COURSE STRUCTURE AND SYLLABUS OF
Five Year Integrated Post Graduate Programme,
NEP 2020
APPLIED GEOLOGY.

(Recommended by B.O.S. in APPLIED GEOLOGY, D.U. in its meetings held on 28.12.2023 and approved by UG Board in its meeting held on ..... and passed by the Academic Council meeting held on…….and effective from the session .....)

DEPARTMENT OF APPLIED GEOLOGY
DIBRUGARH UNIVERSITY
DIBRUGARH

PREAMBLE

The prime objective of this four years degree course in Geology of Dibrugarh University is to generate efficient and skilled human resources who can serve the society at larger extent and play a major role in preserving the Mother Planet. This model curriculum for Master of Science in Applied Geology is prepared following the guidelines of NEP 2020 includes basic foundation, core and the theoretical as well as applied components of the Geology course. It aims at to empower the Post graduate students to explore and understand various aspects of the Planet Earth. A Learning Outcome-based Curriculum Framework (LOCF) is approached so that the students can experience the prime objectives of the course, engage themselves in the programme of their choice, acquire advance knowledge and perform better at examination level. This postgraduate curriculum is expected to prepare the students academia, industry employability. The student will unfold decisive thinking, analytical and interdisciplinary skills which can be applied to various scientific and environmental contexts and gain a deeper appreciation in the subject. This course is also designed to counselling the postgraduate students for maintaining the physical and mental well-being, emotional stability, stress management and social justice and sustainability.

INTRODUCTION

The Post Graduate (PG) syllabus of Applied Geology in light of New Education Policy (NEP), 2020 consists of Major (Core) disciplines, Minor disciplines, Generic Elective Courses (GEC), Ability Enhancement Courses (AEC), Value Added Courses (VAC), Skill Enhancement Courses (SEC), Environmental Education (EE), YOGA, Community Based Engagement (NCC/NSS/Adult Education/Student Mentoring/NGO/Govt. Institutions, etc.), Digital and Technological Solutions/Digital Fluency (DTS/DF), Geological Fieldwork, Internship, Project, Research Ethics and Methodology, Research Project (Development of Project/Research Proposal, Review of related literature), Dissertation Project Work and Discipline Specific Electives (DSE).

The PG degree programme offers certificates, diplomas and degrees as follows:

UG Certificate: Students who opt to exit after completion of the first year (Two Semesters) and have secured 44 credits will be awarded a UG certificate. These students are allowed to re-enter within three years and complete the degree programme within the stipulated maximum period of seven years.

Certificate course consists of two Major disciplines, two Minor disciplines, two GEC, two AEC, four VAC, two SEC, YOGA and Environmental Education with emphasis on community-based activities.

UG Diploma: Students who opt to exit after completion of the second year (Four Semesters) and have secured 88 credits will be awarded the UG diploma. These students are allowed to re-enter within a period of three years and complete the degree programme within the maximum period of seven years.

Diploma course consists of eight Major disciplines, four Minor disciplines, three GEC, three AEC, five VAC, three SEC, YOGA, Environmental Education with emphasis on community-based activities and Digital and Technological Solutions/Digital Fluency and Community engagement.

3-year UG Degree: Students who wish to undergo a 3-year (Six Semesters) UG programme will be awarded UG Degree in the Major discipline after successful completion of three years, securing 132 credits.

3-year UG degree course consists of sixteen Major disciplines, six Minor disciplines, three GEC, three AEC, five VAC, three SEC, YOGA, Environmental Education with emphasis on community-

based activities, Digital and Technological Solutions/Digital Fluency, Community engagement, Internship and Project.

4-year UG Degree (Honours with Research): Students who secure 75% marks and above in the first six semesters and wish to undertake research at the undergraduate level can choose a research stream in the fourth year (Two Semesters). They should do a research project or dissertation under the guidance of a faculty member of the University/College. The research project/dissertation will be in the major discipline. The students who secure 176 credits, including 12 credits from a research project/dissertation, are awarded UG Degree (Honours with Research).

4-year UG degree course consists of twenty-two Major disciplines, eight Minor disciplines, three GEC, three AEC, five VAC, three SEC, YOGA, Environmental Education with emphasis on community-based activities, Digital and Technological Solutions/Digital Fluency, Community engagement, Internship, Project, Research Ethics and Methodology, Research Project or one DSE and Dissertation or two DSE.

UG Degree Programmes with Single Major: A student has to secure a minimum of 50% credits from the major discipline for the 3-year/4-year UG degree to be awarded a single major.

UG Degree Programmes with Double Major: A student has to secure a minimum of 40% credits from the second major discipline for the 3-year/4-year UG degree to be awarded a double major.

Interdisciplinary UG Programmes: The credits for core courses shall be distributed among the constituent disciplines/subjects so as to get core competence in the interdisciplinary programme.

Multidisciplinary UG Programmes: In the case of students pursuing a multidisciplinary programme of study, the credits to core courses will be distributed among the broad disciplines such as Earth and Energy Sciences, Life sciences, Physical Sciences, Mathematical and Computer Sciences, Social Sciences, Humanities, etc.

Five Year Integrated Post Graduate Programme (FYIPGP)

Students who secure 75% marks and above in the first eight semesters and wish to undertake postgraduate level can choose a post graduate stream in the fifth year (Two Semesters). They will complete four DSC and five DSE courses in ninth and tenth semester. They should do a research project or dissertation under the guidance of a faculty member of the University. The research project/dissertation will be in the major discipline.
The students on exit shall be awarded a **PG Degree** (in the Field of Study/Discipline), or Integrated 5 years PG Degree) after securing the requisite 220 Credits on completion of Semester 10.

The statutory bodies of the Universities and Colleges such as the Board of Studies and Academic Council will decide on the list of courses under major category and credit distribution for double major, interdisciplinary and multidisciplinary programmes.

AIM

The aims of Five Year Integrated Post Graduate Programme(FYIPGP) in Applied Geology are:

1. To know the fundamentals of Geology, its scope and its various branches.
2. To introduce fundamental aspects of Earth and Planetary system and its related changes with time. This course will mainly emphasize to provide knowledge on the Mineralogy, Petrology, Structural Geology and Plate Tectonics, Stratigraphy, Paleontology, various mineral exploration methods etc.
3. To introduce about the different sources of natural resources such as hydrocarbons, ground water and ores.
4. To associate the naturally occurring landforms with erosive and depositional action of the rivers, wind and glaciers.

5. Students will be able to understand scientific methodologies and by applying the methods finding solutions to selected problems in different fields of Geology.

GRADUATE ATTRIBUTES OF THE FYIPGP IN GEOLOGY

Graduate attributes include both disciplinary knowledge related to the particular discipline and generic attributes that the graduates of all the disciplines of study should acquire and demonstrate. Graduate attributes of the FYIPGP in Applied Geology are:

Disciplinary Knowledge: The graduates should have the ability to demonstrate the attribute of comprehensive knowledge and understanding of the discipline of Geology.

Communication Skills

Capability to express various Geological ideas clearly through computational methods, graphical methods, examples and their graphical representations; ability to use Geology effectively as a precise language of communication in other fields; ability to pay close attention, read texts and research papers critically, and communicate complicated information clearly and concisely to a variety of organisations and audiences.

Moral and Ethical Awareness/Reasoning

Ability to recognise ethical issues that are pertinent to one's work and pledge not to engage in unethical behavior such as plagiarism, copyright and infringement of intellectual property rights; ability to appreciate recent developments in various fields and one’s research with honesty and integrity in all aspects.

Multicultural Competence

Ability to correlate and compare recent developments in various branches of Geology in a variety of organizations worldwide; ability to collaborate research in various fields of geology with other researchers from a variety of communities and organisations; ability to effectively participate in a multicultural group or society and interact politely with diverse groups, and the acquisition of knowledge of the values and beliefs of multiple cultures, and a global viewpoint to honour diversity.

Information/Digital Literacy

Ability to access, asses and utilize Information and Communications Technology (ICT) tools. Ability to understand, read and write programming language/packages/modules (MATLAB; C) for computation, simulation, graphs and solutions.

Reflective Thinking

An understanding of how a researcher or an investigator influences and shapes the information one creates; ability to formulate appropriate questions pertaining to the ideas in various branches of Geology in order to propose new solutions using the domain knowledge of Geology; ability to interpret the findings and use them to solve a variety of problems found in numerous fields of Geology and real-life.

Cooperation/Team Work

During field work ability to collaborate with diverse teams in an effective and respectful manner; capacity to cooperate with people from varied backgrounds in the interests of a common goal.

Research Related Skills

To formulate appropriate questions, problems, and hypotheses by analysing and interpreting the ideas from various branches of Geology; ability to demonstrate the results, theories, techniques and proofs using the concepts of various fields of Geology; ability to develop methodology and design research proposals.

Problem Solving

To work independently and do in-depth study to find ways that Geology is used in various industries and in daily life to improve job possibilities in a wide range of fields and academic study; ability to use innovative, imaginative, lateral thinking, interpersonal skills, and emotional intelligence; ability to tackle various challenges in both familiar and unfamiliar circumstances, then apply what they've learned to actual scenarios.

Critical Thinking

Capability to analyse and synthesize theoretical and applied problems, as well as acquire knowledge and skills through logical reasoning, analytical thinking and evaluations; ability to find gaps and logical faults in arguments; inculcate a healthy attitude to be a lifelong learner.

PROGRAM OUTCOMES

1. Students will understand the genesis of Geology and its importance.
2. The students will gain fair knowledge of understanding of the subject concerned and also recent trends developed in the subject.
3. The University expects maximum involvement of the student fraternity in utilising the benefits of such a flexible yet rigorous curriculum framework at the undergraduate level and reaping the benefits of it through enrichment of their skills in their area of interest which will eventually help them in gaining employment, entrepreneurship, start-ups and various other ways of a dignified life and living as a global citizen with contemporary global demands.
4. Students, after completing this course, are expected to be well prepared to pursue future studies and research in the field of Geology. The Pursuit of higher studies in the subject will help in the academic upliftment of the subject and society as a whole.
5. Further, the students will be benefited in preparing for the various competitive examinations.
6. The course will impart life skills such as communication, cooperation, teamwork, and resilience.

TEACHING LEARNING PROCESS

The programme allows to use varied pedagogical methods and techniques both within classroom and beyond.

1. Lecture
2. Tutorial
3. Power point presentation
4. Documentary film on related topic
5. Project Work/Dissertation
6. Group Discussion and debate
7. Seminars/workshops/conferences

8. Field visits and Report/Excursions
9. Mentor/Mentee

TEACHING LEANING TOOLS

1. Projector
2. Smart Television for Documentary related topic
3. LCD Monitor
4. WLAN
5. White/Green/Black Board
6. Fieldwork

ASSESSMENT

1. Home assignment
2. Project Report
3. Class Presentation: Oral/Poster/Power point
4. Group Discussions
5. In semester examinations
6. End Semester examinations
7. Field work

Course Structure

Year	Semester	Course	Title of the Course	Total Credit
Year01	1st Semester	**AGC- 1.1**	Earth System Science	4
		AGM- 1.1	Essentials of Earth Science	4
		AGG- 1A	Minerals, Rocks and Ores	3
		AEC01	Modern Indian Language	4
		VAC (Any one)	Understanding India (VAC01)	2
			Health and Wellness (VAC02)	
		AGSEC-1.1	Basic Geological Field Training	3
		Total		**20**
	2nd Semester	**AGC- 2.1**	Mineralogy and Crystallography	4
		AGM- 2.1	Mineralogy and Crystallography	4
		AGG- 2A	Earthquake Studies	3
		AEC02	English Language and Communication Skills	4
		VAC (Any one)	Environmental Science (VAC03)	2
			Yoga Education (VAC04)	
		AGSEC-2.1	Basic Surveying Techniques and GIS	3
		Total		**20**
The students on exit shall be awarded Under graduate Certificate (in the Field of Study/Discipline)after securing the requisite 40 Credits in Semester 1 and 2 provided they secure 4 credits in work based vocational courses offered during summer term or internship/Apprenticeship in addition to 6 credits from skill based courses earned During 1st and 2nd Semester				
Year02	3rd Semester	**AGC- 3.1**	Principles of Structural Geology	4
		AGC- 3.1	Paleontology	4
		AGM- 3.1	Fundamentals of Petrology	4
		AGG- 3A	Geoheritage and Geotourism	3
		SEC-03-T	Geological Mapping	3
		VAC (Any one)	Digital and Technological Solutions / Digital Fluency (VAC05)	2
			Communicative English /Mathematical Ability (VAC06)	
		Total		**20**

DETAILED SYLLABUS OF 1st SEMESTER

Course Title **: Earth System Science**
Course Code **: AGC- 1.1**
Nature of Course **: Major (Core)**
Total Credits **:** 04 credits
Distribution of Marks **:** 60 (End-Sem.) + 40 (In-Sem.)

COURSE OBJECTIVES: Earth system science programme aims to explore, understand, communicate and teach the earth as a planet, its complex processes, past and future evolution and interaction with society. In short language, it provides integrated understanding of the earth system. It also deals with complex interaction among lithosphere, biosphere and atmosphere.

UNITS	CONTENTS	L	T	P	Total Hours
I (20 Marks)	**Universe, Solar and Earth System** Formation and evolution of the Universe, meteorites and asteroids; theories of origin of the earth, brief geological history and age of earth. Planet Earth, moon, planetary properties, orbital and rotational characteristics of the earth, physical characteristics; atmosphere, hydrosphere, lithosphere, biosphere and cryosphere; gravitational and magnetic field of the earth, Interior of the Earth: core, mantle and crust.	**16**	**04**		**20**
II (10 Marks)	**Basics of Geology** Various branches of geology and its interdisciplinary and multidisciplinary perspectives Minerals and rocks: concept of native elements, mineraloids, rock forming minerals. Brief introduction to rocks: igneous, metamorphic and sedimentary rocks, the rock cycle Rock weathering; Soil: formation, soil profile and soil types.	**08**	**02**		**10**
III (15 Marks)	**Advance concepts of Geology** Brief idea about different geomorphic processes and their products. Geomorphic divisions of Indian subcontinent. Concept of plate tectonics, origin of oceans, continents, mountains and rift valleys. Earthquake and earthquake belts. Volcanoes- types, products and their distribution. Earth's heat budget, land-air-sea interactions; atmospheric and ocean circulation, Coriolis effect, concepts of eustasy. Stratigraphy and historical geology – basic principles; Introduction to the geology of India.	**12**	**03**		**15**
IV Practical (15 Marks)	Identification of minerals and rock in hand specimen Identification of mega fossils Identification of structural models **Note book**			**15**	**30**

				75

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- **Two Internal Examination - 15 + 15**
- **Others (Any one) - 10**
  - **Group Discussion**
  - **Seminar presentation on any of the relevant topics**
  - **Debate**
  - **Home Assignment**

COURSE OUTCOMES (Cos):
Student will be able to: -

CO 01: Understand the Formation and Evolution of the Universe

LO 1.1: Describe the major theories regarding the formation and evolution of the universe.
LO 1.2: Identify the role and significance of meteorites and asteroids in the solar system.
LO 1.3: Summarize the main theories of Earth's origin.
LO 1.4: Outline the key events in Earth's geological history and methods for determining its age.
LO 1.5: Compare the physical and orbital characteristics of Earth, the moon, and other planets.
LO 1.6: Explain the structure and composition of Earth's atmosphere, hydrosphere, lithosphere, biosphere, and cryosphere.
LO 1.7: Analyze the gravitational and magnetic fields of Earth.
LO 1.8: Describe the structure of Earth's core, mantle, and crust.

CO 02: Understand the Basics of Geology

LO 2.1: Identify and explain the various branches of geology and their interdisciplinary and multidisciplinary perspectives.
LO 2.2: Define native elements, mineraloids, and rock-forming minerals.
LO 2.3: Distinguish between igneous, metamorphic, and sedimentary rocks and explain the rock cycle.
LO 2.4: To know the processes involving Rock Weathering and describe soil formation, soil profiles, and different soil types

CO 03: Gain knowledge of Advanced Concepts of Geology

LO 3.1: Discuss various geomorphic processes and their resultant landforms.
LO 3.2: Identify and describe the geomorphic divisions of the Indian subcontinent.
LO 3.3: Explain the concept of plate tectonics and its role in the origin of oceans, continents, mountains, and rift valleys.
LO 3.4: Describe the causes and effects of earthquakes and the distribution of earthquake belts.
LO 3.5: Identify different types of volcanoes, their products, and their global distribution.
LO 3.6: Explain Earth's heat budget and the interactions between land, air, and sea.
LO 3.7: Describe atmospheric and ocean circulation patterns and the Coriolis effect.
LO 3.8: Define the concept of eustasy and its implications.
LO 3.9: Explain the basic principles of stratigraphy.

CO 04: Understand Geology of India
LO 4.1: Provide an overview of the geological history of India.

CO 05: Acquire Practical Skills
LO 5.1: Identify common minerals and rocks in hand specimens.
LO 5.2: Recognize and identify mega fossils.
LO 5.3: Identify and interpret geological structural models.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	**CO 01, CO 02, CO 04**	**CO 02, CO 03**	**CO 05**			
Conceptual Knowledge		**CO 02, CO 03, CO 05**	**CO 05**	**CO 03, CO 04, CO 05**	**CO 05**	
Procedural Knowledge		**CO 05**	**CO 05**	**CO 05**		
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	M	M	S	S	M
CO2	S	M	M	S	S	M
CO3	S	M	M	S	S	M
CO4	S	M	M	S	S	M
CO5	M	S	M	S	S	M

Where, S= Strong Correlation and M= Medium Correlation

SUGGESTED READINGS

1. Brian J. Skinner, B. J. & Porter, S. C.: (2012). The Blue Planet: An Introduction to Earth System Science. John Wiley & Sons.Inc.
2. Thompson G.R.R., Turk J. (1997) Introduction to Physical Geology. Brooks Cole.
3. Tarbuck, E. J. &Lutgens, F. K. (1998). Earth: An Introduction to Physical Geology. Pearson
4. Charles, C. P., Carlson, D., &Mcgeary, D. (2009) Physical Geology. McGraw-Hill Higher Education
5. Duff, P. M. D., & Duff, D. (Eds.). (1993). Holmes' principles of physical geology.Taylor & Francis.
6. Emiliani, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.

Course Title : **Essentials of Earth Science**
Course Code : **AGM- 1.1**
Nature of Course : **Minor**
Total Credits : 04 credits
Distribution of Marks : 60 (End-Sem.) + 40 (In-Sem.)

COURSE OBJECTIVES: The "Essentials of Earth Science" course aims to provide students with a foundational understanding of Earth's systems, including geology. Students will explore the dynamic processes shaping our planet, such as plate tectonics, weather patterns, and climate change. Emphasis is placed on scientific inquiry, critical thinking, and the application of earth science principles to real-world issues.

UNITS	CONTENTS	L	T	P	Total Hours
I (15 Marks)	**Introduction:** **Origin of the Earth:** The Origin of Planets, Early Earth and Formation of a Layered Planet, Earth as a System of interacting Components, Earth through Geologic Time. **Plate Tectonics:** The Discovery of Plate Tectonics, The Mosaic of Plates, Rates and History of Plate Motions, The Grand Reconstruction, The Engine of Plate Tectonics.	**10**	**05**		**15**
II (15 Marks)	**Earth Materials** **Minerals:** The Atomic Structure of Minerals. Rock-Forming Minerals, Physical properties of Minerals. **Rocks:** Igneous Rocks, Sedimentary Rocks, Metamorphic Rocks. The Rock Cycle, Rock and Fossil Record and the Geological Time Scale. **Mineral Resources:** Geology of Mineral Deposits and its distributions.	**10**	**05**		**15**
III (15 Marks)	**Earth Processes** **Weathering and Erosion:** Physical weathering, Chemical and Biological weathering, Mass Wasting. Endogenic and Exogenic processes. **Dynamic Processes of Solid Earth:** Folds, Faults, and other Records of Rock Deformation, Evolution of the Continents, Tectonics of Indian Plate, Origin of Himalayas Groundwater and Hydrogeological Cycle. Waves and Tides, Physical and chemical sedimentation in the ocean. **Natural Hazards:** Flood, Landslide, Earthquakes, Tsunamis, Volcano.	**10**	**05**		**15**
Unit IV (15 Marks)	**Energy, Environment and Global Change** **Energy Resources:** Oil and Natural Gas, Coal, Alternatives to Fossil Fuels, Conservation of Energy Policy. Environment: Global Change and Human Impacts, The Climate System: Natural Climate Variability, The Carbon Cycle: Human Activity and Global Change.	**10**	**05**		**15**
	Total				**60**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- **Two Internal Examination - 15 + 15**
- **Others (Any one) - 10**
  - **Group Discussion**
  - **Seminar presentation on any of the relevant topics**
  - **Debate**
  - **Home Assignment**

COURSE OUTCOMES (COs):
Student will be able to: -

CO 01: Get an idea about the origin of earth and plate tectonics

LO 1.1: Explain the processes involved in the origin of planets and the early formation of Earth as a layered planet.

LO 1.2: Describe Earth as a system of interacting components, including the lithosphere, atmosphere, hydrosphere, and biosphere.

LO 1.3: Summarize the major events in Earth's history through geologic time and understand methods used to date these events.

LO 1.4: Discuss the discovery and development of plate tectonics theory, including the identification and movement of Earth's tectonic plates, the history of plate motions, and the forces driving plate tectonics.

CO 02: Gain a comprehensive understanding of Earth's origin, structure, dynamic processes, and the classification and significance of minerals and rocks.

LO 2.1: Explain the atomic structure and physical properties of minerals, including the identification of common rock-forming minerals.

LO 2.2: Classify and describe the formation processes of igneous, sedimentary, and metamorphic rocks, and understand their roles in the rock cycle.

LO 2.3: Interpret the rock and fossil record, and explain its importance in the geological time scale.

LO 2.4: Discuss the geology of mineral deposits, their formation, and global distribution.

CO 03: Gain a deep understanding of Earth's dynamic processes, including weathering, erosion, tectonic activity, sedimentation, groundwater dynamics, and natural hazards.

LO 3.1: Describe the processes of physical, chemical, and biological weathering. Analyze the impact of weathering on landscape evolution. Explain the mechanisms and consequences of mass wasting.

LO 3.2: Differentiate between endogenic and exogenic geological processes. Illustrate how these processes shape Earth's surface and affect geological formations.

LO 3.3: Identify and interpret folds, faults, and other records of rock deformation. Analyze the evolution of continents and the tectonics of the Indian Plate. Explain the geological processes leading to the formation of the Himalayas.

LO 3.4: Describe the characteristics and causes of floods, landslides, earthquakes, tsunamis, and volcanic eruptions. Evaluate the impact of these natural hazards on human populations and environments.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	**CO 01**	**CO 02, CO 03**				
Conceptual Knowledge		**CO 02, CO 03**		**CO 03**		
Procedural Knowledge		**CO 03**				
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	M	M	S	S	M
CO2	S	M	M	S	S	M
CO3	S	M	M	S	S	M

Where, S= Strong Correlation and M= Medium Correlation

Suggested books:

1. Frank Press Raymond Siever: Understanding Earth (3rd ed). W.H. Freeman and Company. New York .2000
2. B. J. Skinner and S.C. Porter: The Dynamic Earth – An Introduction to Physical Geology 3rd edition. John Wiley & Sons, New York. 1995
3. P. McL. D. Duff: Holme's Principles of Physical Geology (4th ed). Chapman & Hall. London. 1996
4. A. Cox & R.B. Hart Plate Tectonics How it works. Blackwell Scientific Publ. Co. Boston. 1986.
5. Philip A. Allen Earth Surface Processes Blackwell Sciences Ltd, Oxford 1997
6. B.W. Murck, B.J. Skinner & S.C. Porter Dangerous Earth – An Introduction to Geologic Hazards John Wiley & Sons New York 1996
7. B.W. Murck, B.J. Skinner & S.C. Porter, Environmental Geology. John Wiley & Sons, New York, 1996

Course Title : **Minerals, Rocks and Ores**
Course Code : **AGG-1A**
Nature of Course : **Multi-Disciplinary Generic Elective**
Total Credits : 3 credits
Distribution of Marks : 60 (End-Sem.) + 40 (In-Sem.)

COURSE OBJECTIVES: The course will provide an introduction to mineralogy, petrology, and related ore deposits**.** Basic principles of mineralogy and microscopy will be built upon to describe and interpret igneous, metamorphic, and economically important rocks and minerals.

UNITS	CONTENTS	L	T	P	Total Hours
I **(20 Marks)**	**Minerals** Definition and different categories of minerals and classification; Common rock forming minerals of Igneous, Sedimentary and Metamorphic rocks. Physical properties of minerals: characters depending on light, senses, heat, magnetism, electricity and radioactivity; Macroscopic identification of Minerals. Minerals used in the industry.	**16**	**03**		**20**
II **(22 Marks)**	**Rocks** The three groups of rocks: Igneous rocks: intrusive and extrusive rocks-their forms with examples. Classification and description of Igneous Rocks. Sedimentary Rocks: classification and description.clastic and non-clastic, Sedimentary rocks and natural resources. Metamorphic Rocks: metamorphism, naming of metamorphic rocks; Types of metamorphic rocks. Commercial use of rocks.	**18**	**04**		**22**
III **(18 Marks)**	**Ores** Definition of ore, ore minerals and average crustal composition; Economic deposit.Ore minerals in human concerns. Metallic and non-metallic ore minerals, gemstones. Use of ores in different mineral industries, refractory, ceramic, cement, fertilizer, chemical industries etc.	**15**	**03**		**18**
	Total				**60**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)
- **Two Internal Examination - 15+15**
- **Others (Any one) - 10**
  - **Group Discussion**
  - **Seminar presentation on any of the relevant topics**
  - **Debate**
  - **Home Assignment**

Course Outcomes (COs):

Students will be able to-

CO 01: Classify and describe different types of minerals, understand their formation in various rock types, and identify their physical properties.

LO 1.1: Classify and Describe Mineral Types and Rock-Forming Minerals**.**

LO 1.2: Identify Physical Properties and Techniques for Mineral Identification.

CO 02: Understand the industrial uses of minerals and evaluate their economic importance and impact on society and the environment.

LO 2.1: Evaluate the Industrial Uses and Economic Importance of Minerals.

LO 2.2: Understand the Role of Technology and Innovation in Mineral Utilization.

CO 03: Classify and describe the major types of rocks (igneous, sedimentary, and metamorphic), understand their formation processes, and recognize their commercial and geological significance.

LO 3.1: Classify Igneous Rocks based on their mineral composition and texture and describe various types and forms of intrusive and extrusive igneous rocks.

LO 3.2: Classify sedimentary rocks into clastic and non-clastic categories, describe their formation processes and analyze the depositional environments of sedimentary rocks and their significance in interpreting Earth's history.

LO 3.3: Explain the processes of metamorphism, including the factors of heat, pressure, and chemically active fluids, and classify metamorphic rocks based on their texture (foliated vs. non-foliated) and mineral composition.

CO 04: Develop the skills to recognize and analyze the economic and commercial uses of rocks, and understand their significance in various industries and natural resource management.

LO 4.1: Evaluate the Economic and Commercial Uses of Igneous Rocks.

LO 4.2: Understand and Analyze the Commercial Uses and Economic Significance of Sedimentary and Metamorphic Rocks

CO 05: Gain a thorough understanding of the nature and significance of ores, including their classification, economic importance, and applications in various industries, and will be able to assess their impact on human society and the environment.

LO 5.1: Define ores and ore minerals, explain their classification and describe their physical and chemical properties that make them valuable for extraction and use.

LO 5.2: Evaluate the Industrial Applications and Economic Importance of Ores

LO 5.3: Assess the Environmental and Societal Impacts of Ore Extraction and Use

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	**CO 01, CO 03**	**CO 01, CO 02**	**CO 04**			
Conceptual Knowledge	**CO 05**	**CO 01, CO 03**			**CO 02, CO 04**	
Procedural Knowledge		**CO 03, CO 04, CO 05**		**CO 05**		
Metacognitive Knowledge						

Mapping of Course Outcomes to Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	S	S	M	S	S
CO2	M	S	S	M	S	S
CO3	S	S	S	S	S	S
CO4	M	S	S	S	S	S
CO5	S	M	S	S	M	S

Where, S= Strong Correlation and M= Medium Correlation

SUGGESTED READINGS:

1. Alexander, P.O. 2009 A Handbook of Minerals, Crystals, Rocks and Ores. New India Pub. Agency, New Delhi.
2. Ehlers & Blatt. (1999). Petrology, Igneous, Sedimentary, Metamorphic. CBS.
3. Winter. (2015). Principles of Igneous and Metamorphic Petrology. Pearson Education India
4. Perkins, D. (2015). Mineralogy. Pearson Education India.
5. Earth Materials- Introduction to Mineralogy and Petrology, Cornelis Klein and Anthony Philpotts,
6. Understanding Earth (Sixth Edition), John Grotzinger and Thomas H. Jordan, 2010, W.H. Freeman andcompany, New York

Course Title : **Basic Geological Field Training**
Course Code : **AGSEC-1.1**
Nature of Course : **Skill Enhancement**
Total Credits : 3 credits
Distribution of Marks : 60 (End-Sem.) + 40 (In-Sem.)

COURSE OBJECTIVES: The purpose of basic field mapping is the skill enhancement to enable us the basic field techniques and procedures.

UNITS	CONTENTS	L	T	P	Total Hours
I **(20 Marks)**	Orientation of topographic maps in field, marking location in toposheets, concept of bearing; Topographic distance, height and pace approximation. Identification of rock types in field; structures and texture of rocks, Use of various field tools. Basic field measurement techniques, preparation of vertical profile.	**15**	**05**		**20**
II **(20 Marks)**	Field Work (06 days of field work)				**45**
III **(20 Marks)**	Preparation of field report.	**08**	**02**		**10**
	Total				**75**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- **One Internal Examination - 20 Marks**
- **Others (Any one) - 20 Marks**
  - **Group Discussion**
  - **Seminar presentation on the Field Report**
  - **Viva-voce**

COURSE OUTCOMES:
Students will be able to-

CO 01: Upon completion of this course, students will be proficient in conducting fieldwork related to geological mapping, rock identification, and basic measurement techniques.

LO 1.1: Orient themselves using topographic maps in the field, understand map scales, and interpret contour lines effectively.

LO 1.2: Identify different types of rocks, analyze their structures and textures, and use appropriate field tools for geological observation and measurement.

LO 1.3: Understand the concept of bearings, calculate topographic distances, approximate heights, and determine pace for field mapping accuracy.

LO 1.4: Acquire skills in basic field measurement techniques, including the preparation of vertical profiles, to interpret geological features and formations accurately.

CO 02: Proficiency in conducting geological fieldwork, applying theoretical knowledge to practical field situations, and analyzing geological formations and processes in natural settings.

LO 2.1: Effectively observe geological features, collect field data, and document their findings using appropriate methods and tools.

LO 2.2: Demonstrate the ability to create geological maps, interpret stratigraphic sequences, and identify rock units and structures in the field.

LO 2.3: Analyze geological data collected during fieldwork, synthesize information to draw conclusions about geological processes, and propose interpretations based on field observations.

LO 2.4: Adhere to safety protocols during field expeditions, demonstrating awareness of potential hazards and practicing responsible conduct in natural environments.

CO 03: Develop practical skills in geological fieldwork and effectively communicate their findings through detailed geological field reports.

LO 3.1: Analyze field data to prepare comprehensive geological field reports with clear interpretations and conclusions.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	**CO 01**	**CO 01**	**CO 01, CO 02**			
Conceptual Knowledge	**CO5**	**CO 01**	**CO 01, CO 02**	**CO 01, CO 02**	**CO 02**	
Procedural Knowledge		**CO 01, CO 02, CO 03**		**CO 02, CO 03**		
Metacognitive Knowledge					**CO 01, CO 02, CO 03**	

Mapping of Course Outcomes to Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	S	S	M	S	S
CO2	M	S	S	M	S	S
CO3	M	S	S	S	S	S

Where, S= Strong Correlation and M= Medium Correlation

SUGGESTED READINGS

1. Mathur, S.M (2001). Guide to Field Geology. Prentice Hall India Learning Private Limited.
2. Gokhale, N.W. (2009). A Guide to Field Geology. CBS.
3. Lahee, F.H. 1916. Field Geology.
4. Compton, R.R, 1985. Geology in the Field.

DETAILED SYLLABUS OF 2nd SEMESTER

Course Title **: Mineralogy and Crystallography**
Course Code **: AGC-2.1**
Nature of Course **: Major (Core)**
Total Credits **:** 04 credits
Distribution of Marks **:** 60 (End-Sem.) + 40(In-Sem.)

COURSE OBJECTIVES: Minerals are the basic building blocks of the solid Earth materials and also used as raw materials for mineral based industries. This requires a fundamental knowledge in mineral genesis, associations and occurrence to understand the mineralogical processes. This course is designed to gain basic principles and concepts behind the arrangement of atoms to form crystal structures and how this is reflected in the external form, chemical composition and mineral properties.

UNITS	CONTENTS	L	T	P	Total Hours
I (18 Marks)	**Crystallography** Crystal, Characteristics of crystal: Faces, Edges, Solid angle, Zone and Zone axis. Crystal symmetry: Planes, Axes and centre of symmetry. Faces, Intercepts and Symbols: Unit face, Parameters, Axial ratio, Miller indices. Fundamental laws of crystallography, crystal habits. Seven crystal system: Cubic, Tetragonal, Hexagonal, Trigonal, Orthorhombic, Monoclinic and Triclinic. Study of elements of symmetry and forms of the holosymmetric class of each crystal system. Crystal aggregates and twinned crystals. Twin laws, types of twins.	**15**	**03**		**18**
II (18 Marks)	**Mineralogy** Definition of mineral, Classification and physical properties of minerals, Isomorphism, Polymorphism and Pseudomorphism, Atomic substitution. Crystal structures of Silicate minerals. Common rock forming mineral Groups and their Structural formula, Physical and optical properties, mode of occurrence.	**15**	**03**		**18**
III (09 Marks)	**Optical Mineralogy** Nature of light, ordinary and plane polarized light. Optical properties of minerals.	**07**	**02**		**09**
IV Practical (15 Marks)	Identification of crystal models Study of crystals and symmetry elements of given crystal models Study and identification of rock forming minerals in hand specimens Mineral thin section study under microscope. Note Book Viva-voce			**15**	**30**
	Total				**75**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: **(40 Marks)**

- **Two Internal Examination -** **15+15**
- **Others (Any one) -** **10**
  - **Group Discussion**
  - **Seminar presentation on any of the relevant topics**
  - **Debate**
  - **Home Assignment**

COURSE OUTCOMES:

Students will be able to-

CO 01: Gain comprehensive knowledge of crystal structures and symmetry.

LO 1.1: Identify and describe the different characteristics of crystals such as faces, edges, solid angles, zones, and zone axes.

LO 1.2: Explain the principles of crystal symmetry including planes, axes, and centers of symmetry.

LO 1.3: Utilize Miller indices to determine and describe the orientation of crystal faces.

LO 1.4: Apply the fundamental laws of crystallography to classify and describe various crystal habits.

CO 02: Acquire the ability to classify and understand the properties of minerals.

LO 2.1: Define and categorize minerals based on physical and chemical properties.

LO 2.2: Describe and differentiate between isomorphism, polymorphism, and pseudomorphism in minerals.

LO 2.3: Explain atomic substitution and its impact on mineral properties.

LO 2.4. Identify and describe the crystal structures of silicate minerals and their significance in rock formation.

CO 03: Develop skills to analyze the optical properties of minerals using microscopy.

LO 3.1: Explain the nature of light and its interaction with minerals.

LO 3.2: Distinguish between ordinary and plane polarized light and their applications in optical mineralogy.

LO 3.3: Identify and describe the optical properties of minerals, such as birefringence, pleochroism, and interference colors.

LO 3.4: Utilize a polarizing microscope to study and identify minerals in thin sections.

CO 4: Demonstrate practical skills in identifying and analyzing crystal models and minerals.

LO 4.1|: Identify crystal models and their symmetry elements through hands-on examination.

LO 4.2: Conduct studies of rock-forming minerals in hand specimens, recognizing key physical properties.

LO 4.3: Prepare and analyze mineral thin sections using a microscope, recording observations in a detailed notebook.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	**CO 01, CO 02, CO 03**	**CO 01, CO 02**	**CO 01, CO 02, CO 03**			
Conceptual Knowledge		**CO 01, CO 02**	**CO 01, CO 02**	**CO 01, CO 02, CO 03**		
Procedural Knowledge		**CO 03, CO 04**	**CO 03, CO 04**	**CO 03, CO 04**		
Metacognitive Knowledge					**CO 01, CO 02, CO 03, CO 04**	

Mapping of Course Outcomes to Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	M	M	M	M
CO2	M	S	M	M	S	M
CO3	S	S	M	M	S	M
CO4	M	S	M	M	S	M

Where, S= Strong Correlation and M= Medium Correlation

SUGGESTED READINGS:

1. Perkins, D. (2015). Mineralogy. Pearson Education India.
2. Klein, C., Dutrow, B., Dwight, J., & Klein, C. (2007). The 23rdEdition of the Manual of Mineral Science (after James D. Dana). J. Wiley & Sons.
3. Deer, W. A., Howie, R. A., &Zussman, J. (1992). An introduction to the rock forming minerals (Vol. 696). London: Longman.
4. Gribble, C. D. (2005). Rutley's Elements of Mineralogy. CBS.
5. Mason & Berry (2004). Mineralogy. CBS.
6. Rabindra, H. N. (2012). Practical Approach to Crystallography and Mineralogy. CBS.
7. Sands, D. E. (1994). Introduction to Crystallography. Dover Publications Inc.
8. Schwarzenbach, D. (1997). Crystallography. Willey

Course Title : **Mineralogy and Crystallography**
Course Code : **AGM-2.1**
Nature of Course : **Minor**
Total Credits : **04 credits**
Distribution of Marks :**60 (End-Sem.) + 40 (In-Sem.)**

COURSE OBJECTIVES: Minerals are the basic building blocks of the solid Earth materials and also used as raw materials for mineral based industries. This requires a fundamental knowledge in mineral genesis, associations and occurrence to understand the mineralogical processes. This course is designed to gain basic principles and concepts behind the arrangement of atoms to form crystal structures and how this is reflected in the external form, chemical composition and mineral properties.

UNITS	CONTENTS	L	T	P	Total Hours
I **(20 Marks)**	**Crystallography** Introduction to crystals, Characteristics of crystal: Faces, Edges, Solid angle, Zone and Zone axis. Crystal symmetry: Planes, Axes and centre of symmetry. Faces, Intercepts and Symbols: Unit face, Parameters, Axial ratio, Miller indices. Fundamental laws of crystallography, crystal habits. Seven crystal system: Cubic, Tetragonal, Hexagonal, Trigonal, Orthorhombic, Monoclinic and Triclinic. Twinning in crystals: types, causes and laws.	**16**	**04**		**20**
II **(25 Marks)**	**Mineralogy** Mineral: Definition & classification, Physical properties of minerals, Isomorphism, Polymorphism and Pseudomorphism, Atomic substitution. Crystal structures of Silicate minerals. Common rock forming mineral Groups and their Structural formula. Optical Mineralogy: Nature of light, ordinary and plane polarized light. Optical properties of minerals.	**20**	**05**		**25**
III **Practical** **(15 Marks)**	Identification of crystal models Study of crystals and symmetry elements of given crystal models Study and identification of rock forming minerals in hand specimens and in thin sections under microscope Note Book Viva-voce			**15**	**30**
	Total				**75**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: **(40 Marks)**

- **Two Internal Examination -** **15+15**
- **Others (Any one) -** **10**
  - **Group Discussion**
  - **Seminar presentation on any of the relevant topics**
  - **Debate**
  - **Home Assignment**

COURSE OUTCOMES:

Students will be able to-

CO 01: Gain comprehensive knowledge of crystal structures and symmetry.

LO 1.1: Identify and describe the different characteristics of crystals such as faces, edges, solid angles, zones, and zone axes.

LO 1.2: Explain the principles of crystal symmetry including planes, axes, and centers of symmetry.

LO 1.3: Utilize Miller indices to determine and describe the orientation of crystal faces.

LO 1.4: Apply the fundamental laws of crystallography to classify and describe various crystal habits.

CO 02: Acquire the ability to classify and understand the properties of minerals.

LO 2.1: Define and categorize minerals based on physical and chemical properties.

LO 2.2: Describe and differentiate between isomorphism, polymorphism, and pseudomorphism in minerals.

LO 2.3: Explain atomic substitution and its impact on mineral properties.

LO 2.4. Identify and describe the crystal structures of silicate minerals and their significance in rock formation.

CO 03: Develop skills to analyze the optical properties of minerals using microscopy.

LO 3.1: Explain the nature of light and its interaction with minerals.

LO 3.2: Distinguish between ordinary and plane polarized light and their applications in optical mineralogy.

LO 3.3: Identify and describe the optical properties of minerals, such as birefringence, pleochroism, and interference colors.

LO 3.4: Utilize a polarizing microscope to study and identify minerals in thin sections.

LO 3.5|: Identify crystal models and their symmetry elements through hands-on examination.

LO 3.6: Conduct studies of rock-forming minerals in hand specimens, recognizing key physical properties.

LO 3.7: Prepare and analyze mineral thin sections using a microscope, recording observations in a detailed notebook.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	**CO 01, CO 02, CO 03**	**CO 01, CO 02**	**CO 01, CO 02, CO 03**			
Conceptual Knowledge		**CO 01, CO 02**	**CO 01, CO 02**	**CO 01, CO 02, CO 03**		
Procedural Knowledge		**CO 03**	**CO 03**	**CO 03**		
Metacognitive Knowledge					**CO 01, CO 02, CO 03**	

Mapping of Course Outcomes to Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	M	M	M	M
CO2	M	S	M	M	S	M
CO3	S	S	M	M	S	M

Where, S= Strong Correlation and M= Medium Correlation

SUGGESTEDREADINGS:

1. Perkins, D. (2015). Mineralogy. Pearson Education India.
2. Klein, C., Dutrow, B., Dwight, J., & Klein, C. (2007). The 23rdEdition of the Manual of Mineral Science (after James D. Dana). J. Wiley & Sons.
3. Deer, W. A., Howie, R. A., &Zussman, J. (1992). An introduction to the rock forming minerals (Vol. 696). London: Longman.
4. Gribble, C. D. (2005). Rutley's Elements of Mineralogy. CBS.
5. Mason & Berry (2004). Mineralogy. CBS.
6. Rabindra, H. N. (2012). Practical Approach to Crystallography and Mineralogy. CBS.
7. Sands, D. E. (1994). Introduction to Crystallography. Dover Publications Inc.
8. Schwarzenbach, D. (1997). Crystallography. Willey

Course Title : **Earthquake Studies**
Course Code : **AGGEC-2.1**
Nature of Course : **Multi-Disciplinary Generic Elective**
Total Credits : 03 credits
Distribution of Marks : 60 (End-Sem.) + 40 (In-Sem.)

COURSE OBJECTIVES: The course is designed to provide students the basic concepts of earthquakes, along with some practice in analyzing seismological database.

UNITS	CONTENTS	L	T	P	Total Hours
I (15 Marks)	Theory of elasticity, Generalized Hooke's law, Different types of elastic waves	**12**	**03**		**15**
II (20Marks)	Earthquakes: Causes and effects, Various magnitude and intensity scales, Elastic rebound theory.	**16**	**04**		**20**
III (25 Marks)	Earthquake belts of the world. Classification of earthquakes, Seismometers, Analysis of seismograms, Seismic networks and arrays, Earthquake forecasting. Seismicity and seismo tectonics of India, Seismic hazard map of India.	**20**	**05**		**25**
	Total				**60**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- **Two Internal Examination - 15+15**
- **Others (Any one) - 10**
  - **Group Discussion**
  - **Seminar presentation on any of the relevant topics**
  - **Debate**
  - **Home Assignment**

Course Outcome:
Students will be able to:

CO 01: Develop a solid foundation in the theory of elasticity and the behavior of elastic waves.

LO 1.1: Explain the fundamental concepts of the theory of elasticity and its significance in geophysics.
LO 1.2: Apply Generalized Hooke's law to describe the relationship between stress and strain in elastic materials.
LO 1.3: Differentiate between various types of elastic waves, such as P-waves, S-waves, and surface waves, and understand their propagation through the Earth.

CO 02: Gain comprehensive knowledge about earthquakes, their causes, effects, and measurement techniques.

LO 2.1: Identify and explain the causes and effects of earthquakes, including the mechanisms behind them.
LO 2.2: Understand and utilize various magnitude and intensity scales to quantify earthquakes.
LO 2.3: Describe the Elastic Rebound Theory and its role in understanding the earthquake cycle.

CO 03: Acquire the skills to classify, analyze earthquakes, with a focus on seismicity and seismotectonics.

LO 3.1: Classify different types of earthquakes and explain their characteristics.
LO 3.2: Operate seismometers, analyze seismograms, and understand the functioning of seismic networks and arrays.

LO 3.3: Explore the seismicity and seismotectonics of India, interpret the seismic hazard map of India, and discuss methods of earthquake forecasting.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	**CO 01, CO 02, CO 03**	**CO 01, CO 02, CO 03**	**CO 03**	**CO 03**		
Conceptual Knowledge		**CO 01, CO 02, CO 03**	**CO 03**	**CO 03**		
Procedural Knowledge		**CO 01, CO 02, CO 03**	**CO 01, CO 02**			
Metacognitive Knowledge					**CO 01, CO 02, CO 03**	

Mapping of Course Outcomes to Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	M	M	S	M
CO2	S	S	M	S	S	M
CO3	S	S	S	S	S	M

Where, S= Strong Correlation and M= Medium Correlation

SUGGESTED READINGS:

1. Shearer, P.M. (2009). Introduction to Seismology. Cambridge University Press.
2. Lowrie, W. (2007). Fundamentals of Geophysics. Cambridge University Press.
3. Scholz, C.H. (2002). The Mechanics of Earthquakes and Faulting. Cambridge University Press.
4. Bullen, K.E. and Bolt, B.A. (1985). An Introduction to the Theory of Seismology. Cambridge University Press.
5. Gubbins, D. (1990). Seismology and Plate Tectonics. Cambridge University Press.

Course Title : **Basic Surveying Techniques and GIS**
Course Code : **AGSEC-2.1**
Nature of Course : **Skill Enhancement**
Total Credits : 03credits
Distribution of Marks : 60 (End-Sem.) + 40 (In-Sem.)

COURSE OBJECTIVES: This course is intended to impart knowledge on various field-based techniques of surveying, their principles, history and development, instrument and techniques and their applications.

UNITS	CONTENTS	L	T	P	Total Hours
I (15 Marks)	**Principles of Surveying** History of development of surveying, applications of surveying in the field of geography, geology and engineering. Great Trigonometric Survey of India. Concept of Geodetic and Plan Survey: Datum, Control Points, Horizontal and Vertical Controls, Geoid: topo surface, geodetic surface, ellipsoidal surface and its significance in maps, Azimuth and bearing. Triangulation and Traversing.	**12**	**03**		**15**
II (15 Marks)	**Surveying and Levelling** Compass, Chain and Plane Table Surveying. Electronic Distance Measurement System. Theodolite and Total Stations. Global Positioning System and its use in surveying. Level, Types of levels and Methods of Levelling: direct method, trigonometrical method, differential leveling, reciprocal method, barometric method Contouring from leveling: triangular intersection method, DEM and DTM. **Applications** Application of surveying in Geological Mapping and Sampling	**12**	**03**		**15**
III (15 Marks)	**GIS** Introduction to Coordinate systems: Cartesian Coordinate System, Geographic Coordinate system, Map Projection. Introduction and definitions of GIS, components, application areas of GIS, advantages and disadvantages of GIS Data formats, Raster data model and vector data model.	**12**	**03**		**15**
IV Practical (15 Marks)	Visual Image Interpretation Working with GIS Software. Note Book Viva Voce			**15**	**30**
	Total				**75**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- **Two Internal Examination - 15+15**
- **Others (Any one) - 10**
  - **Group Discussion**
  - **Seminar presentation on any of the relevant topics**
  - **Debate**
  - **Home Assignment**

COURSE OUTCOME:
Students will be able to-

CO 01: Acquire a comprehensive understanding of the principles and historical development of surveying and its applications.

LO 1.1: Describe the history of the development of surveying and its applications in geography, geology, and engineering.
LO 1.2: Understand and differentiate between geodetic and plan surveys, including concepts such as datum, control points, and horizontal and vertical controls.
LO 1.3: Explain the significance of geoid, topo surface, geodetic surface, and ellipsoidal surface in mapping, and discuss the concepts of azimuth and bearing, triangulation, and traversing.

CO 02: Develop practical skills in various surveying and leveling techniques and understand their applications.

LO 2.1: Operate traditional surveying instruments such as compass, chain, and plane table, and understand the basics of electronic distance measurement systems.
LO 2.2: Utilize advanced surveying instruments like theodolites, total stations, and the Global Positioning System (GPS) for accurate measurements.
LO 2.3: Apply different methods of leveling, including direct, trigonometrical, differential, reciprocal, and barometric methods, and use contouring techniques to create Digital Elevation Models (DEM) and Digital Terrain Models (DTM).

CO 03: Gain foundational knowledge and practical skills in Geographic Information Systems (GIS) and their applications.

LO 3.1: Understand the basics of coordinate systems, including Cartesian and Geographic Coordinate Systems, and the principles of map projection.
LO 3.2: Define GIS, its components, application areas, advantages, and disadvantages, and differentiate between raster and vector data models.
LO 3.3: Demonstrate proficiency in visual image interpretation and working with GIS software to analyze spatial data and create maps, supported by practical notebook work and a viva voce.

CO 04: Develop practical skills in visual image interpretation and GIS software for spatial data analysis.

LO 4.1: Demonstrate proficiency in visual image interpretation for extracting meaningful information from spatial data.
LO 4.2: Work effectively with GIS software to analyze spatial data, create maps, and present findings in a well-documented notebook, culminating in a viva voce to demonstrate practical knowledge and skills.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	**CO 01, CO 02, CO 03**	**CO 01, CO 02, CO 03**	**CO 01, CO 02, CO 03, CO 04**			
Conceptual Knowledge		**CO 02, CO 03**	**CO 02, CO 03**	**CO 02, CO 03**		
Procedural Knowledge		**CO 02, CO 03, CO 04**	**CO 02, CO 03, CO 04**			
Metacognitive Knowledge					**CO 01, CO 02, CO 03, CO 04**	

Mapping of Course Outcomes to Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	M	M	S	M
CO2	S	S	M	S	S	M
CO3	S	S	S	S	S	M
CO4	M	S	S	M	M	M

Where, S= Strong Correlation and M= Medium Correlation

SUGGESTED READINGS:

1. Surveying and Leveling by N.N. Basak.
2. Surveying and Leveling by Rangawala
3. "GIS Fundamentals: A First Text on Geographic Information Systems" by Paul Bolstad.

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course : PRINCIPLES OF STRUCTURAL GEOLOGY
Course Code : AGC 3.1
Nature of The Course : Core
Total Credits : 04 Credits
Distribution of Marks : 60 (End Sem) + 40 (In-Sem)

COURES OBJECTIVES: The primary objective of structural geology is to learner's understanding of the history of deformation in rocks. The deformation of the lithosphere by tectonic forces can be learnt through this subject. Further, this subject helps us to understand the geodynamics in the regional and global scale. Students can acquire knowledge about the structural control on ore localisation and landscape evolution are also learnt through this subject. To help students to understand the application of structural geology in the civil engineering geology projects is huge.

UNITS	CONTENTS	L	T	P	Total Hours
I (12 marks)	**Geological Structures and Topography:** Topographic and structural maps Importance of scale of the map. **Introduction to Rock Mechanics:** Concept of rock deformation. Stress and Strain in rocks. Strain ellipses of different types and their significances. Stress at a point: Mohr diagram.	**10**	**2**		**12**
II (16 marks)	**Folds, foliation and lineations:** Fold morphology; Geometric and genetic classification of folds; Mechanics and causes of folding: Buckling, Bending and Flexural slip folding. Description and origin of foliations: axial plane cleavage and its tectonic significance. Description and origin of lineation and relationship with the major structures	**13**	**03**		**16**
III (17 marks)	**Faults, Joints, shear zones and unconformities:** Geometric and genetic classification of fractures and faults. Effects of faulting on the outcrops. Criteria for recognition of faults. Geometric and genetic classification of joints. Introduction shear zones: significance of mylonite and cataclasites. Unconformities: classification and significance **Orogeny:** Concept of Orogeny and orogenesis. Important Orogenic belts of the world. Structural framework of NE-India, Assam and Assam-Arakan basin.	**14**	**03**		**17**
IV Practical (15marks)	Drawing profile sections and interpretation of geological maps of different complexities. Exercises of stereographic projections of mesoscopic structural data (planar, linear, folded etc.). Solving problems through geometric methods.			**15**	**30**
	Total				**75**

L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: **(40 Marks)**

- **Two Internal Examination -** **20 + 10**
- **Others (Any one) -** **5**
  - **Group Discussion**
  - **Seminar presentation on any of the relevant topics**
  - **Debate**
  - **Home Assignment**
- **One practical In-sem** **5**

COURSE OUTCOMES:
Students will be able to:

CO 01: Develop a thorough understanding of geological structures, topographic mapping, and rock mechanics, with a focus on stress and strain in rocks.

LO 1.1: Explain the importance of scale in topographic and structural maps and interpret these maps for geological analysis.
LO 1.2: Understand the basic concepts of rock mechanics, including rock deformation, and describe how stress and strain affect rock structures.
LO 1.3: Illustrate the significance of strain ellipses and analyze stress conditions in rocks using the Mohr diagram.

CO 02: Gain knowledge of the morphology, classification, and mechanics of folds, as well as the origin and significance of foliations and lineations.

LO 2.1: Describe fold morphology and classify folds based on geometric and genetic criteria; understand the mechanics and causes of folding, including buckling, bending, and flexural slip folding.
LO 2.2: Explain the description and origin of foliations, particularly axial plane cleavage, and its tectonic significance.
LO 2.3: Describe the origin of lineations and their relationship with major geological structures.

CO 03: Acquire comprehensive knowledge of the classification and significance of faults, joints, shear zones, and unconformities, and understand orogeny and structural frameworks.

LO 3.1: Classify fractures and faults geometrically and genetically, recognize the effects of faulting on outcrops, and identify criteria for recognizing faults.
LO 3.2: Classify joints geometrically and genetically, and understand the significance of shear zones, including mylonites and cataclasites.
LO 3.3: Explain the concept and significance of unconformities, orogeny, and describe important orogenic belts of the world and the structural framework of NE-India, Assam, and the Assam-Arakan basin.

Co 04: Develop practical skills in drawing profile sections, interpreting geological maps, and solving structural geology problems.

LO 4.1: Draw and interpret profile sections of geological maps of varying complexities.
LO 4.2: Conduct exercises in stereographic projections of mesoscopic structural data, including planar, linear, and folded structures.
LO 4.3: Solve geological problems using geometric methods and interpret the results effectively**.**

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	**CO 01**	**CO 01, CO 02, CO 03**	**CO 01, CO 02, CO 03, CO 04**	**CO 01, CO 02, CO 03, CO 04**		
Conceptual Knowledge		**CO 02, CO 03, CO 04**	**CO 02, CO 03, CO 04**	**CO 02, CO 03, CO 04**		
Procedural Knowledge		**CO 04**	**CO 04**	**CO 04**		
Metacognitive Knowledge					**CO 01, CO 02, CO 03, CO 04**	

Mapping of Course Outcomes to Program Outcomes

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	S	M	S	S	M
CO2	S	S	M	S	S	M
CO3	S	S	M	S	S	M
CO4	S	S	S	S	S	M

Where, S= Strong Correlation and M= Medium Correlation

SUGGESTED READING:

1. Pluijm, B. A. V.D., and Marshak, S, 2003. Earth Structure. Second Edition. W.W. Norton and Company. ISBN 0-393-92467-X.
2. Fossen, H. 2010. Structural Geology, Cambridge University Press, ISBN: 978-0-521-51664-8,
3. Ghosh, S.K., 1993. Structural Geology: Fundamentals and Modern Developments, Pergamon Press, Oxford, p 598.
4. Pollard, D. D. (2005) Fundamental of Structural Geology. Cambridge University Press.

Course Title : **Palaeontology**
Course Code : **AGC 3.2**
Nature of Course : **Core**
Total Credits : **04 credits**
Distribution of Marks : **60 (End-Sem.) + 40 (In-Sem.)**

COURSE OBJECTIVES: Palaeontology deals with identification, classification and taxonomic description of past life forms as fossils. It aids in their construction of palaeoenvironment, palaeoclimate, palaeoecology, palaeoceanography and palaeobiogeography. It is an important tool applied for hydrocarbon exploration.

UNITS	CONTENTS	L	T	P	Total Hours
I (15 Marks)	**Introduction to Palaeontology, Fossil Nomenclature and Taxonomy** Palaeontology: definition, branches, scopes and applications. Fossil: definition and types. Process of fossilization. Conditions and modes of preservation. Fossil: Nomenclature, Type specimens, Concept of species, Taxonomy, Taxonomic hierarchy, Binomial system of nomenclature, Naming of genera and species. General principles of Palaeontology: Phylogenetic and Phenetic classification Theory of organic evolution interpreted from fossil records.	**12**	**03**		**15**
II (15 Marks)	**Vertebrate and Invertebrate Fossils** General idea of vertebrate fossils: Origin of vertebrates and their evolution. Mesozoic reptiles with special reference to origin, diversity and extinction of dinosaurs. Evolution of horse and intercontinental migrations. Human evolution. Brief introduction to important invertebrate groups: Brachiopoda, Pelecypoda, Gastropoda, Cephalopoda, Trilobita, Echinoidea, Anthozoa and Foraminifera and their biostratigraphic significance. **Microfossils** Microfossils, what are they? Classification of microfossils	**12**	**03**		**15**
III (15 Marks)	**Palaeobotany** General idea about Palaeobotany, Plant fossils and Palynology. Gondwana Floras of India. **Applied Palaeontology** Biostratigraphy, Biozones and Correlation Application of Fossils for palaeoenvironment analysis, palaeoclimatic interpretation, reconstruction of palaeobiogeography and hydrocarbon exploration. Palaeoecology-fossils as a window to the evolution of ecosystems.	**12**	**03**		**15**
IV Practical (15 Marks)	Study of fossils showing various modes of preservation. Study of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate, vertebrate and plant fossils.			**15**	**30**

	Note Book Viva Voce				
	Total				**75**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- **Two Internal Examination - 20 (T) + 10 (P)**
- **Others (Any one) - 10**
  - **Group Discussion**
  - **Seminar presentation on any of the relevant topics**
  - **Debate**
  - **Home Assignment**

COURSE OUTCOMES:
Students will be able to:

CO 01: Develop a foundational understanding of palaeontology, fossil nomenclature, taxonomy, and the interpretation of organic evolution from fossil records.

LO 1.1: Define palaeontology and explain its branches, scopes, and applications.
LO 1.2: Describe the process of fossilization, conditions, and modes of preservation.
LO 1.3: Explain fossil nomenclature, including type specimens, the concept of species, taxonomy, taxonomic hierarchy, and the binomial system of nomenclature.
LO 1.4: Compare and contrast phylogenetic and phenetic classifications in palaeontology.
LO 1.5: Discuss the theory of organic evolution as interpreted from fossil records.

CO 02: Gain knowledge of vertebrate and invertebrate fossils, their evolution, and their significance in palaeontology.

LO 2.1: Explain the origin and evolution of vertebrates, with a focus on important groups and their evolutionary trends.
LO 2.2: Discuss Mesozoic reptiles, particularly dinosaurs, covering their origin, diversity, and extinction.
LO 2.3: Trace the evolution of the horse and analyze intercontinental migrations in vertebrate evolution.
LO 2.4: Provide a brief introduction to important invertebrate groups such as Brachiopoda, Pelecypoda, Gastropoda, Cephalopoda, Trilobita, Echinoidea, Anthozoa, and Foraminifera, emphasizing their biostratigraphic significance.
LO 2.5: Define microfossils and classify them based on their types.

CO 03: Understand the principles and applications of palaeobotany and applied palaeontology in geological sciences.

LO 3.1: Describe the field of palaeobotany, including plant fossils and palynology.
LO 3.2: Discuss Gondwana Floras of India, focusing on their composition and significance.
LO 3.3: Explain biostratigraphy, biozones, and correlation using fossils.
LO 3.4: Apply fossils for palaeoenvironmental analysis, palaeoclimatic interpretation, reconstruction of palaeobiogeography, and hydrocarbon exploration.
LO 3.5: Explore palaeoecology and how fossils provide insights into the evolution of ecosystems.

CO 04: Acquire practical skills in studying fossils, including modes of preservation, morphological characters, systematic position, and stratigraphic and chronological placement.

LO 4.1: Analyze fossils showing various modes of preservation and their implications for interpretation.
LO 4.2: Identify diagnostic morphological characters of various invertebrate, vertebrate, and plant fossils.
LO 4.3: Determine the systematic position of fossils within taxonomic classifications.

LO 4.4: Establish the stratigraphic position and age of fossils through stratigraphic and chronostratigraphic methods.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	**CO 01, CO 02, CO 03**	**CO 02, CO 03**	**CO 01, CO 02, CO 03, CO 04**	**CO 01, CO 02, CO 03, CO 04**		
Conceptual Knowledge		**CO 01, CO 02, CO 03**	**CO 01, CO 02, CO 03**	**CO 01, CO 02, CO 03, CO 04**		
Procedural Knowledge						
Metacognitive Knowledge					**CO 01, CO 02, CO 03, CO 04**	

Mapping of Course Outcomes to Program Outcomes

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	S	M	S	S	M
CO2	S	S	M	S	S	M
CO3	S	S	S	S	S	M
CO4	M	M	S	S	S	S

Where, S= Strong Correlation and M= Medium Correlation

SUGGESTEDREADINGS:

1. Dasgupta A. An Introduction to Palaeontology, World Press.
2. Jain & Anantharaman (2016). Palaeontology, Palaeobiology. Vishal Publishing Co.
3. Benton, M. (2014). Vertebrate Palaeontology 4thEdition.Wiley-Blackwell
4. Raup, D.M., Stanley, S. M., Freeman, W. H.(1971)Principles of Paleontology
5. Clarkson, E. N. K. (2012) Invertebrate paleontology and evolution 4th Edition by Blackwell Publishing.
6. Benton, M.(2009).Vertebrate paleontology. John Wiley & Sons.
7. Shukla, A.C., & Misra, S.P.(1975).Essentials of paleobotany. Vikas Publisher
8. Shrock R. R. and Twenhofel W. H. Principles of Invertebrate Palaeontology, CBS Publishers & Distributors
9. Armstrong, H.A., & Brasier, M.D.(2005) Microfossils. Blackwell Publishing.
10. Kathal P. K., Applied Geological Micropalaeontology: Scientific Publishers, India
11. Nield E.W. and Tucker V.C.T. Palaeontology – An Introduction,Pergamon Press
12. Jain P.C. and Anantharaman M.S. Palaeontology (Palaeobiology) Evolution and Animal Distribution Vishal Publishing Co.

Course Title : **Fundamentals of Petrology**
Course Code : **AGM 3.1**
Nature of Course : **Minor**
Total Credits : **04 credits**
Distribution of Marks :**60 (End-Sem.) + 40 (In-Sem.)**

COURSE OBJECTIVES: The course aims to provide a comprehensive understanding of the origin, composition, structure, and classification of rocks, with a focus on igneous, sedimentary, and metamorphic processes. Students will learn to identify and interpret petrologic features, gaining insights into Earth's geological history and its implications for resource exploration and environmental studies.

UNITS	CONTENTS	L	T	P	Total Hours
I (15 Marks)	**Igneous petrology**: General idea of igneous petrology. Magma & Lava: Definitions, origin and generation of magma, physical properties, composition & chemical properties, types of lava flows. Evolution of Magma, Magmatic differentiation, Mixing and Assimilation. Textures, structures and mode of occurrences of igneous rocks. Classification of Igneous rocks: Textural, mineralogical and chemical. IUGS Classification of igneous rocks.	**12**	**03**		**15**
II (15 Marks)	**Sedimentary petrology:** Origin of Sediments: weathering and erosion, physical and chemical weathering, transportation of sediments by running water, wind, ice, gravity and sea waves. Diagenesis and lithification. Sedimentary textures and structures. Use of textures and structures in interpreting depositional conditions. Sedimentary environments and facies. Classification of sedimentary rocks: textural and genetic classification of clastic and non-clastic sedimentary rocks.	**12**	**03**		**15**
III (15 Marks)	**Metamorphic Petrology:** Metamorphism: definition and controlling factors. Types of metamorphism: contact, regional, fault zone metamorphism, impact metamorphism. Texture and structure of metamorphic rocks. Classification of metamorphic rocks: pelitic, basic, calcic and calc-silicates. Concept of metamorphic zones and facies: Index minerals, Metamorphic zones and isograde. Concept of metamorphic facies and grade.	**12**	**03**		**15**
IV Practical (15 Marks)	Study of igneous, sedimentary and metamorphic rocks in hand specimens. Study of igneous, sedimentary and metamorphic rocks in thin section (mineralogy, texture and petrogenesis). Note Book and Viva Voce			**15**	**30**

	Total		75

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- **Two Internal Examination - 20 (T) + 10 (P)**
- **Others (Any one) - 10**
  - **Group Discussion**
  - **Seminar presentation on any of the relevant topics**
  - **Debate**
  - **Home assignment**

COURSE OUTCOMES:
Students will be able to:

CO 01: Understand the principles of igneous petrology, including the origin of magma, types of lava flows, magmatic evolution, and the classification of igneous rocks.

LO 1.1: Define magma and lava, and describe their origin and generation processes.
LO 1.2: Explain the physical and chemical properties of magma and lava, and their compositions.
LO 1.3: Discuss the processes of magmatic differentiation, mixing, and assimilation.
LO 1.4: Identify and describe the textures, structures, and occurrences of igneous rocks.
LO 1.5: Classify igneous rocks based on textural, mineralogical, and chemical criteria, following the IUGS classification system.

CO 02: Gain knowledge of sedimentary petrology, covering sediment origin, transportation, diagenesis, lithification, and the classification of sedimentary rocks.

LO 2.1: Explain the origin of sediments through weathering and erosion processes.
LO 2.2: Describe physical and chemical weathering processes and the transportation of sediments by various agents.
LO 2.3: Discuss diagenesis and lithification processes in sedimentary rocks.
LO 2.4: Identify and interpret sedimentary textures and structures and their implications for depositional environments.
LO 2.5: Classify sedimentary rocks based on textural and genetic criteria for both clastic and non-clastic rocks.

CO 03: Understand metamorphic petrology, including the definition of metamorphism, types of metamorphism, texture and structure of metamorphic rocks, and the classification of metamorphic rocks.

LO 3.1: Define metamorphism and identify its controlling factors.
LO 3.2: Differentiate between contact, regional, fault zone, and impact metamorphism.
LO 3.3: Describe the textures and structures characteristic of metamorphic rocks.
LO 3.4: Classify metamorphic rocks into pelitic, basic, calcic, and calc-silicate categories.
LO 3.5: Explain the concept of metamorphic zones, facies, index minerals, metamorphic zones, isograde, and metamorphic grade.

CO 04: Develop practical skills in the identification and study of igneous, sedimentary, and metamorphic rocks using hand specimens and thin sections.

LO 4.1: Identify and describe the characteristics of igneous rocks in hand specimens, including mineralogy, texture, and petrogenesis.
LO 4.2: Analyze sedimentary rocks in hand specimens, interpreting their depositional environments based on texture and structure.
LO 4.3: Study metamorphic rocks in hand specimens, identifying textures, structures, and petrogenetic processes.
LO 4.4: Analyze thin sections of igneous, sedimentary, and metamorphic rocks, describing mineralogy, texture, and petrogenetic features under a microscope.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge		**CO 01, CO 02, CO 03**	**CO 01, CO 02, CO 03, CO 04**	**CO 01, CO 02, CO 03, CO 04**		
Conceptual Knowledge		**CO 01, CO 02, CO 03, CO 04**	**CO 01, CO 02, CO 03**	**CO 01, CO 02, CO 03, CO 04**		
Procedural Knowledge						
Metacognitive Knowledge					**CO 01, CO 02, CO 03, CO 04**	

Mapping of Course Outcomes to Program Outcomes

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	S	M	S	S	M
CO2	S	S	M	S	S	M
CO3	S	S	M	S	S	M
CO4	S	S	S	S	S	S

Where, S= Strong Correlation and M= Medium Correlation

SUGGESTEDREADINGS:

1. "Igneous and Metamorphic Petrology" by Myron G. Best
2. "Petrology: Igneous, Sedimentary, and Metamorphic" by Harvey Blatt, Robert J. Tracy, and Brent Owens
3. "Principles of Igneous and Metamorphic Petrology" by John D. Winter
4. "Metamorphic Petrology" by Bruce Yardley
5. Ehlers & Blatt. (1999). Petrology, Igneous, Sedimentary, Metamorphic.

Course Title : **Geo-heritage and Geo-tourism**
Course Code : **AGG 3A**
Nature of Course : **Multi-Disciplinary Generic Elective**
Total Credits : 03 credits
Distribution of Marks :60 (End-Sem.) + 40 (In-Sem.)

COURSE OBJECTIVES: The primary objective of offering the course of Geotourism is to understand the various aspects of Geoheritage sites and their tourism potential.

UNITS	CONTENTS	L	T	P	Total Hours
I (15 Marks)	Introduction and history of geoheritage concept, geoheritage resources, geosites, geodiversity, heritage stone. Geoparks: creation, management and outputs.	**12**	**03**		**15**
II (20 Marks)	Global geoheritage. National Geological Monuments: fossil parks, rock monuments, geological marvels, other monuments. National Geological Monuments/ Geological type- sections in Northeast India.	**16**	**04**		**20**
III (25 Marks)	Definition of geotourism and modern geotourism, scope of geotourism, methods of geotourism, potentiality for a geotourism site The Geotourism Industry in the 21st Century: A futuristic approach; Geotrails. Visit to geotourism sites.	**20**	**05**		**25**
	Total				**60**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- **Two Internal Examination - 15 + 15**
- **Others (Any one) - 10**
  - **Group Discussion**
  - **Seminar presentation on any of the relevant topics**
  - **Debate**
  - **Home Assignment**

COURSE OUTCOMES:
Students will be able to:

CO 01: Understand the concept of geoheritage, geoparks, and their management, including the significance of heritage stones and geodiversity.

LO 1.1: Explain the concept and historical development of geoheritage.
LO 1.2: Identify geoheritage resources and geosites, and describe their importance.
LO 1.3: Define geodiversity and discuss its role in geoheritage conservation.
LO 1.4: Describe heritage stones and their significance in architectural and cultural contexts.
LO 1.5: Outline the creation, management strategies, and outputs of geoparks.

Co 02: Explore global geoheritage and focus on national geological monuments, including their types and significance in Northeast India.

LO 2.1: Analyze global geoheritage sites and their geological significance.
LO 2.2: Identify and classify national geological monuments such as fossil parks, rock monuments, and geological marvels.
LO 2.3: Describe specific geological type-sections and their importance in Northeast India.

LO 2.4: Evaluate the preservation and management strategies of national geological monuments.

CO 03: Define geotourism, explore its scope, methods, and potential for development as a sustainable tourism industry.

LO 3.1: Define geotourism and modern approaches to promoting geological attractions.
LO 3.2: Discuss the scope and potential for geotourism development at various sites.
LO 3.3: Analyze methods used in geotourism to enhance visitor experience and environmental conservation.
LO 3.4: Explore the futuristic approach of the geotourism industry in the 21st century.
LO 3.5: Plan and design geo-trails to facilitate educational and recreational visits to geotourism sites.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	**CO 01, CO 02, CO 03**	**CO 01, CO 02, CO 03**	**CO 01, CO 03**	**CO 02, CO 03**		
Conceptual Knowledge	**CO 01, CO 02, CO 03**		**CO 03**			
Procedural Knowledge						
Metacognitive Knowledge					**CO 01, CO 02, CO 03**	

Mapping of Course Outcomes to Program Outcomes

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	M	S	M	M	S	M
CO2	S	S	M	M	S	M
CO3	M	S	M	M	S	M

Where, S= Strong Correlation and M= Medium Correlation

SUGGESTED READINGS:

1. Geoheritage and Geotourism resources edited by N. Santangeolo and E. Valente
2. Principles of Geotourism by A. Chen, Y. Lu, Young C.Y.NG

Course Title : **Geological Mapping**
Course Code : **AGSEC 3.1**
Nature of Course : **Skill Enhancement Course**
Total Credits : 3 credits
Distribution of Marks : 60 (End-Sem.) + 40 (In-Sem.)

COURSE OBJECTIVES: Geological mapping deals with use of the different instruments and techniques in the field and enhance the skill of understanding the earth through measurement, plotting, sketching, correlating etc.

UNITS	CONTENTS	L	T	P	Total Hours
I (20 Marks)	Geological mapping, Identification and field documentation of primary (scalars and vectors) and secondary structures (linear and planar); Stratigraphic correlation Trend, plunge, Rake/Pitch of geological structures, Stereo plots of linear and planar structures, Orientation analyses	**10**	**05**		**15**
II (20 Marks)	Field work				**45**
III (20 Marks)	Field Report	**10**	**05**		**15**
	Total				**75**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (30 Marks)

- **One Internal Examination - 10**
- **Others (Any one) - 20**
  - **Group Discussion**
  - **Seminar presentation on Field Report**
  - **Viva-voce**

COURSE OUTCOMES:

Syudents will be able to:

CO 01: Develop proficiency in geological mapping techniques and structural analysis, including the identification, documentation, and interpretation of geological structures.

LO 1.1: Perform geological mapping, identifying primary structures (scalars and vectors) and secondary structures (linear and planar).

LO 1.2: Document geological structures in the field, including their orientation, trend, plunge, and rake/pitch.

LO 1.3: Apply stratigraphic correlation techniques to establish relationships between rock units.

LO 1.4: Construct stereo plots of linear and planar structures using field data.

LO 1.5: Analyze orientation data using statistical methods and interpret geological structures.

CO 02: Gain practical experience in conducting fieldwork, applying theoretical knowledge to real-world geological settings.

LO 2.1: Demonstrate proficiency in field techniques for geological mapping and structural analysis.

LO 2.2: Apply fieldwork skills to identify and document geological features and structures accurately.

LO 2.3: Collaborate effectively with peers and instructors during field exercises.

LO 2.4: Practice safety protocols and ethical considerations during fieldwork operations.

CO 03: Develop skills in compiling and presenting comprehensive field reports based on geological fieldwork observations and analyses.

LO 3.1: Compile field observations, measurements, and interpretations into a structured field report.

LO 3.2: Analyze and interpret geological data collected during fieldwork.

LO 3.3: Present findings clearly and concisely, using appropriate terminology and diagrams.

LO 3.4: Incorporate recommendations and conclusions based on field observations and analyses.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge		**CO 01**	**CO 02, CO 03**	**CO 01, CO 02, CO 03**		
Conceptual Knowledge	**CO 01, CO 02, CO 03**	**CO 01, CO 02, CO 03**	**CO 02**			
Procedural Knowledge						
Metacognitive Knowledge					**CO 01, CO 02, CO 03**	

Mapping of Course Outcomes to Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	M	M	M	M	M
CO2	M	S	M	M	S	M
CO3	S	S	M	M	S	M

Where, S= Strong Correlation and M= Medium Correlation

SUGGESTED READINGS:

1. Lahee, F.H. 1916. Field Geology.
2. Compton, R.R, 1985. Geology in the Field.
3. Barnes, J.W. 4th Edition, Basic Geological Mapping.
4. Mathur, S.M (2001). Guide to Field Geology. Prentice Hall India Learning Private Limited.
5. Gokhale, N.W. (2009). A Guide to Field Geology.CBS.