes of the Earth system and the principles of plate tectonics.
2. Understanding: Students will describe and explain the relationships between the Earth's systems, including the effects of human activities on the Earth's environment.
3. Applying: Students will apply their knowledge of Earth Science to analyse and interpret maps and geospatial data.
4. Analysing: Students will evaluate the dynamics of the Earth's atmosphere and oceans and the impact of climate change on the Earth's systems.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Geodynamics** Dynamics of lithosphere: Plate Tectonic Theory Origin of oceans, continents and mountains. Origin of Himalaya. Concept of Mobile belts, cratons and shield.	9
Unit 2	**Geomorphology in Engineering practices** Denudation: weathering, erosion and mass wasting. Processes and landforms associated with river. Issues of urbanization: Hill slope stability, River bank stability. Flood control, Siltation, Construction of dam	9
Unit 3	**Fuel Geology** Origin of coal and petroleum, Basic classification of coal. Migration of Petroleum. Source and Reservoir rocks, Hydrocarbon Traps. Occurrence of Coal and Petroleum in NE India. Introductory concepts of Shale gas, Coal Bed Methane, Geothermal Energy. Nuclear Fuels.	9
Unit 4	**Hydrogeology** Hydrologic cycle. Groundwater and its vertical distribution. Brief idea of aquifers. Introductory idea of Groundwater exploration (resistivity method). Groundwater recharging. Groundwater uses and problems related to groundwater exploitation. Groundwater pollution and associated problems.	9
	Total	**36**

Text Books Suggested:

1) Essentials of Geology - Stephen Marshak, 4th edition, W. W. Norton & Company
2) Introduction to Physical Geology – Thompson & Turk

Reference Books:

1) Todd, D. K. 2006. Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.
2) Textbook of Geology – P. K. Mukherjee; World Press Pvt. Ltd.

Paper: AECC 3	Communicative English - II: Conversation and Public Speaking L-T-P-C: 1-0-0-1 Credit Units: 1	Subject Code: CEN982A201

Scheme of Evaluation: Theory + Viva-Voce + Extempore Speech
Continuous Evaluation: 30 Marks
Semester End Examination: Component A – Theory (30 Marks)
Component B + C – Viva-Voce + Extempore speech (40 Marks)

Course Objectives:
The objective of the course is to give students a platform to enhance their speaking and conversational skills in English by engaging them in meaningful discussions and interactive activities.

Course Outcomes:
After the completion of course, students will be expected to:

- Improve speaking skill.
- Develop a life skill on conversation.
- Improve the skill of public speaking.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Speaking Skills** Speaking – The Art of Speaking, Goals, Speaking Styles, The Speaking Process Importance of Oral Communication, Choosing the form of Communication, Principles & Guidelines of Successful Oral Communication, Barriers to Effective Oral Communication Three aspects of Oral Communication – Conversing, Listening and Body Language Intercultural Oral Communication	**4**
Unit 2	**Conversational Skills: Listening and Persuasive Speaking** Conversation – Types of Conversation, Strategies for Effectiveness, Conversation Practice, Persuasive Functions in Conversation, Telephonic Conversation and Etiquette Dialogue Writing, Conversation Control	**4**
Unit 3	**Transactional Analysis** The Role of Intonation, Strokes, Psychological Characteristics of Ego States (The Parent, The Adult, The Child), Structure and Aspects of Human Personality Analysing Transactions – Complementary Transactions, Crossed Transactions, Duplex or Ulterior Transactions, How to Identify the Ego States of Interacting Individuals, How to Manage Conversations, Structural Analysis, Certain Habits of Ineffective Conversationalists	**4**
Unit 4	**Public Speaking** Business Presentation and Speeches – Difference Elements of a Good Speech – Planning, Occasion, Audience, Purpose, Thesis, Material Organising and Outlining a Speech Outline, Types of Delivery Guidelines for Delivery – Verbal Elements, Non-Verbal Elements, Vocal Elements, Visual Elements, Controlling Nervousness and Stage Fright	**4**
	Total	**16**

Text/Reference books:

1) Mehra, Payal. (2012). Business Communication for Managers: Dorling Kindersley (India) Pvt. Ltd. Page 75 – 83. ISBN 978-81-317-5865-6
2) Raman, Meenakshi and Singh, Prakash. (2012). Business Communication (2nd Edition): Oxford University Press. Page 123 – 165.ISBN-13:978-0-19-807705-03
3) Raman, Meenakshi and Sharma, Sangeeta. (2011). Technical Communication: Principles and Practice (2nd Edition): Oxford University Press. Page 137 – 148 ISBN-13:978-0-19-806529-6
4) Sengupta, Sailesh. (2011) Business and Managerial Communication. New Delhi: PHI Learning Pvt. Ltd. Page 136-153.ISBN-978-81-203-4435-8

Paper: AECC 4	Behavioural Science - I L-T-P-C: 1-0-0-1 Credit Units: 1	Subject Code: BHS982A202

Scheme of Evaluation: Theory + Viva-Voce + Extempore Speech
Continuous Evaluation: 30 Marks
Semester End Examination: Component A – Theory (30 Marks)
Component B + C – Viva-Voce + Extempore speech (40 Marks)

Course Objectives:
To increase one's ability to draw conclusions and develop inferences about attitudes and behaviour, when confronted with different situations that are common in modern organizations

Course Outcomes:
After the completion of course, students will be expected to:

- Understand culture and personality
- Understand Value.
- Demonstrate leadership.
- Develop a life skill on motivation

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Culture and Personality** Relation Between Culture and Personality with Relevant Examples, Cultural Iceberg, Overview of Hofstede's Framework, Discussion of the four dimensions of Hofstede's Framework.	**4**
Unit 2	**Attitudes and Values** Attitude's definition: changing our own attitudes, Process of cognitive dissonance Types of Values, Value conflicts, Merging personal and Organisational values, changes of values with time, male & female values differences.	**4**
Unit 3	**Leadership** Definition of leadership, types of leadership, Leadership Continuum, Transformational & transactional Leadership, Ethical Leadership.	**4**
Unit 4	**Motivation** Definition of motivation with example, Theories of Motivation (Maslow & X and Y) Applications of motivation.	**4**
	Total	**16**

Text books:

1) Organizational Behaviour by Kavita Singh (Vikas publishers, 3rd Edition).
2) Organisational behaviour by S.P Robbins, Judge, Vohra 18th Ed.

B. Sc. (Honours) Course in Geology: Semester-III

Paper I Core Course	SEDIMENTOLOGY			Subject Code:
	L-T-P-C: 2-0-4-4	Credit Units: 4	Scheme of Evaluation: (T + P)	GEOL162C311

Course Objectives: This course will focus on the processes of sedimentation, the diagenesis of sediments, and the properties and classification of sedimentary rocks. Topics covered will include sedimentary environments, depositional processes, sedimentary structures, mineralogy, texture, and sedimentary rock classification. The course will also cover the interpretation of sedimentary rocks in terms of paleoenvironmental and paleoclimatic conditions.

Course outcomes:

1. Remembering: Students will be able to recall and recognize the key concepts, principles, and facts related to sedimentary petrology.
2. Understanding: Students will be able to explain the processes of sedimentation, diagenesis, and lithification that result in the formation of sedimentary rocks.
3. Applying: Students will be able to apply the principles and concepts of sedimentary petrology to analyze and interpret the origin, composition, and classification of sedimentary rocks.
4. Analysing: Students will be able to analyse sedimentary rocks in terms of their texture, mineralogy, sedimentary structures, and depositional environments.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Weathering and sedimentary flux: Physical and chemical weathering. Sedimentary texture: size, shape, roundness, sphericity, fabric, packing. Concepts of diagenesis, Stages of diagenesis, Compaction and cementation. Textural classification of sediments and sedimentary rocks. Sediment dynamics: Nature of fluid flow – Laminar vs. turbulent flow, concept of flow regime and sediment transport. Sedimentary structures – bedforms and internal stratification.	12
Unit 2	Concept of sedimentary facies. Depositional features associated with fluvial, marine, desert, glacial and lacustrine environments (textural properties and structures). Concept of Paleocurrent analysis. Mineralogical classification of sediments and sedimentary rocks (clastics and non-clastics). Geochemical fence.	12
Unit 3 Practical	Grain size analysis of sediments (sieve and pipette method) Determination of roundness and sphericity of sediment grains. Study of sedimentary structures in hand specimens/peel specimens. Paleocurrent analysis.	12
Unit 4 Practical	Petrography of clastic and non-clastic rocks through hand specimens. Petrography of clastic and non-clastic rocks through thin sections. Heavy mineral study.	12
	Total	**48**

Text Books Suggested:

1) Introduction to Sedimentology – S. M. Sengupta, (2018), CBS.
2) Depositional Sedimentary Environments - Reineck and Singh, (1980), Springer – Verlag.

Reference Books:

1) Sedimentology and Stratigraphy - Nichols, G. (2009), Second Edition. Wiley Blackwell.
2) Sedimentary Rocks – F. J. Pettijohn.
3) Sedimentary Petrology – Tucker, M. E. (2006), Blackwell Publishing.
4) Petrology of Sedimentary Rocks – Sam Boggs, (2nd edition, 2009), Cambridge University Press, New York.

Paper II Core Course	PALAEONTOLOGY			Subject Code:
	L-T-P-C: 4-0-0-4	Credit Units: 4	Scheme of Evaluation: (T + P)	GEOL162C312

Course Objectives: Palaeontology is the study of ancient life, focusing on the evolution, diversity, and extinction of organisms over geological time. This course will cover the history and methods of palaeontological research, the principles of evolutionary biology, and the study of fossils as evidence of past life. Topics covered will include the origin and evolution of life, major extinction events, the use of fossils in stratigraphy, and the interpretation of the ecological and biogeographic contexts of ancient ecosystems.

Course outcomes:

1. Remembering: Students will be able to recall and recognize the key concepts, principles, and facts related to the study of palaeontology.
2. Understanding: Students will be able to explain the principles of evolutionary biology and the methods used in palaeontological research.
3. Applying: Students will be able to apply palaeontological principles to identify, describe, and interpret the significance of fossils in the context of past life and environments.
4. Analysing: Students will be able to analyse the morphology, diversity, and distribution of fossil organisms and their significance in the evolutionary history of life.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Nature and importance of fossil record; Fossilization processes and modes of preservation. Types of fossils (body fossils, trace fossils, leaked fossils, etc.), Importance of Index fossils. Theory of organic evolution as interpreted from fossil record. Speciation, Taxonomic hierarchy. Introduction to Palaeobotany and Ichnology.	12
Unit 2	Brief introduction to important invertebrate groups (Bivalvia, Gastropoda, Brachiopoda, Cephalopoda, Foraminifera) and their biostratigraphic significance. Brief introduction to vertebrate palaeontology (Hominidae, Equidae, Proboscidae, reptiles).	12
Unit 3	Identification of fossils in hand specimens. Derivation of evolutionary trend in a given set of fossils. Identification of fossil assemblages and their stratigraphic horizon.	12
Unit 4	Identification of micro-fossils with the help of microscope. Exercises related to fossil spores and pollens.	12
	Total	**48**

Text Books Suggested:

1) An Introduction to Palaeontology – Amal Dasgupta, The World Press Private Limited.
2) Palaeontology: (Palaeobiology) Evolution and Animal Distribution – P.C. Jain, M.S. Anantharaman, Vishal Publishing Co.

Reference Books:

1) Introduction to Paleobiology and the Fossil Record – Michael J. Benton, David A. T. Harper, and Robert L. Carroll, 2nd edition, 2013 by Wiley-Blackwell.
2) Principles of Paleontology - D. M. Raup & S. M. Stanley. W. H. Freeman (1971).
3) Fossils in Earth Sciences – Anis Ray.

Paper III DSE Course	GEOMORPHOLOGY			Subject Code:
	L-T-P-C: 2-0-4-4	Credit Units: 4	Scheme of Evaluation: (T + P)	GEOL162D311

Course Objectives: Geomorphology is the study of landforms, their processes, and the evolution of the Earth's surface. This course will explore the fundamental principles and processes of geomorphology, including the study of landforms and their origin, the mechanics of surface processes, and the impact of climate, tectonics, and human activity on landform evolution.

Course outcomes:

1. Remembering: Students will be able to recall and recognize the key concepts, principles, and facts related to the study of geomorphology.
2. Understanding: Students will be able to explain the fundamental principles and processes of geomorphology, including the origin and evolution of landforms and the mechanics of surface processes.
3. Applying: Students will be able to apply geomorphological principles to analyze and interpret the formation of landforms, including mountain ranges, rivers, glaciers, and coastlines.
4. Analysing: Students will be able to analyse the impact of climate, tectonics, and human activity on landform evolution, and evaluate the interactions between these factors.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Introduction to Geomorphology** Introduction to Geomorphology; concept of base level and datum, Topography, Hypsometry; Major Morphological features of earth; Large Scale Topography: Ocean basins, large scale mountain ranges (with emphasis on Himalaya). Surficial processes and geomorphology; weathering, erosion, mass-wasting and their types.	12
Unit 2	**Landforms** Landforms produced by – glacial and periglacial processes, fluvial processes, aeolian processes, coastal processes. Landforms associated with igneous activities. Endogenic – Exogenic processes of earth and their interactions, Rates of uplift and denudation, Tectonics and drainage development, Sea-level change. Models of long-term landscape development. Overview of Indian Geomorphology.	12
Unit 3 Practical	Interpretation of geomorphic processes from the geomorphology of the area (with the help of geomorphic models) Preparation of longitudinal profile of a river Calculation of Stream length gradient index	12
Unit 4 Practical	Understanding active tectonism with the help of different morphometric parameters. Estimation of incision deficit, rate of sedimentation and erosion, sediment rating curve.	12
	Total	**48**

Text Books Suggested:

1) Fundamentals of Geomorphology - Richard John Huggett, (4th edition, 2016), Routledge.
2) Introduction to Geomorphology - Frank Ahnert, (1st edition, 29 May 1998), Routledge.

Reference Books:

1) Fundamentals of Fluvial Geomorphology: Charton, R.,2007.
2) River Morphology: Grade, R.J.,2006.
3) Geomorphological Techniques: Gaudie, A.,1990.
4) Geomorphology; Longman Scientific & Technical: Spark, B.W.,1986.

Paper IV DSE Course	RIVER SCIENCE			Subject Code:
	L-T-P-C: 4-0-0-4	Credit Units: 4	Scheme of Evaluation: (T)	GEOL162D302

Course Objectives: River Science is an interdisciplinary field of study that focuses on the physical, chemical, and biological processes that govern the behaviour of rivers and streams. This course will introduce students to the fundamental principles of River Science, including the study of water flow, sediment transport, river morphology, and ecology. Students will learn how to use field and laboratory techniques to collect and analyse data, and will gain an understanding of the role of rivers in shaping landscapes and ecosystems.

Course outcomes:

1. Remembering: Students will be able to recall and recognize the key concepts, principles, and facts related to River Science, including the properties of water, sediment, and river channels.
2. Understanding: Students will be able to explain the fundamental principles of River Science, including water flow, sediment transport, river morphology, and ecology.
3. Applying: Students will be able to apply River Science principles to analyse and interpret data from field and laboratory experiments, and to design and conduct their own research projects.
4. Analysing: Students will be able to analyse the interactions between physical, chemical, and biological processes in river ecosystems, and evaluate the impact of human activities on these processes.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Stream hydrology and River basin** Basic stream hydrology, Physical properties of water, sediment and channel flow. River discharge, River hydrographs (UH, IUH, SUH, GIUH) and its application in hydrological analysis. Flood frequency analysis. Sediment source and catchment erosion processes, Sediment load and sediment yield, Sediment transport processes in rivers, Erosion and sedimentation processes in channel.	12
Unit 2	**Drainage** Drainage network, Quantitative analysis of network organization – morphometry. Random Topology (RT) model and fractal analysis. Role of drainage network in flux transfer. Evolution of drainage network in geological time scale.	12
Unit 3	**Rivers in time and space** River diversity in space, Patterns of alluvial rivers - braided, meandering and anabranching channels, Dynamics of alluvial rivers. Channel patterns in stratigraphic sequences. Different classification approaches in fluvial geomorphology and its applications.	12
Unit 4	**Channels and Landscapes** Bedrock channels, Bedrock incision process River response to climate, tectonics and human disturbance Bedrock channel processes and evolution of fluvial landscapes. Fluvial hazards: Integrated approach to stream management, Introduction to river ecology.	12
	Total	**48**

Text Books Suggested:

1) Davies, T. (2008) Fundamentals of hydrology. Routledge Publications.
2) Knighton, D. (1998) Fluvial forms and processes: A new perspective. Amold Pubs.
3) Richards. K. (2004) Rivers: Forms and processes in alluvial channels. Balckburn Press.

Reference Books:

1) Bryirely and Fryirs (2005) Geomorphology and river management. Blackwell Pub.,
2) Julien, P.Y. (2002) River Mechanics. Cambridge University Press.
3) Robert, A. (2003) River Processes: An introduction to fluvial dynamics. Arnold Publications.
4) Tinkler, K.J., Wohl, E.E. (eds.) 1998. Rivers over rock. American Geophyscial Union Monograph, Washington, DC.
5) Spellman Frank, R.,2008: The Science of Water; Concept and Applications, 2nd edn., Taylor & Francis Group.

Paper V	PROJECT			Subject Code:
	L-T-P-C: 0-0-0-4	Credit Units: 4	Scheme of Evaluation: (P)	GEOL162C321

Course Objectives: This course is designed to provide students with hands-on experience in geologic field methods and techniques. Topics covered will include geologic mapping, structural geology, stratigraphy, and palaeontology. Students will participate in field trips to local geologic sites and will be required to prepare geologic maps and reports.

Course Outcomes:

1. Remembering: Students will be able to recall and recognize the key concepts, principles, and facts related to geologic field methods and techniques.
2. Understanding: Students will be able to explain the fundamental principles and processes of geologic field methods and techniques, including geologic mapping, structural geology, stratigraphy, and palaeontology.
3. Applying: Students will be able to apply geologic field methods and techniques to collect, record, and interpret geologic data from field sites.
4. Analysing: Students will be able to analyse geologic field data to identify geologic structures, interpret stratigraphic relationships, and reconstruct geologic histories.
5. Evaluating: Students will be able to evaluate the quality and reliability of geologic data collected in the field, and assess the strengths and weaknesses of different field techniques and methods.
6. Creating: Students will be able to design and execute a geologic field project, including developing hypotheses, collecting and analysing data, and presenting findings.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Collection and preparation of litho-log from sedimentary terrain. Interpretation of the sedimentary sequence from litho-log.	6
Unit 2	Techniques of collection of sedimentary samples.	6
Unit 3	Fossils sampling techniques from field. Extraction of fossils and preparation of slides.	6
Unit 4	Field visit to sedimentary terrain (with probable fossil record). Oil field visit.	6
	Total	**24**

Text Books Suggested:

1) Guide to Field Geology – S. M. Mathur, PHI Publications
2) Field Geology – F. H. Lahee, CBS Publishers and Distributors Pvt Ltd; Sixth Edition (2002)

Reference books:

1) Manual of Field Geology – Robert R. Compton; John Wiley & Sons.
2) Basic Methods of Structural Geology – Stephen Marshak & Gautam Mitra; Pearson Publication.
3) "Geologic Field Techniques" by Maurice E. Tucker and Christopher R. Barnes, published by Wiley-Blackwell.
4) "Structural Geology: An Introduction to Geometrical Techniques" by Donal M. Ragan, published by Cambridge University Press.
5) "Stratigraphy: Principles and Methods" by Alan M. R. Cook and Bas van de Schootbrugge, published by Wiley-Blackwell.
6) "Fossils: The Key to the Past" by Richard A. Fortey, published by Harvard University Press.
7) "Geological Field Guide" edited by David R. Bridgland, published by Wiley-Blackwell.

B. Sc. (Generic Elective) Course in Geology: Semester-III

Paper: GE 5 Generic Elective	PHYSICS AND CHEMISTRY OF EARTH			Subject Code:
	L-T-P-C: 3-0-0-3	Credit Units: 3	Scheme of Evaluation: (T)	GEOL162G301

Course Objectives: This course explores the fundamental principles of physics and chemistry that govern Earth's geologic processes. Topics covered will include thermodynamics, mineralogy, geochemistry, and geophysics. Students will develop an understanding of the physical and chemical properties of Earth materials and their role in shaping Earth's structure, composition, and evolution.

Course Outcomes:

1. Remembering: Students will be able to recall and recognize the key concepts, principles, and facts related to the physics and chemistry of Earth.
2. Understanding: Students will be able to explain the fundamental principles and processes of physics and chemistry that govern Earth's geologic processes.
3. Applying: Students will be able to apply physical and chemical principles to analyze geologic data and solve problems related to Earth's structure, composition, and evolution.
4. Analyzing: Students will be able to analyze geologic data to interpret the physical and chemical properties of Earth materials, and to evaluate the role of these materials in shaping Earth's geologic history.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Earth's surface features: Continents, continental margins, oceans Earth's interior - variation of physical quantities and seismic wave velocity inside the earth, major sub divisions and discontinuities. Core: Seismological and other geophysical constraints Convection in the mantle	6
Unit 2	Elements of earth's magnetism: Convections in the earth's core and production of magnetic field Secular variation and westward drift Solar activity and magnetic disturbance	6
Unit 3	Elements: Origin of elements/nucleosynthesis. Abundance of the elements in the solar system / planet earth Geochemical classification of elements. Earth accretion and early differentiation	6
Unit 4	Isotopes and their applications in understanding Earth processes. Stable isotopes: Stable isotope fractionation. Oxygen isotopes Sublithospheric Mantle (Mineralogy/phase transitions)	6
	Total	**24**

Text books:

1) Holmes, A., Principles of Physical Geology, 1992, Chapman and Hall
2) Condie, K.C. Plate Tectonics and Crustal Evolution, Pargamon Press, 1989.
3) Krauskopf, K. B., & Dennis, K. Bird, 1995, Introduction to Geochemistry. McGraw-Hill

Reference books:

1) Faure, G. Principles and Applications of Geochemistry, 2/e (1998), Prentice Hall, 600 pp.
2) Anderson, G. M. (1996). Thermodynamics of natural systems. John Wiley & Sons Inc.
3) Steiner, E. (2008). The chemistry maths book. Oxford University Press.
4) Yates, P. (2007) Chemical calculations. 2nd Ed. CRC Press.

Paper: GE 6 Generic Elective	Fundamentals of Geology			Subject Code:
	L-T-P-C: 3-0-0-3	Credit Units: 3	Scheme of Evaluation: (T)	GEOL162G102

Course Objectives: This course introduces students to the fundamental concepts and principles of geology. Topics covered will include the structure and composition of Earth, plate tectonics, Earth's history, minerals and rocks, natural hazards, and the environment. Students will develop an understanding of the processes that shape Earth's surface and subsurface, and the role of geology in society and the environment.

Course Outcomes:

1. Remembering: Students will be able to recall and recognize the basic concepts, principles, and terminology of geology.
2. Understanding: Students will be able to explain the fundamental processes and phenomena that shape Earth's surface and subsurface, and the role of geology in society and the environment.
3. Applying: Students will be able to apply geologic principles and concepts to analyze and solve problems related to Earth's structure, composition, and history.
4. Analyzing: Students will be able to analyze geologic data to interpret the physical and chemical properties of Earth materials, and to evaluate the role of these materials in shaping Earth's geologic history.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Physical Geology** Earth as a planet, Exogenous and Endogenous processes and their associated landforms. Earthquake and Volcanism, Introduction to the interior of the earth.	6
Unit 2	**Minerals and Rocks** Introduction to minerals, Crystallisation of minerals. Brief idea of the mineral groups. Introduction to rocks and their types. Origin of Igneous, Sedimentary and Metamorphic rocks.	6
Unit 3	**Stratigraphy** Introduction to the Standard stratigraphic time scale, Global Stratotype Section and Point. Laws of superposition and faunal succession. Concept of uniformitarianism. Unconformity and its types, recognition of unconformity.	6
Unit 4	**Fossils** Definition of fossil, modes of fossil preservation. Role of fossils in development of geological time scale. Brief introduction to various fossils groups. Introduction to micro-palaeontology.	6
	Total	**24**

Text books:

1) Essentials of Geology - Stephen Marshak, 4th edition, W. W. Norton & Company
2) Principles of Engineering Geology by K.M. Bangar

Reference books:

1) Manual of Mineral Science (after James D. Dana) – Klein, C., Dutrow, B., Dwight, J., & Klein, C. (2007), 23rd Edition.
2) Introduction to Physical Geology – Thompson & Turk
3) A Textbook of Geology – G. B. Mahapatra; CBS publishers.

B. Sc. (Honours) Course in Geology: Semester-IV

Paper I Core Course	PRINCIPLES OF STRATIGRAPHY			Subject Code:
	L-T-P-C: 2-0-4-4	Credit Units: 4	Scheme of Evaluation: (T + P)	GEOL162C441

Course Objectives: This course provides an introduction to the fundamental principles and concepts of stratigraphy. Students will learn about the methods and techniques used to study and interpret the layers of rocks that make up Earth's crust, including the principles of relative and absolute dating, correlation, and stratigraphic nomenclature. The course will also cover the major events and processes that have shaped Earth's geologic history, as recorded in the rock record.

Course outcomes:

1. Remembering: Students will be able to recall and recognize the basic concepts, principles, and terminology of stratigraphy.
2. Understanding: Students will be able to explain the fundamental processes and phenomena that shape the rock record, and the principles and methods used to study and interpret stratigraphic data.
3. Applying: Students will be able to apply stratigraphic principles and techniques to analyse and interpret geologic data and to reconstruct the geologic history of a region.
4. Analysing: Students will be able to analyse the spatial and temporal relationships between rock units, and to evaluate the relative ages and depositional environments of these units.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	The scope and objectives of stratigraphy The major events and processes that have shaped Earth's geologic history The evolution of life on Earth and its relation to geologic events The geologic time scale and its subdivisions.	12
Unit 2	Concepts of Lithostratigraphy, Chrono-stratigraphy and Bio-stratigraphy. The principles and guidelines for stratigraphic nomenclature. Introductory concepts of sequence, chemo- and magneto-stratigraphy.	12
Unit 3	Concepts and methods of stratigraphic correlation. The use of biostratigraphy and chemo-stratigraphy in stratigraphic correlation. The Quaternary Period and its divisions, Neogene-Quaternary and Pleistocene-Holocene boundary, the Anthropocene.	12
Unit 4	Quaternary stratigraphy- oxygen isotope stratigraphy, magnetic stratigraphy – principles and application in Quaternary sequences (Indian examples), pedostratigraphy, soil profile and palaeosol, Quaternary records from marine and continental settings, event stratigraphy.	12
List of Practicals	Construction of geologic sections and interpretation of stratigraphy. Study of reconstruction of different Proterozoic supercontinents with time. Drawing of various paleogeographic maps of Precambrian and Phanerozoic time (Indian subcontinent). Study of geological map of India and identification of major Precambrian units. Study of geological map of India and identification of major Phanerozoic units. Study of rocks in hand specimens from various Indian stratigraphic horizons.	12
	Total	**60**

Text Books Suggested:

1. Stratigraphic Principles and Practices – J. M. Weller; Universal Book Stall, Delhi.
2. Principles of Sedimentology and Stratigraphy, by Sam Boggs, Jr., 4th Edition, Pearson Prentice Hall, 2006.

Reference Books:

1. Stratigraphy: Principles and Methods by Stanley, Steven M.
2. Stratigraphy: A Modern Synthesis by Sloss, L. L.
3. The Geologic Time Scale 2020 by Gradstein, Felix M.
4. Sedimentary Geology: An Introduction to Sedimentary Rocks and Stratigraphy by Prothero, Donald R.
5. Basic Concepts in Sedimentology and Stratigraphy by Nichols, Gary.

Paper II Core Course	INDIAN STRATIGRAPHY			Subject Code:
	L-T-P-C: 4-0-0-4	Credit Units: 4	Scheme of Evaluation: (T)	GEOL162C402

Course Objectives: This course is designed to provide an overview of the stratigraphic framework of India. It will cover the geological history of the Indian subcontinent, the different stratigraphic units, and their characteristics. The course will also discuss the tectonic and depositional history of India and its relationship with the surrounding regions.

Course outcomes:

1. Remember: Identify and recall the different stratigraphic units in India and their characteristics.
2. Understand: Explain the geologic history of the Indian subcontinent and the tectonic and depositional history of India and its relationship with the surrounding regions.
3. Apply: Apply the principles of stratigraphy in the interpretation of the geological history of India.
4. Analyse: Analyse the economic significance of the different stratigraphic units and interpret the depositional environments of the different stratigraphic units.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Brief introduction to the physiographic subdivisions of India. Introduction to Indian Shield and mobile belts. Geological and tectonic history of India. Introduction to Proterozoic basins of India.	12
Unit 2	Brief geology of Dharwar, Bastar, Singhbhum and Aravalli. Geology of Vindhyan and Cudappah basins of India. Palaeozoic Succession of Kashmir and its correlatives from Spiti and Zanskar. Stratigraphy, structure and sedimentation of Gondwana basins.	12
Unit 3	Mesozoic stratigraphy of India: a. Triassic successions of Spiti, b. Jurassic of Kutch, c. Cretaceous successions of Cauvery basin. Cenozoic stratigraphy of India: a. Siwalik successions, b. Assam-Arakan basins.	12
Unit 4	Volcanic provinces of India: Deccan Trap, Rajmahal Trap, Sylhet Trap, Abor Volcanics. Important Stratigraphic boundaries in India: a. Precambrian-Cambrian boundary b. Permian-Triassic boundary c. Cretaceous-Tertiary boundary Introduction to Quaternary Stratigraphy: Glacial and interglacial deposits, Fluvial and Aeolian sediments.	12
	Total	**48**

Text Books Suggested:

1. The Making of India – K. S. Valdiya, Macmillan India Pvt. Ltd. (2010)
2. Indian Stratigraphy by Srikant Das, Birbal Sahni Institute of Paleobotany (2018)

Reference Books:

1. Indian Geology: An Introduction by D. N. Wadia, Tata McGraw-Hill Education (2007)
2. Geology of India: A Review by N. C. Pant and B. P. Radhakrishna, Springer (2014)
3. Geology of India by V. P. Dimri, Springer (2020)
4. Geology of India (Vol. 1 & 2) – M. Ramakrishnan & R. Vaidyanadhan, Geological Society of India, Bangalore (2008).

Paper III DSE Course	EARTH AND CLIMATE			Subject Code:
	L-T-P-C: 4-0-0-4	Credit Units: 4	Scheme of Evaluation: (T)	GEOL162D401

Course Objectives: This course aims to provide students with an understanding of the Earth's climate system, including its components, interactions, and variability over different time scales. The course will cover the basic principles of atmospheric science, oceanography, and paleoclimate, and their applications in climate modelling, climate change, and environmental issues.

Course outcomes:

1. Remember: Students should be able to recall the basic concepts and terminology used in Earth and Climate science, including atmospheric and oceanic circulation, radiative forcing, greenhouse gases, and climate proxies.
2. Understand: Students should be able to explain the fundamental physical and chemical processes that govern the Earth's climate system, including energy balance, feedback mechanisms, and climate variability.
3. Apply: Students should be able to apply their knowledge of Earth and Climate science to analyse and interpret climate data, and to evaluate the scientific evidence for climate change and its impacts on natural and human systems.
4. Analyse: Students should be able to analyse the complexity and uncertainty of climate science, including the role of natural and anthropogenic factors in climate change, and the challenges of climate prediction and mitigation.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Definition of climate and climate system Historical perspectives on climate science Scientific methods and tools for climate research Components of climate system Basic concepts of Forcing and Response of Climate system	12
Unit 2	Incoming solar radiation and its variability Receipt and storage of heat. Heat transformation Earth’s heat budget. Interactions amongst various sources of earth’s heat. Land-ocean-atmosphere interactions and feedbacks	12
Unit 3	Atmospheric structure and composition, Greenhouse effect Oceanic circulation and heat transport El Niño-Southern Oscillation (ENSO) and other climate oscillations Mechanism of monsoon; Monsoonal variation through time Factors associated with monsoonal intensity; Effects of monsoon on Earth’s climate.	12
Unit 4	Milankovitch cycles and variability in the climate. Glacial-interglacial stages. The Last Glacial maximum (LGM); Pleistocene Glacial-Interglacial cycles. Younger Dryas. Paleoclimatology and proxy records Evidence for past and present climate change Impacts of climate change on natural and human systems	12
	Total	**48**

Text Books Suggested:

1. Earth's Climate: Past and Future by William F. Rudd

Reference Books:

1. "Climate: A Very Short Introduction" by Mark Maslin
2. "The Earth System" by Lee R. Kump, James F. Kasting, and Robert G. Crane
3. "Global Physical Climatology" by Dennis L. Hartmann
4. "Paleoclimatology: Reconstructing Climates of the Quaternary" by Raymond S. Bradley

Paper IV DSE Course	SOIL GEOLOGY			Subject Code:
	L-T-P-C: 4-0-0-4	Credit Units: 4	Scheme of Evaluation: (T)	GEOL162D402

Course Objectives: This course introduces students to the study of soils as a natural resource and its relationship with geology. Students will learn about the physical, chemical, and biological properties of soils, and how these properties relate to geological processes and history. The course will cover topics such as soil formation, classification, nutrient cycles, and land use, as well as the environmental impact of soil degradation and conservation.

Course outcomes:

1. Remembering: Students will recall and identify the basic properties of soils and the geologic processes involved in soil formation.
2. Understanding: Students will describe and explain the relationships between soils and geology, including the effects of weathering and erosion on soil properties.
3. Applying: Students will apply their knowledge of soil geology to analyse and interpret soil profiles and properties.
4. Analysing: Students will evaluate the environmental impact of soil degradation and develop strategies for sustainable land use.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Definition and characteristics of soil. Soil forming processes: Physical weathering, loosening and particle size reduction; pressure release; thermal expansion; growth of foreign crystal. Chemical weathering; Oxidation; Carbonation; Hydrolysis; Hydration; Base Exchange; Chelation; Microbial weathering. General soil forming regimes: Gleization; podzolization; lessivage; ferrallitization; calcification; salinization.	12
Unit 2	Geochemistry: molecular ratios; chemical weathering indices. Stable isotope geochemistry: carbon^{13} and oxygen^{18} system for vegetation, temperature, pCO_2. Soil structures; horizons; roots; Fe-Mn mottles and concretions; pedogenic carbonate.	12
Unit 3	Introduction to paleopedology and paleosols; role of factors controlling paleosol formation-parent material, climate, vegetation, topography, time. Introduction to soil taxonomy and paleosol taxonomy. Precambrian paleosols: evolution of paleoatmospheric conditions.	12
Unit 4	Paleozoic paleosols: evolution of land animals and plants, coal, Permian-Triassic transition paleosols and extinction events. Mesozoic-Cenozoic paleosols: fossil soils at K-T extinction event, Paleogene fossil soils at green house to ice house transition, evolution of Asian monsoon system. Pleistocene-Holocene paleosols: human impact on landscape and soils, climate change, neotectonics.	12
	Total	**48**

Text Books Suggested:

1. Retallack, G.J. (2001) Soils of the Past: An Introduction to Paleopedology (2nd edition): Oxford, Blackwell Science, Ltd., 416 p.
2. Birkeland, P.W. (1999) Soil and Geomorphology. Oxford University Press (430 pp.).

Reference Books:

1. Sheldon, N.D., Tabor, N.J. (2009) Quantitative paleoenvironmental and paleoclimatic reconstruction using paleosols. Earth-Science Reviews 95, 1–52.
2. Stoops, G. (2003) Guidelines for analysis and distribution of soil and regolith thin sections. Soil Sci. Soc. Am., Madison, Wisconsin, 184 pp.
3. Soil Survey Staff, (2006) Key to Soil Taxonomy, 10th ed. USDA Natural Resources Conservation Service, Washington D.C. (341 pp.)

Paper V SEC	FIELD GEOLOGY - III			Subject Code:
	L-T-P-C: 0-0-4-2	Credit Units: 2	Scheme of Evaluation: (P)	GEOL162S411

Course Objectives: This course is designed to provide students with hands-on experience in geologic field methods and techniques. Topics covered will include geologic mapping, structural geology, stratigraphy, and palaeontology. Students will participate in field trips to local geologic sites and will be required to prepare geologic maps and reports.

Course Outcomes:

1. Remembering: Students will be able to recall and recognize the key concepts, principles, and facts related to geologic field methods and techniques.
2. Understanding: Students will be able to explain the fundamental principles and processes of geologic field methods and techniques, including geologic mapping, structural geology, stratigraphy, and palaeontology.
3. Applying: Students will be able to apply geologic field methods and techniques to collect, record, and interpret geologic data from field sites.
4. Analysing: Students will be able to analyse geologic field data to identify geologic structures, interpret stratigraphic relationships, and reconstruct geologic histories.
5. Evaluating: Students will be able to evaluate the quality and reliability of geologic data collected in the field, and assess the strengths and weaknesses of different field techniques and methods.
6. Creating: Students will be able to design and execute a geologic field project, including developing hypotheses, collecting and analysing data, and presenting findings.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Field training along Phanerozoic basin of India. Collection and documentation of stratigraphic details in the field. Concept of facies distribution at basinal-scale.	6
Unit 2	Field transects in any Precambrian terrain Study of craton ensemble including basic intrusive suites	6
Unit 3	Precambrian sedimentary basin. Basement-Cover relation in: a) fold belts, b) sedimentary successions.	6
Unit 4	Identification and characterization of major structural boundaries in Himalaya viz. MBT, MFT etc. or Field along any suitable transect of Himalayan foreland or Field transects in Siwalik	6
	Total	**24**

Text Books Suggested:

1) Guide to Field Geology – S. M. Mathur, PHI Publications
2) Field Geology – F. H. Lahee, CBS Publishers and Distributors Pvt Ltd; Sixth Edition (2002)

Reference books:

1. Manual of Field Geology – Robert R. Compton; John Wiley & Sons.
2. Basic Methods of Structural Geology – Stephen Marshak & Gautam Mitra; Pearson Publication.
3. "Geologic Field Techniques" by Maurice E. Tucker and Christopher R. Barnes, published by Wiley-Blackwell.
4. "Structural Geology: An Introduction to Geometrical Techniques" by Donal M. Ragan, published by Cambridge University Press.
5. "Stratigraphy: Principles and Methods" by Alan M. R. Cook and Bas van de Schootbrugge, published by Wiley-Blackwell.
6. "Fossils: The Key to the Past" by Richard A. Fortey, published by Harvard University Press.
7. "Geological Field Guide" edited by David R. Bridgland, published by Wiley-Blackwell.

Paper: GE 7 Generic Elective	Earth Surface Processes			Subject Code:
	L-T-P-C: 3-0-0-3	Credit Units: 3	Scheme of Evaluation: (T)	GEOL162G401

Course Objectives: This course provides an introduction to the physical and chemical processes that shape the Earth's surface. The course covers the fundamental concepts and principles of weathering, erosion, sediment transport, and deposition, with an emphasis on the interactions between these processes and the Earth's climate and tectonic activity.

Course Outcomes:

1. Remembering: Recall the fundamental concepts and principles of Earth surface processes.
2. Understanding: Explain the role of climate and tectonic activity in shaping the Earth's surface.
3. Applying: Analyse and interpret data on sediment transport and deposition using basic mathematical and statistical methods.
4. Evaluating: Evaluate the impact of human activity on Earth surface processes.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Introduction to earth surface processes** Geomorphic concepts, terrestrial relief, scales in geomorphology. Weathering and formation of soils, karst and speleology, slope and catchment erosion processes, fluvial, aeolian, glacial, peri-glacial and coastal processes and resultant landforms.	6
Unit 2	**Controlling factors and surface processes** Climate change and geomorphic response of fluvial systems of arid and humid regions. Geomorphic response to tectonics, sea level/base level change, anthropogenic affects. Introduction to Anthropocene.	6
Unit 3	**Geomorphic concepts in cause-effect relationship** Spatial & temporal scales, geomorphic system, connectivity, buffering, magnitude-frequency concept, time lag, sensitivity, equilibrium, threshold, non-linearity & complexities.	6
Unit 4	**Rates and changes in surface processes** Techniques for measuring rates of processes: sediment budgeting, rock magnetism, isotope geochemical tracers, cosmogenic nuclides, OSL & C-14 dating.	6
	Total	**24**

Text Books suggested:

1) Introduction to Geomorphology - Kale, V.S. and Gupta A (2001) Orient Longman Ltd.
2) Global Geomorphology - Summerfield M A (1991) Prentice Hall.
3) Geomorphology: A Systematic Analysis of Late Cenozoic Landforms - Bloom, A. L., (1998) Pearson Education.

Reference Books:

1) Alien, P.A., 1997. Earth Surface Processes, Blackwell publishing.
2) Bridge, J.S. and Demicco, R.V., 2008. Earth Surface Processes, Landforms and Sediment Deposits, Cambridge University Press.
3) Esterbrook, D.J., 1992. Surface Processes and Landforms, MacMillan Publ.

Paper: GE 8 Generic Elective	EARTH SCIENCES L-T-P-C: 3-0-0-3 Credit Units: 3 Scheme of Evaluation: (T)	Subject Code: GEOL162G202

Course Objectives: This course provides a broad overview of the interdisciplinary field of Earth Sciences, which encompasses geology, meteorology, oceanography, and astronomy. Students will explore the processes that shape the Earth's surface, the dynamics of the Earth's atmosphere and oceans, and the formation and evolution of the solar system. The course will introduce students to the methods and tools used in Earth Science research and the interdisciplinary nature of the field.

Course Outcomes:

1. Remembering: Students will recall and identify the major components and processes of the Earth system and the principles of plate tectonics.
2. Understanding: Students will describe and explain the relationships between the Earth's systems, including the effects of human activities on the Earth's environment.
3. Applying: Students will apply their knowledge of Earth Science to analyse and interpret maps and geospatial data.
4. Analysing: Students will evaluate the dynamics of the Earth's atmosphere and oceans and the impact of climate change on the Earth's systems.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Geodynamics** Dynamics of lithosphere: Plate Tectonic Theory Origin of oceans, continents and mountains. Origin of Himalaya. Concept of Mobile belts, cratons and shield.	9
Unit 2	**Geomorphology in Engineering practices** Denudation: weathering, erosion and mass wasting. Processes and landforms associated with river. Issues of urbanization: Hill slope stability, River bank stability. Flood control, Siltation, Construction of dam	9
Unit 3	**Fuel Geology** Origin of coal and petroleum, Basic classification of coal. Migration of Petroleum. Source and Reservoir rocks, Hydrocarbon Traps. Occurrence of Coal and Petroleum in NE India. Introductory concepts of Shale gas, Coal Bed Methane, Geothermal Energy. Nuclear Fuels.	9
Unit 4	**Hydrogeology** Hydrologic cycle. Groundwater and its vertical distribution. Brief idea of aquifers. Introductory idea of Groundwater exploration (resistivity method). Groundwater recharging. Groundwater uses and problems related to groundwater exploitation. Groundwater pollution and associated problems.	9
	Total	**36**

Text Books Suggested:

1) Essentials of Geology - Stephen Marshak, 4th edition, W. W. Norton & Company
2) Introduction to Physical Geology – Thompson & Turk

Reference Books:

1) Todd, D. K. 2006. Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.
2) Textbook of Geology – P. K. Mukherjee; World Press Pvt. Ltd.

B. Sc. (Honours) Course in Geology: Semester-V

Paper I Core Course	HYDROGEOLOGY			Subject Code:
	L-T-P-C: 2-0-4-4	Credit Units: 4	Scheme of Evaluation: (T + P)	GEOL162C541

Course Objectives: This course introduces students to the fundamental principles of groundwater, including the physical and chemical properties of water, aquifer types and characteristics, groundwater flow, well design and construction, and groundwater contamination. The course also covers water resources management and environmental issues related to groundwater.

Course outcomes:

1. Remembering: Define and explain the basic principles of hydrogeology, including groundwater flow, aquifer types, and hydraulic conductivity.
2. Understanding: Evaluate the relationship between groundwater and surface water, including water budgeting and streamflow measurement.
3. Applying: Apply Darcy's Law to calculate groundwater flow rates and velocities.
4. Analysing: Analyse hydrogeologic data to determine aquifer properties and hydraulic conductivity.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Scope of hydrogeology and its societal relevance. Hydrologic cycle: precipitation, evapo-transpiration, run-off, infiltration and subsurface movement of water. Rock properties affecting groundwater, Vertical distribution of subsurface water. Types of aquifers, aquifer parameters.	12
Unit 2	**Groundwater flow and Well hydraulics** Darcy's law and its validity; Intrinsic permeability and hydraulic conductivity. Groundwater flow rates and flow direction; Laminar and turbulent groundwater flow. Basic Concepts of Well hydraulics (drawdown; specific capacity etc).	12
Unit 3	**Groundwater exploration and Groundwater chemistry** Surface-based groundwater exploration methods. Introduction to subsurface borehole logging methods. Physical and chemical properties of water and water quality.	12
Unit 4	**Groundwater management** Sea water intrusion in coastal aquifers; Surface and subsurface water interaction; Groundwater level fluctuations; Rainwater harvesting and artificial recharge of groundwater. Groundwater pollution.	12
List of Practicals	Preparation and interpretation of water level contour maps and depth to water level maps. Study, preparation and analysis of hydrographs for differing groundwater conditions. Water potential zones of India (map study). Graphical representation of chemical quality data and water classification (C-S and Trilinear diagrams) Simple numerical problems related to: determination of permeability in field and laboratory, Groundwater flow, Well hydraulics etc.	12
	Total	**60**

Text Books Suggested:

1. Todd, D. K., & Mays, L. W. (2004). Groundwater Hydrology (3rd ed.). Wiley.
2. Fetter, C. W. (2001). Applied Hydrogeology (4th ed.). Prentice Hall.

Reference Books:

1. Chery, L., & Drogue, C. (2010). Environmental Hydraulics for Open Channel Flows. ISTE Press - Elsevier.
2. Freeze, R. A., & Cherry, J. A. (1979). Groundwater. Prentice Hall.
3. Karanth K.R., Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co. Ltd.
4. Raghunath, H.M., 1983: Ground Water; Wiley Eastern Ltd., New Delhi.

Paper II Core Course	ECONOMIC GEOLOGY			Subject Code:
	L-T-P-C: 2-0-4-4	Credit Units: 4	Scheme of Evaluation: (T + P)	GEOL162C542

Course Objectives: This course provides an introduction to the principles and practices of economic geology, with a focus on the identification, exploration, and exploitation of mineral resources. Topics covered include ore genesis, mineral deposits, and exploration techniques, as well as the economic, social, and environmental impacts of mineral extraction.

Course outcomes:

1. Remembering: Recall the basic principles and concepts of economic geology.
2. Understanding: Explain the geological processes that lead to the formation of mineral deposits.
3. Applying: Apply different exploration techniques to identify mineral deposits in a given area.
4. Analysing: Analyse the economic, social, and environmental impacts of mineral extraction.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Ores, gangue minerals, tenor, grade and lodes. Resources and reserves- Economic and Academic definitions. Mineral occurrence, Mineral deposit and Ore deposit. Concordant and discordant ore bodies.	12
Unit 2	Endogenous processes: Magmatic concentration, skarns, greisens, and hydrothermal deposits. Exogenous processes: weathering products and residual deposits, oxidation and supergene enrichment, placer deposits.	12
Unit 3	Mineral Exploration and exploitation techniques. Remote Sensing, Geophysical and Geochemical Explorations. Ore grade and Reserve, assessment of grade, reserve estimation.	12
Unit 4	Metallogenic provinces and epochs. Important mineral deposits of India including atomic minerals. Non-metallic and industrial rocks and minerals, in India. Introduction to gemstones.	12
List of Practicals	Megascopic identification of the following ore minerals: Iron, copper, Manganese, Lead and Zinc, Aluminium, Chromium. Study of microscopic properties of ore forming minerals (Oxides and sulphides). Assessment of grade of ore and reserve estimation. Preparation of maps: Distribution of important ores and other economic minerals in India.	12
	Total	**60**

Text Books Suggested:

1. Economic Geology: Principles and Practice by Walter L. Pohl (2011)
2. Ore Deposit Geology by John Ridley (2013)

Reference Books:

1. Introduction to Economic Geology and Its Environmental Impact by Anthony M. Evans (2011)
2. Economic Geology: Genesis and Evolution of Ore Deposits by Heinrich Robert Rollinson (2012)
3. Evans, A.M. (1993) Ore Geology and Industrial minerals. Wiley
4. Bateman, A.M. and Jensen, M.L. (1990) Economic Mineral Deposits. John Wiley.
5. Mineral Deposit Evaluation: A practical approach by Anthony M. Evans (1997)

Paper: DSE 1	Remote Sensing and GIS			Subject Code:
	L-T-P-C: 2-0-4-4	Credit Units: 4	Scheme of Evaluation: (T + P)	GEOL162D541

Course Objectives: This course introduces the fundamental principles of remote sensing and Geographic Information Systems (GIS) and their applications in Earth Sciences. The course covers the principles of electromagnetic radiation, remote sensing sensors, and image interpretation techniques. Students will also learn the basic concepts of GIS and spatial analysis.

Course outcomes:

1. Remembering: Recall basic concepts and facts related to remote sensing and GIS.
2. Understanding: Explain the principles and theories behind remote sensing and GIS techniques.
3. Applying: Apply remote sensing and GIS techniques to analyse and interpret spatial data.
4. Analysing: Analyse and interpret remotely sensed data to derive meaningful information.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Types and acquisition of aerial photographs; Scale and resolution; Principles of stereoscopy, relief displacement, vertical exaggeration and distortion. Elements of aerial photo interpretation; Identification of sedimentary, igneous and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms.	12
Unit 2	Concepts in Remote Sensing, History of Remote Sensing. Sensors, scanners and platforms. Satellites and their characteristics. Data formats- Raster and Vector.	12
Unit 3	Digital Image Processing, Image Errors, Rectification and Restoration. FCC, Image Enhancement, Filtering, Image Rationing. Image classification and accuracy assessment.	12
Unit 4	GIS, Datum, Coordinate systems and Projection systems, Introduction to DEM analysis. GPS: Concepts of GPS; Integrating GPS data with GIS. Applications of GPS in earth system sciences.	12
List of Practicals	Aerial Photo interpretation, identification of sedimentary, igneous and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms. Registration of satellite data with a toposheet of the area. Enhancing the satellite images. Classification of images. DEM analysis: generating slope map, aspect map and drainage network map and its applications.	12
	Total	**60**

Text Books Suggested:

1. Fundamentals of Satellite Remote Sensing by Emilio Chuvieco and Alfredo Huete (2010)
2. GIS Fundamentals: A First Text on Geographic Information Systems by Paul Bolstad (2016)

Reference Books:

1. Remote Sensing and GIS for Ecologists: Using Open-Source Software by Martin Wegmann, Benjamin Leutner, Stefan Dech (2016)
2. Remote Sensing and GIS Integration: Theories, Methods, and Applications by Qihao Weng (2015)

Paper: DSE 2	CLIMATOLOGY AND OCEANOGRAPHY			Subject Code:
	L-T-P-C: 4-0-0-4	Credit Units: 4	Scheme of Evaluation: (T)	GEOL162D502

Course Objectives: This course provides an introduction to the basic principles and concepts of climatology and oceanography. It covers the study of atmospheric and oceanic circulation patterns, climate variability, climate change, and their impacts on human societies and the environment.

Course outcomes:

1. Remembering: Define key terms and concepts related to climatology and oceanography.
2. Understanding: Explain the physical, chemical, and biological processes that govern the earth's climate and ocean systems.
3. Applying: Apply the concepts and techniques of climatology and oceanography to analyse real-world problems.
4. Analysing: Analyse and interpret data from various sources to understand climatic and oceanographic phenomena.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Fundamentals of Climatology** The field of Climatology and its subdivisions; The structure and composition of Earth's atmosphere; Elements of weather and climate; Factors affecting the distribution of temperature, Vertical and horizontal and seasonal distribution of temperature; Insolation and heat budget; Temperature inversion; Pressure systems, Air circulation and Coriolis effect.	12
Unit 2	**Elements and factors of Weather and Climate** Cyclones: Tropical Cyclones, Temperate Cyclones; Anticyclones; Monsoon - Origin and Mechanism; Jet Streams; Atmospheric Moisture: Evaporation, Humidity, Condensation, Fog and Clouds, Precipitation Types, Stability and Instability; Climatic Regions, Climate change and global warming.	12
Unit 3	**Fundamentals of Oceanography** Definition and scope of oceanography; branches of Oceanography. Age and origin of oceans; Ocean floor profile- continental shelf, slope, submarine canyons, continental rise, abyssal plains; Approaches to paleooceanographic reconstructions. Distribution of temperature, salinity and density of oceans. Hypsometry and Bathymetry. Coral reefs-origin and distribution.	12
Unit 4	**Ocean circulation, Sediments and resources of Ocean** Oceanic water movements: Waves, Tsunamis and Tides. Surface ocean currents of Atlantic, Pacific and Indian Oceans; Thermohaline circulation; effects of ocean currents on global climate; El nino and La nina. Concept of Eustasy. Marine sediments; food and mineral resources of the sea.	12
	Total	**48**

Text Books Suggested:

1. Essentials of Oceanography: Alan P. Trujillo & Harold V. Thurman (12th Edition, 2016).
2. Ahrens, C. D. (2018). Meteorology today: An introduction to weather, climate, and the environment. Cengage Learning.

Reference Books:

1. Barry, R. G., & Chorley, R. J. (2019). Atmosphere, weather and climate. Routledge.
2. Wallace, J. M., & Hobbs, P. V. (2006). Atmospheric science: An introductory survey. Academic Press.
3. Talley, L. D., Pickard, G. L., Emery, W. J., & Swift, J. H. (2011). Descriptive physical oceanography: An introduction. Elsevier.

Paper: DSE 3	EXPLORATION GEOLOGY			Subject Code:
	L-T-P-C: 4-0-0-4	Credit Units: 4	Scheme of Evaluation: (T)	GEOL162D503

Course Objectives: This course provides an overview of the principles and methods of mineral exploration geology. It covers topics such as geological mapping, geophysical and geochemical exploration methods, drilling techniques, and mineral resource assessment. The course aims to develop skills in exploration geology and mineral resource evaluation.

Course outcomes:

1. Knowledge: Understand the principles and techniques of mineral exploration, including geological mapping, geophysical surveys, drilling, and sampling.
2. Understanding: Understand the principles and methods of exploration geology, and its role in resource discovery and evaluation.
3. Application: Apply geological knowledge and techniques to design and implement exploration programs for a variety of mineral deposits.
4. Analysis: Evaluate the effectiveness of different exploration methods and their limitations in various geological settings.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Mineral Resources** Resource reserve definitions, Mineral resources in industries – historical perspective and present, A brief overview of classification of mineral deposits with respect to processes of formation in relation to exploration strategies.	12
Unit 2	**Prospecting and Exploration** Principles of mineral exploration, Prospecting and exploration- conceptualization, methodology and stages, Sampling, subsurface sampling including pitting, trenching and drilling, Geochemical exploration. Evaluation of sampling data: Mean, mode, median, standard deviation and variance	12
Unit 3	**Drilling and Logging** Core and non-core drilling Planning of bore holes and location of boreholes on ground Core-logging	12
Unit 4	**Reserve estimations and Errors** Principles of reserve estimation, density and bulk density Factors affecting reliability of reserve estimation Reserve estimation based on geometrical models (square, rectangular, triangular and polygonal blocks), Regular and irregular grid patterns, statistics and error estimation	12
	Total	**48**

Text Books Suggested:

1. Exploration Geology, W. Scott Dunbar, John Wiley & Sons, Inc.
2. Mineral Exploration: Principles and Applications, Swapan Kumar Haldar, Elsevier Science Publishing

Reference Books:

1. Mineral Exploration and Mining Essentials, Robert Stevens, Academic Press
2. Introduction to Mineral Exploration, Charles Moon, Academic Press
3. Moon, C.J., Whateley, M.K.G., Evans, A.M., 2006, Introduction to Mineral Exploration, Blackwell Publishing.

B. Sc. (Honours) Course in Geology: Semester-VI

Paper I Core Course	ENGINEERING GEOLOGY			Subject Code:
	L-T-P-C: 2-0-4-4	Credit Units: 4	Scheme of Evaluation: (T + P)	GEOL162C641

Course Objectives: This course covers the study of geology in relation to civil engineering and construction. The course emphasizes the application of geological knowledge in site investigation, planning, design, construction, and maintenance of civil engineering projects.

Course outcomes:

1. Knowledge: Students will be able to define and explain the principles and concepts of engineering geology.
2. Understand: Students will be able to interpret and understand geological data for engineering purposes.
3. Application: Students will be able to apply geological knowledge in solving engineering problems and making decisions related to civil engineering projects.
4. Analysis: Students will be able to evaluate and assess the geological hazards and risks associated with civil engineering projects.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Geology vs. Engineering, Role of Engineering geologists in planning, design and construction of major man-made structural features. Engineering properties of soil: Atterberg limits and significance, Soil compressibility, consolidation, Shear strength of soil. Clay minerals and their engineering significance.	12
Unit 2	Properties of Rock Mass and Rock Materials. Concept, Mechanism and Significance of Rock Quality Designation (RQD), Rock Structure Rating (RSR), Rock Mass Rating (RMR), Tunnelling Quality Index (Q-system).	12
Unit 3	Geological, Geotechnical and Environmental considerations for Dams and Reservoirs, Tunnels and Bridges. Foundation and Abutment treatment: Grouting, Rock Bolting and other support mechanisms.	12
Unit 4	Landslides: Causes, Factors and their analyses, corrective/Preventive measures. Earthquakes; Causes, Factors and corrective/Preventive measures.	12
List of Practicals	Computation of reservoir area, catchment area, reservoir capacity and reservoir life. Merits, demerits & remedial measures based upon geological cross sections of project sites. Computation of Index properties of rocks. Computation of RQD, RSR, RMR and 'Q'	12
	Total	**60**

Text Books Suggested:

1. Modern Geotechnical Engineering: Alam Singh; 3rd edition, CBS Publishers, 2006.
2. Basic Soil Mechanics And Foundations: Alam Singh; CBS Publishers, 2018.

Reference Books:

1. Engineering Geology: Butterworth-Heineman; Bell, F.G, 2007.
2. Foundations of Engineering Geology (3rd Edn.) Taylor & Francis, Waltham, T., 2009.
3. Basic Environmental and Engineering Geology Whittles Publishing, Bell, F.G-, 2006.

Paper II Core Course	FUEL GEOLOGY			Subject Code:
	L-T-P-C: 4-0-0-4	Credit Units: 4	Scheme of Evaluation: (T)	GEOL162C602

Course Objectives: This course introduces the students to the exploration, extraction, and utilization of fuel resources, including coal, oil, and gas. The course provides an overview of the geological processes involved in the formation of these resources, their occurrence, and distribution, as well as the methods used to extract and refine them.

Course outcomes:

1. Describe the geological processes that lead to the formation of coal, oil, and gas deposits. (Remembering)
2. Understand the physical and chemical properties of different types of fuel resources. (Understanding)
3. Evaluate the economic and environmental impact of fuel resource exploration, extraction, and utilization. (Evaluating)
4. Apply geological concepts and techniques to identify potential fuel resource sites. (Applying)

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Coal** Definition and origin of Coal; Basic classification of coal. Fundamentals of Coal Petrology - Introduction to lithotypes, microlithotypes and macerals in coal. Proximate and Ultimate analysis. Coal Bed Methane (CBM): global and Indian scenario Underground coal gasification; Coal liquefaction.	12
Unit 2	**Petroleum** Chemical composition and physical properties of crudes in nature; Origin of petroleum; Migration of petroleum; Maturation of kerogen; Biogenic and Thermal effect. Reservoir rocks: general attributes and petrophysical properties. Classification of reservoir rocks - clastic and chemical.	12
Unit 3	**Petroleum Reservoirs and Traps** Hydrocarbon traps: definition, anticlinal theory and trap theory. Classification of hydrocarbon traps - structural, stratigraphic and combination Time of trap formation and time of hydrocarbon accumulation. Cap rocks - definition and general properties. Plate tectonics and global distribution of hydrocarbon reserves.	12
Unit 4	**Other fuels** Gas Hydrate: Occurrence and origin; structure of gas hydrate, Types of gas hydrate; Geological setting of Hydrate; Stability of gas hydrates; Gas hydrate reservoir; Volume of gas in hydrate; inhibitors. Nuclear Fuel: Mineralogy of U and Th bearing economic minerals, geochemistry of U-Th and their distribution in ore bodies through geologic time. U and Th metallogenic provinces of India. Detectors of radioactivity: Geiger, proportional and scintillation counters and spectrometers.	12
	Total	**48**

Text Books Suggested:

1. Chandra, D., Singh, R.M., Singh, M.P., 2000: Textbook of Coal (Indian Context); Tara Book Agency, Varanashi.
2. Shelly R. C. (2014). Elements of Petroleum geology: Third Edition, Academic Press

Reference Books:

1. Bastia, R., & Radhakrishna, M. (2012). Basin evolution and petroleum prospectivity of the continental margins of India (Vol. 59). Newnes.
2. Larry Thomas, 2002: Coal Geology; John Wiley & Sons.
3. A.I. Levorsen, 1985: Geology of Petroleum; CBS Publishers, New Delhi.
4. Chandra D. (2007). Chandra's Textbook on applied coal petrology. Jijnasa Publishing House.

Paper: DSE 1	EVOLUTION OF LIFE THROUGH TIME			Subject Code:
	L-T-P-C: 4-0-0-4	Credit Units: 4	Scheme of Evaluation: (T)	GEOL162D601

Course Objectives: The course "Evolution of Life Through Time" explores the origin and evolution of life on Earth. It covers the geological time scale and the major events in Earth's history that have influenced the development of life. Students will learn about the evolution of single-celled organisms, the diversification of life during the Cambrian explosion, the rise of vertebrates, and the evolution of humans. The course will also focus on the methods and tools used to study the history of life, including palaeontology, molecular biology, and biogeography.

Course outcomes:

1. Remembering: Students will be able to recall important events and milestones in the evolution of life on Earth.
2. Understanding: Students will be able to explain the processes and mechanisms that have driven the evolution of life, as well as the scientific methods used to study it.
3. Applying: Students will be able to apply their understanding of evolutionary concepts to analyse and interpret scientific data and observations.
4. Analysing: Students will be able to critically evaluate different hypotheses and models of evolutionary history, and assess their evidence.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Fossil and chemical remains of ancient life. Exceptional preservation sites- age and fauna. Biosphere as a system, processes and products. Biogeochemical cycles. Abundance and diversity of microbes, extremophiles. Microbes-mineral interactions, microbial mats.	12
Unit 2	Possible life sustaining sites in the solar system, life sustaining elements and isotope records. Archean life: Earth's oldest life, Transition from Archean to Proterozoic, the oxygen revolution and radiation of life. Precambrian macrofossils – The garden of Ediacara. The Snow Ball Earth Hypothesis.	12
Unit 3	Paleozoic Life: The Cambrian Explosion. Biomineralization and skeletonization. Origin of vertebrates and radiation of fishes. Origin of tetrapods - Life out of water. Early land plants and impact of land vegetation. Mesozoic Life: Life after the largest (P/T) mass extinction, life in the Jurassic seas. Origin of mammals. Rise and fall of dinosaurs. Origin of birds; and spread of flowering plants.	12
Unit 4	Cenozoic Life: Aftermath of end Cretaceous mass extinction – radiation of placental mammals. Evolution of modern grasslands and co-evolution of hoofed grazers. Rise of modern plants and vegetation. Back to water – Evolution of Whales. The age of humans: Hominid dispersals and climate setting. Climate Change during the Phanerozoic - continental break-ups and collisions.	12
	Total	**48**

Text Books Suggested:

1. "Evolution: The Story of Life" by Douglas Palmer.
2. "The Story of Life in 25 Fossils" by Donald R. Prothero.

Reference Books:

1. "The Origin of Species" by Charles Darwin.
2. "Wonderful Life: The Burgess Shale and the Nature of History" by Stephen Jay Gould.

Paper: DSE 2	PLANETARY GEOLOGY			Subject Code:
	L-T-P-C: 4-0-0-4	Credit Units: 4	Scheme of Evaluation: (T)	GEOL162D602

Course Objectives: This course is designed to introduce undergraduate students to the geological processes, surface features, and history of the planets and moons in our solar system. Through lectures, readings, and hands-on activities, students will explore the formation and evolution of planetary bodies, the role of impact cratering, volcanism, tectonics, and erosion in shaping their surfaces, and the search for life beyond Earth.

Course outcomes:

1. Remembering: Students will be able to recall the names, physical characteristics, and orbital properties of the planets and moons in our solar system, as well as key geological features and events associated with each body.
2. Understanding: Students will be able to explain the geological processes responsible for the formation and evolution of planets and moons, as well as the methods used to study planetary geology.
3. Applying: Students will be able to analyse and interpret geological data from planetary missions and map planetary surfaces using topographic and geologic maps.
4. Analysing: Students will be able to evaluate competing theories and hypotheses related to the formation and evolution of planets and moons based on geological evidence.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Origin of the Solar System** Origin of the elements, Origin and composition of solar system, Methods of Solar system exploration. Evidence of early history from meteorites, asteroids, and comets, Effects of large early collisions (earth-moon system), Impact cratering as a geological process, Dating of surfaces using cratering records. Thermal history vs. planetary size, Planetary atmospheres, origin & retention of atmospheres and volatiles, Relative cratering rates and crater retention.	12
Unit 2	**Geology of Solar System Bodies** Internal structures, Surface Processes, Atmosphere and Hydrosphere of Moon, Venus and Mercury. General features of Asteroids, comets and meteorites, Interplanetary Dust Particle. Meteorites: Definition, importance of meteorite study. Types and classifications of meteorites. The giant planets and their satellites.	12
Unit 3	**Lunar and Martian Geology** Lunar rocks: types, mineralogy, petrology and geochemistry. Lunar crater morphology & lunar stratigraphy. Martian Geology: Evolution of Mars, History of the exploration of Mars; The Journey of Mangalyaan, Impact structures, Volcanic features, Layered deposits, Eolian dunes, Debris flow, Martian outflow channels, Glacial processes, Mountain building. Martian meteorites: types and importance of Martian meteorites study.	12
Unit 4	**Planetary habitability in the Solar System** Records of detecting water and habitable environment in extra-terrestrial bodies. Drake equation. Direct and indirect scientific search of extra-terrestrial life. Physical and chemical conditions supportive of permanent Mars occupation; Terraforming of Mars and its challenges; New Trends for Human Missions to Mars and Human colonization of Mars.	12
	Total	**48**

Text Books Suggested:

1. An Introduction to the Solar System - 2004, by Neil McBride and Lain Gilmour, The Open University and Cambridge University Press
2. Fairen, A.G., Mars: Evolution, Geology and Exploration. Nova Publishers, ISBN: 978-1-62618102-1

Reference Books:

1. Ahrens, P. (2007). The Terraformation of Worlds. Nexial Quest, 22 p.
2. Gerstell, M. F.; Francisco, J. S.; Yung, Y. L.; Boxe, C.; Aaltonee, E. T. (2001). Keeping Mars warm with new super greenhouse gases. Proceedings of the National Academy of Sciences 98 (5): 2154-2157.

Paper: DSE 3	ANALYTICAL GEOLOGY			Subject Code:
	L-T-P-C: 4-0-0-4	Credit Units: 4	Scheme of Evaluation: (T)	GEOL162D603

Course Objectives: Analytical Geology is an undergraduate level course that provides an introduction to various analytical techniques used in geology. The course focuses on the application of chemical, physical, and mathematical techniques in geology, and provides students with an understanding of how these techniques are used in the analysis of geological materials.

Course outcomes:

1. Remembering: Students will be able to recall and describe the principles and techniques used in analytical geology, such as spectroscopy, X-ray diffraction, and chromatography.
2. Understanding: Students will be able to explain the theoretical basis and limitations of different analytical methods, and interpret data obtained from them.
3. Applying: Students will be able to apply analytical techniques to solve problems related to the identification and characterization of rocks and minerals.
4. Analysing: Students will be able to analyse and evaluate the quality and reliability of analytical data, and draw conclusions based on it.

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	Overview of analytical techniques used in geology. Optical and electron microscopy techniques. Brief introduction to spectrometric techniques (XRF, XRD, SEM, TEM, etc.) Principles and applications of X-ray diffraction in geology. Interpretation of X-ray diffraction patterns.	12
Unit 2	Principles and applications of electron probe microanalysis in geology. Using electron probe microanalysis to determine the composition of minerals. Introduction to chromatographic techniques (GC, HPLC, IC, etc.) Introduction to mass spectrometric techniques (ICP-MS, SIMS, etc.)	12
Unit 3	Principles and applications of stable isotopes in geology. Stable isotope analysis techniques. Principles and applications of radiometric dating in geology. Radiometric dating techniques.	12
Unit 4	Statistical methods for data analysis. Interpretation of analytical data. Case studies of analytical geology in geological investigations. Developing critical thinking and problem-solving skills for geological investigations.	12
	Total	**48**

Text Books Suggested:

1. "Analytical Methods in Geochemical Prospecting" by G. A. McKay
2. "Handbook of Geochemistry" by K. H. Wedepohl

Reference Books:

1. "Introduction to Geochemical Modeling" by C. M. Bethke
2. "Analytical Geochemistry" by W. M. White
3. "Geochemical and Biogeochemical Reaction Modeling" by Craig M. Bethke
4. "Analytical Chemistry in Geochemistry" by R. S. Harmon
5. "Geochemistry" by F. Albarede

Paper: DSE 4	INTRODUCTION TO GEOPHYSICS			Subject Code:
	L-T-P-C: 4-0-0-4	Credit Units: 4	Scheme of Evaluation: (T)	GEOL162D604

Course Objectives: Introduction to Geophysics is an undergraduate level course designed to provide an overview of various geophysical techniques used to study the Earth's subsurface. The course covers the basic principles of geophysics, such as seismic, magnetic, gravity, and electrical methods, and their applications in geological and environmental studies. The course also includes practical exercises and fieldwork to enhance the students' understanding of geophysical data acquisition and interpretation.

Course outcomes:

1. Recall the basic principles and concepts of geophysics, including seismic, magnetic, gravity, and electrical methods. (Remembering)
2. Interpret and analyse geophysical data obtained from different methods to study the Earth's subsurface structures. (Understanding and Analysing)
3. Design and conduct geophysical surveys for geological and environmental studies. (Applying)

Detailed Syllabus:

Modules	Topics and Course Content	Periods
Unit 1	**Geology and Geophysics** Interrelationship between geology and geophysics, Role of geological and geophysical data in explaining geodynamical features of the earth. Different types of geophysical methods - gravity, magnetic, electrical and seismic; their principles and applications. Concepts and Usage of corrections in geophysical data.	12
Unit 2	Different types of surveys, grid and route surveys, profiling and sounding techniques. Scales of survey, Presentation of geophysical data. Regional geophysics, oil and gas geophysics, ore geophysics, groundwater geophysics, engineering geophysics.	12
Unit 3	Correction to measured quantities, geophysical, anomaly, regional and residual (local) anomalies, factors controlling anomaly, and depth of exploration. Ambiguities in geophysical interpretation, planning and execution of geophysical surveys.	12
Unit 4	Anomaly and background- Graphical method. Study and interpretation of seismic reflector geometry. Problems on gravity anomaly.	12
	Total	**48**

Text Books Suggested:

1. Lowrie, W. (2007). Fundamentals of geophysics. Cambridge University Press.

Reference Books:

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

Paper SEC	FIELD GEOLOGY - IV			Subject Code:
	L-T-P-C: 0-0-4-2	Credit Units: 2	Scheme of Evaluation: (P)	GEOL162S611

Course Objectives: This course is designed to provide students with hands-on experience in geologic field methods and techniques. Topics covered will include geologic mapping, structural geology, stratigraphy, and palaeontology. Students will participate in field trips to local geologic sites and will be required to prepare geologic maps and reports.

Course Outcomes:

1. Remembering: Students will be able to recall and recognize the key concepts, principles, and facts related to geologic field methods and techniques.
2. Understanding: Students will be able to explain the fundamental principles and processes of geologic field methods and techniques, including geologic mapping, structural geology, stratigraphy, and palaeontology.
3. Applying: Students will be able to apply geologic field methods and techniques to collect, record, and interpret geologic data from field sites.
4. Analysing: Students will be able to analyse geologic field data to identify geologic structures, interpret stratigraphic relationships, and reconstruct geologic histories.
5. Evaluating: Students will be able to evaluate the quality and reliability of geologic data collected in the field, and assess the strengths and weaknesses of different field techniques and methods.
6. Creating: Students will be able to design and execute a geologic field project, including developing hypotheses, collecting and analysing data, and presenting findings.

Detailed Syllabus:

Modules	Topics and Course Content	Hours
Unit 1	Geological mapping of a project site (Dam sites, Tunnel alignments etc) On site visit & to study various geotechnical aspects related to the project site.	15
Unit 2	Identification of geotechnical problems of a project site and remedial measures to be taken. Computation of rock mass Properties (RQD, RSR, RMR & Q) in the field.	15
Unit 3	Visit to any mineral deposit, underground or open cast mine. Underground mapping/ Bench mapping, Isopach and Isochore maps	15
Unit 4	Identification of environmental problems of a project site and remedial measures to be taken. Identification of potential suspected/probable sites of Natural Disaster and suggestions about corrective/preventive measures.	15
	Total	**60**

Text Books Suggested:

1) Guide to Field Geology – S. M. Mathur, PHI Publications
2) Field Geology – F. H. Lahee, CBS Publishers and Distributors Pvt Ltd; Sixth Edition (2002)

Reference books:

1. Manual of Field Geology – Robert R. Compton; John Wiley & Sons.
2. Basic Methods of Structural Geology – Stephen Marshak & Gautam Mitra; Pearson Publication.
3. "Geologic Field Techniques" by Maurice E. Tucker and Christopher R. Barnes, published by Wiley-Blackwell.
4. "Structural Geology: An Introduction to Geometrical Techniques" by Donal M. Ragan, published by Cambridge University Press.
5. "Stratigraphy: Principles and Methods" by Alan M. R. Cook and Bas van de Schootbrugge, published by Wiley-Blackwell.
6. "Fossils: The Key to the Past" by Richard A. Fortey, published by Harvard University Press.
   "Geological Field Guide" edited by David R. Bridgland, published by Wiley-Blackwell.