Assam University, Silchar

Four Year Undergraduate Programme

Implemented under NEP 2020

Effective from the Academic Year 2023-24

Syllabus of Geology

Approved in the 94th meeting (Special) of the Academic Council held on 20th July, 2023 vide Resolution No AC:94:7-23:6

Programme Specific Outcome

Bachelor in Geology with Honours/Honours and Research

This programme enables students in developing a successful and progressing geology career. The programme is devised to promote critical thinking and employable skills and also to encourage them to become responsible citizens.

Programme Specific Outcomes

- To ensure a comprehensive understanding of the different branches of geology.
- To comprehend students understanding of the age, composition, structure, processes, and evolutionary history of the Earth.
- To enable the students to explore and manage various Earth resources like minerals, fossil fuel and natural gas, coal, building stones, underground and surface water etc.
- To provide students with an understanding of the potential of natural processes in causing hazards and disasters.
- To empower students with an awareness of scientific procedures and solve problems in various disciplines of geology.
- To foster a sense of scientific responsibility as well as social and environmental awareness.

Table 1: Semester-wise list of Geology DSC (Discipline Specific Core) Courses

Semester	Course Code	Title of Courses	Credits
I	GEL-DSC-101	Introduction to Geology	3
	GEL-DSC-102	Crystallography and Mineralogy	3
II	GEL-DSC-151	Introduction to Petrology	3
	GEL-DSC-152	Practicals on GEL-DSC-101, -102 & -151	3
III	GEL-DSC-201	Structural Geology and Plate Tectonics	4
	GEL-DSC-202	Geomorphology and Hydrogeology	4
IV	GEL-DSC-251	Descriptive Mineralogy and Mineral Optics	4
	GEL-DSC-252	Principles of Palaeontology and Stratigraphy	4
	GEL-DSC-253	Practicals on GEL-DSC-201, -202, -251 & -252	4
V	GEL-DSC-301	Igneous and Metamorphic Petrology	4
	GEL-DSC-302	Sedimentology	4
	GEL-DSC-303	Practicals on GEL-DSC-301, and -302	4
VI	GEL-DSC-351	Palaeontology and Indian Stratigraphy	4
	GEL-DSC-352	Economic Geology	4
	GEL-DSC-353	Elements of Geophysics and Geochemistry	4
	GEL-DSC-354	Practicals on GEL-DSC-351, -352 & -353	4
VII	GEL-DSC-401	Engineering and Mining Geology	4
	GEL-DSC-402	Environmental Geology and Remote Sensing	4
	GEL-DSC-403	Geology of NE India and Himalayan Geology	4
	GEL-DSC404	Practicals on GEL-DSC-401, -402, & -403	4
VIII	GEL-DSC-451	Research Methodology/ Advanced Petrology	4
	GEL-DSC-452	Fuel Geology	4
	GEL-DSC-453	Advanced Palaeontology	4
	GEL-DSC-454	Climatology and Oceanography	4
	GEL-DSC-455	Research Project/Dissertation	12

Table 2: Semester-wise list of Geology DSM (Discipline Specific Minor) Courses

Semester	DSM1/DSM2	Course Code	Title of Courses	Credits
I	DSM1	GEL-DSM-101	Crystallography, Mineralogy and Petrology	3
II	DSM2	GEL-DSM-151	Introduction to Minerals and Rocks	3
III	DSM1	GEL-DSM-201	Physical Geology and Structural Geology	3
IV	DSM1	GEL-DSM-251	Practicals on GEL-DSM-101 & -201	3
	DSM2	GEL-DSM-252	Petrology	3
V	DSM1	GEL-DSM-301	Geobiology and Stratigraphy	3
	DSM2	GEL-DSM-302	Geomorphology and Structural Geology	3
VI	DSM2	GEL-DSM-351	Practicals on GEL-DSM-151, -252 & -302	3
VII	DSM1	GEL-DSM-401	Engineering and Environmental Geology	3
VIII	DSM2	GEL-DSM-451	Palaeontology and Stratigraphy	3

Table 3: Semester-wise list of Geology SEC (Skill Enhancement Course) Courses

Semester	Course Code	Title of Courses	Credits
I	GEL-SEC-101	Skill in Geology-I and Practical/Field work	3
II	GEL-SEC-151	Skill in Geology-II, Project and Field work	3
III	GEL-SEC-201	Skill in Geology-III and Practical/Field work	3

Table 4: Semester-wise list of Geology IDC (Inter-Disciplinary Course) Courses

Semester	Course Code	Title of Courses	Credits
I	GEL-IDC-101	General Geology and Planetary Geology	3
II	GEL-IDC-151	Evolution of Life Through Time	3
III	GEL-IDC-201	Geoenvironment and Geohazards	3

Syllabi of Geology DSC Courses

Semester **: FIRST**
Course Type **: Discipline Specific Core**
Course Code **: GEL-DSC-101**
Name of the Course **: Introduction to Geology**
Learning level **: Introductory Course**
Credits **: 03**
Contact Hours **: 45 Hours**
Total Marks **: 100**
End Semester Marks **: 70**
Internal Marks **: 30 (Written Test: 20 marks + Attendance: 10 marks)**

Course Objectives: The course is designed to provide basic understandings of geology, its scope and its various branches; to impart fundamental knowledge on the Earth System, crystals, minerals and fossils.

UNIT - I: Geology and its different branches, Scope of Geology, Geological Time Scale, Solar System, Theories of origin of the Earth.

UNIT - II: Interior of the Earth; Elementary knowledge of lithosphere, biosphere, hydrosphere and atmosphere and their interrelationship; Endogenic and Exogenic processes of the Earth.

UNIT - III: Concept of crystalline and amorphous state of matters; Types of Crystals; Basics of Crystal Systems; Mineral and it's physical properties: colour, streak, lustre, fracture, cleavage, hardness, structure and forms.

UNIT - IV: Concept of stratigraphy; Understanding the past from stratigraphic records; Nature of stratigraphic records; Introduction to age dating of rocks, fossil and its types; Evolution of life through geological time.

UNIT - V: Introduction to different rock types and their characteristics; Lithospheric plates: continental and oceanic; Fundamentals of plate tectonics; Basic idea about cratons, shield, platforms, mobile-belts, geosynclines; Concepts of orogeny and sea floor spreading.

***Course Learning Outcomes*:**

- Students can explain the Earth's structure and composition.
- Students can define and explain fundamental geological concepts, definitions and theories (such as minerals, rocks, plate tectonics and orogeny).
- Students will have preliminary idea about fossils and evolution of life through geologic time.
- Students will be able to understand the concept of plate tectonics.

Books Recommended:

1. WD Thornbury, 2002. Principles of Geomorphology. CBS Publ. New Delhi.
2. Arthur Holmes, 1992. Principles of Physical Geology. Chapman and Hall, London.

3. P.M.D. Duff, and D. Duff, (Eds.) 1993. Holmes' principles of Physical Geology. Taylor & Francis
4. C Emiliani, 1992. Planet Earth: Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press.
5. Miller, 1949. An Introduction to Physical Geology. East West Press Ltd.
6. E.V. Spencer, 1962. Basic concepts of Physical Geology. Oxford & IBH.
7. G.B. Mahapatra, 1994. A text book of Physical geology. CBS Publishers.
8. E.S. Dana, and W.E. Ford, 2002. A Textbook of Mineralogy (Reprints).
9. Y. Flint, 1975. Essential of crystallography, Mir Publishers.
10. F.C. Phillips, 1963. An introduction to crystallography. Wiley, New York.
11. M.S. Krishnan, 1982. Geology of India and Burma, 6th Edition. CBS Publ.
12. Ravindra Kumar, 1985. Fundamentals of Historical Geology & Stratigraphy of India. Wiley Eastern.
13. G.W Tyrell, 1989. Principles of Petrology. Methuren and Co (Students ed.).

Semester	**: FIRST**
Course Type	**: Discipline Specific Core**
Course Code	**: GEL-DSC-102**
Name of the Course	**: Crystallography and Mineralogy**
Learning level	**: Introductory Course**
Credits	**: 03**
Contact Hours	**: 45 Hours**
Total Marks	**: 100**
End Semester Marks	**: 70**
Internal Marks	**: 30 (Written Test: 20 marks + Attendance: 10 marks)**

Course Objectives: The paper aims to provide understandings of the basics of crystallography and mineralogy that helps in understanding and building the overall knowledge in Geology. The students will learn crystal structure and forms; symmetry elements of crystals, stereographic projection, crystal parameters, indices, lattice concepts, point groups, and space groups; will familiarise themselves with the physical properties of minerals and concepts of mineral twinning.

UNIT - I: Crystal and crystallization; Parts of crystals: face, edge, apex, solid angle, interfacial angle and zone; Crystal form and habit; Laws of crystallography; Axial ratio; Laws of rational indices.

UNIT - II: Classification of crystals into systems and description of symmetry elements of normal classes of each system; Stereographic projection – concepts, principles, construction of Wolf's net.

UNIT - III: Crystal parameters and indices; Concept of lattice, space-lattice, point group, space group; Bravis' space lattice; Crystal symmetry- elements of symmetry; H. M. symbols.

UNIT - IV: Twinning- concept, elements, types; Laws of twinning; twinning in feldspar, quartz and staurolite; X-ray crystallography, X-ray diffraction, Bragg's law; Powder and single crystal methods.

UNIT - V: Concept of mineral; classification of minerals into rock and ore forming minerals; Chemical classification of minerals; Physical properties of minerals and their significance; Moh's scale of hardness; Silicate minerals: definition and classification based on silicate structure; Isomorphism, polymorphism, pseudomorphism, solid solution and exsolution.

***Course Learning Outcomes*:**

- Students will build understandings of crystallography, including crystal structures and forms.
- Students will gain proficiency in classification of crystals based on symmetry elements and applying stereographic projection for visual representation.
- They will be able to interpret crystal parameters, indices, and understand lattice concepts, point groups, and space groups.
- They will develop knowledge of mineral classification, including rock and ore-forming minerals, chemical classification, and physical properties.

- They will be familiar with silicate minerals and their classification based on structures, as well as concepts such as isomorphism, polymorphism, pseudomorphism, solid solution, and exsolution.

Books Recommended:

1. E.S. Dana and W.E. Ford, 2002. A Textbook of Mineralogy (Reprints).
2. Y. Flint, 1975. Essential of Crystallography. Mir Publishers.
3. F.C. Phillips, 1963. An Introduction to Crystallography. Wiley, New York.
4. L.G. Berry, B. Mason, and RV Dietrich, 1982. Mineralogy. CBS Publ.
5. D.W. Nesse, 1986. Optical Mineralogy. McGraw Hill.
6. H.H. Read, 1968. Rutley's Element of Mineralogy (Rev. Ed.). Thomas Murby and Co.
7. Berry and Mason, 1961. Mineralogy. W.H. Freeman & Co.
8. B.F. Kerr, 1995. Optical Mineralogy (5th Ed.) Mc Graw Hill, New York

Semester	**: SECOND**
Course Type	**: Discipline Specific Core**
Course Code	**: GEL-DSC-151**
Name of the Course	**: Introduction to Petrology**
Learning level	**: Introductory Course**
Credits	**: 03**
Contact Hours	**: 45 Hours**
Total Marks	**: 100**
End Semester Marks	**: 70**
Internal Marks	**: 30 (Written Test: 20 marks + Attendance: 10 marks)**

Course Objectives: The paper aims to provide understandings on origin of magma and various forms and textures of igneous rocks; to gain knowledge of sedimentary rock forming processes, classification and texture and structure of sedimentary rocks; to comprehend agents and types of metamorphism and their effects on structures and textures.

UNIT - I: Origin, composition and types of magma; Mode of occurrence; Forms and textures of igneous rocks; Bowen's reaction principle and crystallization of magma; IUGS classification of Igneous rocks.

UNIT - II: Nomenclature and a brief petrographic description of the following common igneous rocks: Granite, Pegmatite, Rhyolite, Diorites, Granodiorite, Gabbro, Dolerite, Syenite, Dunite, Peridotite, Basalt, Dacite, Andesite, Trachyte.

UNIT - III: Sediments and their genetic classes/types; Sedimentary rock forming processes - disintegrating rock into clasts, chemical weathering reactions, clastic transport, deposition, Chemical and biochemical sedimentation, lithification and diagenesis (compaction, dissolution, cementation, precipitation, recrystallisation, replacement); Soils and Paleosols; Mineralogical composition of sedimentary rocks; Geological importance of sedimentary rocks.

UNIT - IV: Classification of sedimentary rocks based on: Mineralogical Composition, Chemical Composition, Texture, Size and shapes of Grain, Mode of Origin and Depositional Basin; Textures of sedimentary rocks; Nomenclature and brief petrographic descriptions of siliciclastic, carbonate and biogenic sedimentary rocks.

UNIT- V: Metamorphism, its agents and types; Forms and structures of metamorphic rocks, Textures of metamorphic rocks; Nomenclature and brief description of the following common metamorphic rocks: Slate, Phyllite, Schist, Gneiss, Amphibolite, Myllonite, Hornfels, Quartzite, Marble, Migmatite, Granulite, Eclogite, Cataclasite and Blueschist.

***Course Learning Outcomes*:**

- Students will gain comprehensive understanding of the formation and characteristics of igneous, sedimentary, and metamorphic rocks.
- Ability to describe various types of rocks based on their composition, and texture
- Gain knowledge of the geological processes involved in the formation of rocks, including crystallization, weathering, sedimentation, and metamorphism.

Books Recommended:

1. J.D. Winter, 2014. Principles of igneous and metamorphic petrology. Pearson.
2. Myron G. Best 2002. Igneous and Metamorphic Petrology. Blackwell Science.
3. M.K. Bose, 1997. Igneous Petrology. World Press, Kolkata
4. Yardley, B. W., & Yardley, B. W. D. 1989. An Introduction to Metamorphic Petrology. Longman Earth Science Series.
5. L. A. Raymond, 2002. Petrology: The Study of Igneous, Sedimentary, and Metamorphic rocks. McGraw Hill, New York.
6. R. Mason, 1978. Petrology of Metamorphic Rocks. CBS Publ.
7. H.G.C. Winkler, 1967. Petrogenesis of Metamorphic Rocks. Narosa Publ.
8. D.R. Prothero, & F. Schwab, 2004. Sedimentary Geology. Macmillan.
9. M. E. Tucker, 2006. Sedimentary Petrology, Blackwell Publishing.
10. J.D. Collinson, & D.B. Thompson, 1988. Sedimentary structures, Unwin-Hyman, London.
11. G. Nichols, 2009. Sedimentology and Stratigraphy Second Edition. Wiley-Blackwell.
12. Sam Boggs, Jr. 2009. Petrology of Sedimentary Rocks, Cambridge.
13. W.G. Ehlers and H. Blatt, 1987. Petrology: Igneous, Sedimentary and Metamorphic rocks. CBS Publishers.
14. Friedman & Sanders, 1978. Principles of Sedimentology. John Wiley and sons.
15. F.J. Pettijohn, 1975. Sedimentary Rocks, Harper & Bros. 3rd Ed.
16. S. Sengupta, 1997. Introduction to Sedimentology. Oxford-IBH.

Semester	**: SECOND**
Course Type	**: Discipline Specific Core**
Course Code	**: GEL-DSC-152**
Name of the Course	**: Practicals on GEL-DSC-101, -102 & -151**
Learning level	**: Introductory Course**
Credits	**: 03**
Contact Hours	**: 60 Hours**
Total Marks	**: 100**
End Semester Marks	**: 100**

Course Objectives: The paper aims to enable students to identify rock-forming and ore-forming minerals, based on physical and optical properties and also to identify and describe common igneous, sedimentary and metamorphic rocks.

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- Study of symmetry elements and forms of the crystals belonging to the normal classes of all crystal systems; Stereographic projection of crystals of normal classes of all crystal systems.
- Study of physical properties of common rock forming minerals in hand specimen
- Identification of common rock forming minerals based on optical properties under Microscopes.
- Megascopic (Hand specimen) and microscopic (Thin-section) studies of igneous rocks. Exercises related to classification of Igneous rocks.
- Megascopic and microscopic studies of sedimentary rocks. Studies of sedimentary structures in hand specimens.
- Exercises related to palaeocurrent analysis.
- Exercises related to Grain-size analysis: plotting and interpretation of size distribution data as frequency and cumulative curves.
- Megascopic and microscopic studies of metamorphic rocks.

***Course Learning Outcomes*:**

- Learn the crystals formation, form, Symmetry of normal crystal classes
- Learn stereographic projection of crystals of normal classes of all crystal systems for visual representation
- Learn the identification of minerals, in hand and in thin-section under Microscope.
- Learn the identification of rocks, in hand and in thin-section under Microscope.

Syllabi of Geology DSM Courses

Semester	**: FIRST**
Course Type	**: Discipline Specific Minor**
Course Code	**: GEL-DSM-101**
Name of the Course	**: Crystallography, Mineralogy and Petrology**
Learning level	**: Introductory Course**
Credits	**: 03**
Contact Hours	**: 45 Hours**
Total Marks	**: 100**
End Semester Marks	**: 70**
Internal Marks	**: 30 (Written Test: 20 marks + Attendance: 10 marks)**

Course Objectives: The paper aims to provide understandings of the basics of crystallography and mineralogy. The paper also aims to provide understandings on the processes of formation of igneous, sedimentary, and metamorphic rocks and their physical characteristics.

UNIT - I: Parts of crystals: face, edge, apex, solid angle, interfacial angle and zone; Crystal form and habit; Laws of crystallography; Axial ratio; Laws of rational indices. Classification of crystals into systems and description of symmetry elements of normal classes of each system.

UNIT -II: Minerals - definition and classification, Moh's scale of hardness, physical and chemical properties, composition of common rock-forming minerals, silicate and non-silicate structures; CCP and HCP structures.

UNIT -III: Concepts of Igneous petrology: Heat flow, geothermal gradients through time, origin and nature of magma; Processes of differentiation and evolution of magma; Bowen's reaction principle and reaction series; IUGS Classification of igneous rocks; Textures and structures of igneous rocks; Mode of occurrence and forms of igneous rocks.

UNIT - IV: Sediments and their genetic classes/types; weathering and sedimentary flux: physical and chemical weathering, lithification and diagenesis (compaction, dissolution, cementation, precipitation, replacement); Classification of sedimentary rocks based on: Mineralogical Composition, Chemical Composition, Texture, Size and Shapes of Grain, Mode of Origin and Depositional Basin; Geological importance of sedimentary rocks.

UNIT - V: Metamorphism: agents and types, factors controlling metamorphism, types of metamorphism - contact, regional, fault zone metamorphism, impact metamorphism, structures and textures of metamorphic rocks.

***Course Learning Outcomes*:**

- Students will build understandings of crystallography, including crystal structures and forms.
- Students will gain proficiency in classification of crystals based on symmetry elements.

- Students will gain comprehensive understanding of the formation and characteristics of igneous, sedimentary, and metamorphic rocks.

Books Recommended:

1. E.S. Dana, and W.E. Ford, 2002. A Textbook of Mineralogy (Reprints).
2. D.W. Nesse, 1986. Optical Mineralogy. McGraw Hill.
3. B.F. Kerr, 1995. Optical Mineralogy 5th Ed. Mc Graw Hill, New York
4. A. Phillpotts, & J. Ague, 2009. Principles of Igneous and Metamorphic Petrology. Cambridge University Press.
5. J.D. Winter, 2014. Principles of igneous and metamorphic petrology. Pearson.
6. Myron G. Best, 2001. Igneous and Metamorphic Petrology,
7. M.K. Bose, 1997. Igneous Petrology.
8. R. Mason, 1978. Petrology of Metamorphic Rocks. CBS Publ.
9. H.G.C. Winkler, 1967. Petrogenesis of Metamorphic Rocks. Narosa Publ.
10. D.R. Prothero & F. Schwab, 2004. Sedimentary Geology. Macmillan.
11. M. E. Tucker, 2006. Sedimentary Petrology. Blackwell Publishing.
12. G. Nichols, 2009. Sedimentology and Stratigraphy Second Edition. Wiley-Blackwell.
13. Sam Boggs, Jr. (2009). Petrology of Sedimentary Rocks, Cambridge.
14. Friedman & Sanders, 1978. Principles of Sedimentology. John Wiley and sons.
15. F.J. Pettijohn, 1975. Sedimentary rocks, Harper & Bros. 3rd Ed.
16. S. Sengupta, 1997. Introduction to sedimentology. Oxford-IBH.

Semester	**: SECOND**
Course Type	**: Discipline Specific Minor**
Course Code	**: GEL-DSM-151**
Name of the Course	**: Introduction to Minerals and Rocks**
Learning level	**: Introductory Course**
Credits	**: 03**
Contact Hours	**: 45 Hours**
Total Marks	**: 100**
End Semester Marks	**: 70**
Internal Marks	**: 30 (Written Test: 20 marks + Attendance: 10 marks)**

Course Objectives: This paper aims to understand minerals and their properties and classification; to gain fundamental knowledge of igneous, metamorphic and sedimentary rocks.

UNIT - I: Minerals - definition and classification, Moh's scale of hardness, physical and chemical properties, composition of common rock-forming minerals, silicate and non-silicate structures; CCP and HCP structures.

UNIT -II: Properties of light and optical microscopy, nature of light and principles of optical mineralogy, introduction to the petrological microscope and identification of common rock-forming minerals, refractive index and its determination, optical accessories- quartz wedge, gypsum plate and mica plate, Types of extinction and determination of extinction angle.

UNIT -III: Concepts of Igneous petrology: Heat flow, geothermal gradients through time, origin and nature of magma; Processes of differentiation and evolution of magma; Bowen's reaction principle and reaction series; IUGS Classification of igneous rocks; Textures and structures of igneous rocks; Mode of occurrence and forms of igneous rocks.

UNIT - IV: Sediments and their genetic classes/types; weathering and sedimentary flux: physical and chemical weathering, lithification and diagenesis (compaction, dissolution, cementation, precipitation, recrystallisation, replacement); Classification of sedimentary rocks based on: Mineralogical Composition, Chemical Composition, Texture, Size and Shapes of Grain, Mode of Origin and Depositional Basin; Geological importance of sedimentary rocks.

UNIT - V: Metamorphism: agents and types, factors controlling metamorphism, types of metamorphism - contact, regional, fault zone metamorphism, impact metamorphism, structures and textures of metamorphic rocks.

Course Learning Outcomes:

- Understandings of classification, properties, and composition of minerals.
- Knowledge of igneous petrology, including magma processes and the classification of rocks.
- Understandings of sedimentary processes, rock classification, and their geological significance.

- Learn the process of metamorphism, including its types, controlling factors, and the structures of metamorphic rocks.

Books Recommended:

1. E.S. Dana, and W.E. Ford, 2002. A Textbook of Mineralogy (Reprints).
2. D.W. Nesse, 1986. Optical Mineralogy. McGraw Hill.
3. B.F. Kerr, 1995. Optical Mineralogy 5th Ed. Mc Graw Hill, New York
4. A. Phillpotts, & J. Ague, 2009. Principles of Igneous and Metamorphic Petrology. Cambridge University Press.
5. J.D. Winter, 2014. Principles of igneous and metamorphic petrology. Pearson.
6. Myron G. Best, 2001. Igneous and Metamorphic Petrology,
7. M.K. Bose, 1997. Igneous Petrology.
8. R. Mason, 1978. Petrology of Metamorphic Rocks. CBS Publ.
9. H.G.C. Winkler, 1967. Petrogenesis of Metamorphic Rocks. Narosa Publ.
10. D.R. Prothero & F. Schwab, 2004. Sedimentary Geology. Macmillan.
11. M. E. Tucker, 2006. Sedimentary Petrology. Blackwell Publishing.
12. G. Nichols, 2009. Sedimentology and Stratigraphy Second Edition. Wiley-Blackwell.
13. Sam Boggs, Jr. (2009). Petrology of Sedimentary Rocks, Cambridge.
14. Friedman & Sanders, 1978. Principles of Sedimentology. John Wiley and sons.
15. F.J. Pettijohn, 1975. Sedimentary rocks, Harper & Bros. 3rd Ed.
16. S. Sengupta, 1997. Introduction to sedimentology. Oxford-IBH.

Syllabi of Geology SEC Courses

Semester	**: FIRST**
Course Type	**: Skill Enhancement Course**
Course Code	**: GEL-SEC-101**
Name of the Course	**: Skill in Geology-I and Practical/Field work**
Learning level	**: Introductory Course**
Credits	**: 03**
Contact Hours	**: 45 Hours**
Total Marks	**: 100**
End Semester Marks	**: 80 (Theory: 50 + Practical: 30)**
Internal Marks	**: 20 (Written Test: 14 marks + Attendance: 6 marks)**

Course objectives: This course aims to provide fundamental knowledge on petrological microscope and its practical uses; to provide elementary idea on geological maps, toposheets, survey, and geological field work; to provide elementary knowledge on Indian occurrences of industrial minerals and rocks.

Section A: Theory; Skill in Geology-I (50 marks)

UNIT - I: Microscope (Petrological) – parts, function, polarization of light, construction of Nicol prism, preparation of thin section of rocks and minerals.

UNIT - II: Introduction to map, Type of maps, scale and their types, Toposheets and its study, Reading toposheets of Survey of India.

UNIT - III: Survey- plain table, Theodolite, Chain survey, Total Station.

UNIT - IV: Basics of field work- uses of field tools- Clinometer, Brunton compass, planning traverse; bearing – azimuth and quadrant; outcrop, concept of bed, dip and strike.

UNIT - V: Properties, occurrences and distribution of the following industrial minerals/ rocks in India: Gold, diamond, chromite, bauxite, magnetite, hematite, sphalerite, limestone, gypsum, graphite, corundum, mica, marble, clay minerals.

Section B: Practical/ Field Work (30 marks)

Course Learning Outcomes:

- Students will have practical knowledge on Petrological microscope.
- They will able to understand geological map and toposheets.
- They will gain understanding about different types of survey and preliminary knowledge on how to conduct a geological field investigation.

- Students will able to understand the properties, occurrences and distributions of industrial minerals and rocks.

Books Recommended:

1. R.J. Lisle, P.J. Brabham, and J.W. Barnes, 2011. Basic Geological Mapping (5^{th} Ed.) Wiley-Blackwell, UK
2. Michael M. Raith, Peter Raase & Jürgen Reinhardt, 2012. Guide To Thin Section Microscopy (Second Edition) ISBN 978-3-00-037671-9
3. Claudia Owen, Diane Pirie, and Grenville Draper 2011, Earth Lab: Exploring the Earth Sciences, Third Edition. Cengage Learning, USA

Semester	**: SECOND**
Course Type	**: Skill Enhancement Course**
Course Code	**: GEL-SEC-151**
Name of the Course	**: Skill in Geology-II, Project and Field work**
Learning level	**: Introductory Course**
Credits	**: 03**
Contact Hours	**: 45 Hours**
Total Marks	**: 100**
End Semester Marks	**: 80 (Theory: 50 + Practical: 30)**
Internal Marks	**: 20 (Written Test: 14 marks + Attendance: 6 marks)**

Course objectives: This course is designed to provide fundamental knowledge on ore microscope and its practical uses, ore polishing techniques and separation of heavy minerals and fossils; to provide understanding on preparation and interpretation of geological maps; to familiar with the drainage basin system.

Section A: Theory; Skill in Geology-II (50 marks)

UNIT - I: Ore Microscope: - parts, functions, properties of ore minerals studied under ore microscope. Techniques of polishing ore.

UNIT - II: Study and interpretation of maps, outcrop completion, preparation of cross- section of geological map.

UNIT - III: Collection and separation of fossil, separation of heavy minerals. Use of chemicals in geology, construction of lithologs.

UNIT - IV: Basics of field data collection, analysis, interpretation and report writing. Techniques of preparing geological map. Interaction between geological structure and topography.

UNIT - V: River system- bank erosion, meandering and ox-bow lake, flood plains paleo-channel, drainage pattern.

Section B: Project and Field Work (30 marks)

Course Learning Outcomes:

- Students will learn functions and working principles of ore microscope.
- They will learn ore polishing techniques and will be able to separate heavy minerals and fossils.
- They will learn how to prepare and interpret a geological map.
- They will have knowledge on different aspects of drainage basin systems.

Books Recommended:

1. R.J. Lisle, P.J. Brabham, and J.W. Barnes, 2011. Basic Geological Mapping (5th Ed.), Wiley-Blackwell, UK

2. Claudia Owen, Diane Pirie, and Grenville Draper 2011, Earth Lab: Exploring the Earth Sciences, Third Edition. Cengage Learning, USA
3. Angela L. Coe (Ed) 2010 Geological Field Techniques. Blackwell Publishing
4. Maria A Mange and Heinz F. W. Maurer, 1992. Heavy minerals in Colours. Chapman and Hall, UK

Syllabi of Geology IDC Courses

Semester **: FIRST**
Course Type **: Inter-Disciplinary Courses**
Course Code **: GEL-IDC-101**
Name of the Course **: General Geology and Planetary Geology**
Learning level **: Introductory Course**
Credits **: 03**
Contact Hours **: 45 Hours**
Total Marks **: 100**
End Semester Marks **: 70**
Internal Marks **: 30 (Written Test: 20 marks + Attendance: 10 marks)**

***Course Objectives*:** The course aims to provide basic understanding on different branches of geology, interior of the Earth and different surficial geological processes; To provide fundamental knowledge on our solar system, Galaxy and Milky-way.

UNIT - I: Geology and its different branches, scope of geology, Geological time scale, Theories of origin of the Earth.

UNIT - II: Interior of the Earth, elementary knowledge of lithosphere, biosphere, hydrosphere and atmosphere and their interrelationship, endogenic and exogenic processes of the Earth.

UNIT - III: Weathering and erosion; Origin, types, geological work and related features of wind, running water, glacier, volcanoes; Physiographic sub-divisions of India.

UNIT - IV: Our Solar System: its origin, structure and components; Physical properties of planets and satellites; Terrestrial planets and outer planets; Study of the surface of Mars, Venus and Mercury, Jupiter's Moons, preliminary concept of stelar system.

UNIT - V: Galaxy and Milky-way- their origin and physical properties; Asteroids and Meteorites- their origin and physical properties; Accretion of planets; Moon- Origin and geological history; Lunar surface environment, Lunar rocks, Lunar maria, Lunar craters and their origin.

Course Learning Outcomes:

- Students will acquire knowledge on exogenic and endogenetic processes of the Earth.
- They will learn the Earth's structure and composition.
- They will learn the origin of the solar system and Earth.
- They will have preliminary knowledge on the origin and physical properties of the Galaxy and Milky-way.

Books Recommended:

1. W.D. Thornbury, 2002. Principles of Geomorphology. CBS Publ. New Delhi.
2. Arthur Holmes, 1992. Principles of Physical Geology. Chapman and Hall, London.

3. P.M.D., Duff & D. Duff, (Eds.). 1993. Holmes' principles of physical geology. Taylor & Francis.
4. C. Emiliani, 1992. Planet Earth: Cosmology, Geology, and the Evolution of Life and Environment. Cambridge University Press.
5. Miller, 1949. An Introduction to Physical Geology. East West Press Ltd.
6. E.V. Spencer, 1962. Basic concepts of Physical Geology. Oxford & IBH.
7. G.B. Mahapatra, 1994. A text book of Physical geology. CBS Publishers.
8. Plummer & McGeary Carlson, 2008. Physical Geology, McGraw-Hill.

Semester	**: SECOND**
Course Type	**: Inter-Disciplinary Courses**
Course Code	**: GEL-IDC-151**
Name of the Course	**: Evolution of Life Through Time**
Learning level	**: Introductory Course**
Credits	**: 03**
Contact Hours	**: 45 Hours**
Total Marks	**: 100**
End Semester Marks	**: 70**
Internal Marks	**: 30 (Written Test: 20 marks + Attendance: 10 marks)**

***Course Objectives*:** The course aims to provide a comprehensive knowledge on the animal- and plant-fossils preserved in rocks, as well as how living forms responded to climatic and environmental catastrophes; to understand origin and evolution of life through geological time.

UNIT - I: **Origin of Life**: Possible life sustaining sites in the solar system; Earth's first life; Evidence of Archean life; Chemical evidence bearing on the origin of life, Transition from Archean to Proterozoic, The Great Oxidation Event; Precambrian macrofossils – The garden of Ediacara. The Snow Ball Earth Hypothesis.

UNIT - II: **Paleozoic Life**: The Cambrian explosion of life; Ordovician life; Episodic mass extinctions of Cambrian trilobites; Ordovician climatic change and mass extinction; Renewed diversification of life during middle Paleozoic: Radiation of fishes, Early land plants and impact of land vegetation.

UNIT - III: **Mesozoic Life**: Life after the largest (P/T) mass extinction; Life in the Jurassic seas; Origin and evolution of mammals; Diversification of reptiles: Archosaurs and the Origin of Dinosaurs, Rise and fall of dinosaurs; Origin and evolution of birds; Spread of flowering plants on land.

UNIT - IV: **Cenozoic Life**: Aftermath of end Cretaceous mass extinction– radiation of mammals in the Paleocene and Eocene; Expansion of modern groups of hoofed animals, carnivores and primates in the Oligocene; Rise of modern plants and vegetation.

UNIT - V: **The age of Humans and Global Climate Change**: The radiation of primates; Human evolution and the Origin of *Homo Sapiens*; Link between climate and geology; The climate system; Usefulness of seafloor sediments in the study of past climates; The greenhouse effect; Natural causes of climate change; Human impacts on global climate; Some possible consequences of global warming, Climatic fluctuations of the last 10,000 years.

Course Learning Outcomes:

- The students will gain knowledge on the animal and plant fossils.
- Students will obtain a greater understanding of the complexity and diversity of life in the world.
- The course will help students to comprehend the evolution of life on earth as well as the interactions between life and the environment.

Books Recommended:

1. S.M. Stanley, 2008. Earth System History
2. Jonathan I. Lumine W. H. Freeman, Earth-Evolution of a Habitable World, Cambridge University Press
3. D.E. Canfield, & K.O. Konhauser, 2012. Fundamentals of Geobiology. Blackwell
4. R., Cowen, 2000. History of Life. Blackwell.
5. Michael Anderson, 2012. Investigating the History of the Earth, Britannica Educational Publishing.