NEW CURRICULUM AND CREDIT FRAMEWORK FOR FOUR-YEAR UNDERGRADUATE PROGRAMMES OF GEOLOGY

(*w.e.f. A.Y. 2023-2024*)

BANKURA UNIVERSITY

BANKURA, WEST BENGAL, PIN 722155

Content

1. Introduction

One of the major initiatives of the University Grants Commission (UGC) for quality improvement in higher education system is the curriculum revision. National Education Policy (NEP) 2020 recognizes the important role of higher education in promoting human as well as societal well-being and in developing India. NEP recommends that the undergraduate (UG) programmes will be of either 3 or 4-year duration with multiple entry and exit options within this period. The recommended programme certifications are: UG certificate after completing 01 (one) year, or a UG diploma after 02 (two) years of study; or a bachelor degree after 03 (three) years and a bachelor degree (with honours/ honours with research) after 04 (four) years.

In accordance with the NEP 2020, the UGC has formulated a new student-centric Curriculum and Credit Framework for Undergraduate Programmes (CCFUP) incorporating a flexible choice-based credit system, multidisciplinary approach, and multiple entry and exit options. This will facilitate students to pursue their career path by choosing the subject/field of their own interest.

Geology as a discipline falls within the special category of science with a multidisciplinary approach. The present syllabus for geology at undergraduate level under the CBCS has been framed in compliance with curriculum and credit framework given by the UGC following NEP. The goal of the syllabus is to equip students with the fundamental knowledge of the diverse fields of earth science. The geology programmes integrate field trips with classroom learning to give the hands-on experience, which is often required to succeed. These opportunities develop the technical skills using measuring instruments and laboratory equipment. Thus, more emphasis has been given on skill enhancement courses.

The ultimate goal of the syllabus is to equip students with knowledge, skills, values, attitudes, leadership readiness/qualities and learning. Hence, at the end, the students will be able to secure very good opportunities as per their own choices.

Abbreviations used:

AEC- Ability Enhancement Courses [e.g., Compulsory English: Literature and Communication; MIL(Modern Indian languages): Santali/Sanskrit/Bengali); DSC - Department Specific Core Course; DSE – Department Specific Electives; ESE – End Semester Examination; IA – Internal Assessment; L – Lecture, P/Pr.- Practical; SEC – Skill Enhancement Course; T – Tutorial Th. – Theoretical; VAC – Value-Added Course (e.g., Environmental studies/Health and Wellness/ Understanding India: Indian Philosophical Traditions and Value Systems /Basics of the Constitution of India/Arts and Crafts of Bengal/ Historical Tourism in West Bengal etc.).

2. Semester-wise credit distribution in different courses of UG programmes of Geology with a single major

Year	Semester	Category of Courses (Credit of each course** x No. of courses)									Semester-wise total credits (No. of courses)
		Major		Minor Discipline	Multi-disciplinary	AEC	SEC	VAC	Internship/ Apprenticeship	Research Project/ Dissertation	
		DSC	DSE								
1st	**I**	(4x1) = 4	-	(4x1) = 4	(3x1) = 3	(2x1) = 2	(3x1) = 3	(4x1) = 4		--	**20**(6)
	II	(4x1) = 4	-	(4x1) = 4	(3x1) = 3	(2x1) = 2	(3x1) = 3	(4x1) = 4		-	**20**(6)
	Total credits (courses) up to 2nd Semester	**8**(2)		**8**(2)	**6**(2)	**4**(2)	**6**(2)	**8** (2)	**4** (2)##		**40** (12)
2nd	**III**	(4x2) = 8	-	(4x1) = 4	(3x1) = 3	(2x1) = 2	(3x1) = 3	-		-	**20**(6)
	IV	(4x4) = 16	-	(4x1) = 4	-	(2x1) = 2	-	-		-	**22**(6)
	Total credits (courses) up to 4th Semester	**32** (8)		**16** (4)	**9**(3)	**8**(4)	**9**(3)	**8**(2)	**4**##	-	**82** (24)
3rd	**V**	(4x2) = 8	(4x2) = 8	(4x1) = 4	-	-	-	-	(2x1) = 2	-	**22** (6)
	VI	(4x2) = 8	(4x2) = 8	(4x1) = 4	-	-	-	-	-		**20** (5)
	Total credits (courses)up to 6th Semester	**64**(16)		**24** (6)	**9**(3)	**8**(4)	**9**(3)	**8**(2)	**2** (1)	-	**124** ((35)
4th	**VII**	(4x1) = 4	(4x3) = 12	(4x1) = 4	-	-	-	-	-	-	**20** (5)
	VIII	(4x1) = 4	(4x3) = 12@@	(4x1) = 4	-	-	-	-	-	12$$	**20** (5/3)
	Total credits (courses) up to 8th Semester	**96** (24)		**32** (8)	**9**(3)	**8**(4)	**9**(3)	**8**(2)	**2** (1)	-	**164** (45)
	Total credits (courses)up to 8th Semester	**84** (21)		**32** (8)	**9**(3)	**8**(4)	**9**(3)	**8**(2)	**2** (1)	**12**$$	**164** (43)

__*Credit of each course***__: Major courses (DSC & DSE) – 4; Minor discipline – 4; Multidisciplinary – 3; AEC – 2; SEC – 3; VAC – 4; Internship/Apprenticeship – 2 and Research Project//Dissertation – 12.

Additional requirement (to be secured during first year and/or second year), if a student wants to get UG Certificate or UG Diploma programme certifications.

@@ Required if a student opt for certification of B. Sc. (Honours) after 4th year and not required if a student is eligible and opt for B. Sc. (Honours with Research) after 4th year.

$$ Required only for students who opt for B. Sc. (Honours with Research), instead of 03 (three) DSE courses with a total of 12 credits

3. Semester-wise detailed course curriculum

SEMESTER-I

COURSE CODE	COURSE TITLE	CREDIT			MARKS				NO. OF HOURS PER WEEK		
		Th	Pr.	Total	IA	ESE		Total	L	T	P
						Th.	Pr				
S/GEL/101/MJC-1	Earth System Science	4	0	4	10	40	0	50	4	0	0
S/GEL/102/MN-1*	Earth System Science	4	0	4	10	40	0	50	4	0	0
S/GEL/103/MD-1*	Introduction to Geology	3	0	3	10	40	0	50	2	1	0
S/GEL/104/SEC-1	Field Geology-I	0	3	3	10	0	40	50	0	0	6
ACS/105/AEC-1	Compulsory English: Literature and Communication	2	0	2	10	40	0	50	2	0	0
ACS/106/VAC-1	Environmental Studies	4	0	4	10	40	0	50	4	0	0
	Total in Semester- I	**17**	**3**	**20**	**60**	**200**	**40**	**300**			

***** To be opted by the students having major course of other discipline

SEMESTER-II

COURSE CODE	COURSE TITLE	CREDIT			MARKS				NO. OF HOURS PER WEEK		
		Th	Pr.	Total	IA	ESE		Total	L	T	P
						Th.	Pr				
S/GEL/201/MJC-2	Mineral Science	3	1	4	10	25	15	50	3	0	2
S/GEL/202/MN-2*	Mineral Science	3	1	4	10	25	15	50	3	0	2
S/GEL/203/MD-2*	Rocks and Minerals	3	0	3	10	25	15	50	2	1	0
S/GEL/204/SEC-2	Field Geology-II	0	3	3	10	0	40	50	0	0	6
ACS/205/AEC-2	MIL-I (Santali/Sanskrit/ Bengali)	2	0	2	10	40	0	50	2	0	0
ACS/206/VAC-2	Health and Wellness/ Understanding India: Indian Philosophical Traditions and Value Systems /Basics of the Constitution of India/Arts and Crafts of Bengal/ Historical Tourism in West Bengal	4	0	4	10	40	0	50	4	0	0
ACS/207/INT-1#	Internship/Apprenticeship-I			4 (2x2)#							
	Total in Semester- II	**15**	**5/**	**20/ 24#**	**60**	**155**	**85**	**300**			

***** To be opted by the students having major course of other discipline.

To be secured additional 4 credits (i.e., 2 internship/apprenticeship, each having 2 credits) by 1st year for programme certification of UG Certificate after 1st year.

SEMESTER-III

COURSE CODE	COURSE TITLE	CREDIT			MARKS				NO. OF HOURS PER WEEK		
		Th	Pr.	Total	IA	ESE		Total	L	T	P
						Th.	Pr				
S/GEL/301/MJC-3	Elements of Geochemistry	4	0	4	10	40	0	50	4	0	0
S/GEL/302/MJC-4	Structural Geology	4	0	4	10	40	0	50	4	0	0
S/GEL/303/MN-3*	Structural Geology	4	0	4	10	40	0	50	4	0	0
S/GEL/304/MD-3*	Physics and Chemistry of the Earth	3	0	3	10	40	0	50	2	1	0
S/GEL/305/SEC-3	Field Geology-III	0	3	3	10	0	40	50	0	0	6
ACS/306/AEC-3		2	0	2	10	40	0	50	2	0	0
Total in Semester- III		**17**	**3**	**20**	**60**	**200**	**40**	**300**			

***** To be opted by the students having major course of other discipline

SEMESTER-IV

COURSE CODE	COURSE TITLE	CREDIT			MARKS				NO. OF HOURS PER WEEK		
		Th	Pr.	Total	IA	ESE		Total	L	T	P
						Th.	Pr				
S/GEL/401/MJC-5	Igneous Petrology	4	0	4	10	40	0	50	4	0	0
S/GEL/402/MJC-6	Sedimentology	4	0	4	10	40	0	50	4	0	0
S/GEL/403/MJC-7	Metamorphic Petrology	4	0	4	10	40	0	50	4	0	0
S/GEL/404/MJC-8	Structural Geology Lab	0	4	4	10	0	40	50	0	0	8
S/GEL/405/MN-4*	Sedimentology	3	1	4	10	25	15	50	3	0	2
ACS/406/AEC-4		2	0	2	10	40	0	50	2	0	0
ACS/407/INT-2#	Internship/Apprenticeship-II			4 (2x2)#							
	Total in Semester- IV	**17**	**5**	**22/ 26#**	**60**	**185**	**55**	**300**			

***** To be opted by the students having major course of other discipline

To be secured additional 4 credits (i.e., 2 internship/apprenticeship, each having 2 credits) by 2nd year for programme certification of UG Diploma after 2nd year.

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SEMESTER-V

COURSE CODE	COURSE TITLE	CREDIT			MARKS				NO. OF HOURS PER WEEK		
		Th	Pr.	Total	IA	ESE		Total	L	T	P
						Th.	Pr				
S/GEL/501/MJC-9	Palaeontology	3	1	4	10	25	15	50	3	0	2
S/GEL/502/MJC-10	Petrology Lab	0	4	4	10	0	40	50	0	0	8
S/GEL/503/MJE-1	Geodynamics/ Urban Geology,	4	0	4	10	40	0	50	4	0	0
S/GEL/504/MJE-2	Geomorphology, Remote Sensing and GIS / Watershed Management	4	0	4	10	40	0	50	4	0	0
S/GEL/505/MN-5*	Palaeontology	4	0	4	10	40	0	50	4	0	0
ACS/506/INT-3	Internship/Apprenticeship-III			2							
Total in Semester- V		**15**	**7**	**22**	**50**	**145**	**55**	**250**			

***** To be opted by the students having major course of other discipline

SEMESTER-VI

COURSE CODE	COURSE TITLE	CREDIT			MARKS				NO. OF HOURS PER WEEK		
		Th	Pr.	Total	IA	ESE		Total	L	T	P
						Th.	Pr				
S/GEL/601/MJC-11	Principles of Stratigraphy and Precambrian Stratigraphy of India	4	0	4	10	40	0	50	4	0	0
S/GEL/602/MJC-12	Phanerozoic Stratigraphy of India	3	1	4	10	25	15	50	3	0	2
S/GEL/603/MJE-3	Fuel Geology/Introduction to Geophysics	3	1	4	10	25	15	50	3	0	2
S/GEL/604/MJE-4	Oceanography and Marine Science/Earth and Climate	4	0	4	10	40	0	50	4	0	0
S/GEL/605/MN-6*	Principles of Stratigraphy and Precambrian Stratigraphy of India	4	0	4	10	40	0	50	4	0	0
Total in Semester- VI		**18**	**2**	**20**	**50**	**170**	**30**	**250**			

***** To be opted by the students having major course of other discipline

SEMESTER-VII

COURSE CODE	COURSE TITLE	CREDIT			MARKS				NO. OF HOURS PER WEEK		
		Th	Pr.	Total	IA	ESE		Total	L	T	P
						Th.	Pr				
S/GEL/701/MJC-13	Economic Geology	3	1	4	10	25	15	50	3	0	2
S/GEL/702/MJE-5	Industrial Minerals/Mineral Beneficiation	4	0	4	10	40	0	50	4	0	0
S/GEL/703/MJE-6	Exploration Geology/Mining Geology	4	0	4	10	40	0	50	4	0	0
S/GEL/704/MJE-7	Isotope Geology/Mineral Economics	4	0	4	10	40	0	50	4	0	0
S/GEL/705/MN-7*	Economic Geology	4	0	4	10	40	0	50	4	0	0
	Total in Semester- VII	**19**	**1**	**20**	**50**	**185**	**15**	**250**			

***** To be opted by the students having major course of other discipline

SEMESTER-VIII

COURSE CODE	COURSE TITLE	CREDIT			MARKS				NO. OF HOURS PER WEEK		
		Th	Pr.	Total	IA	ESE		Total	L	T	P
						Th.	Pr				
S/GEL/801/MJC-14	Hydrogeology	3	1	4	10	25	15	50	3	0	2
S/GEL/802/MJE-8$	Engineering Geology/Natural Hazards and Disaster Management	4	0	4	10	40	0	50	4	0	0
S/GEL/803/MJE-9$	Environmental Geology/ Gemology	4	0	4	10	40	0	50	4	0	0
S/GEL/804/MJE-10$	Medical and Forensic Geology/Mathematical Geology	4	0	4	10	40	0	50	4	0	0
S/GEL/805/MN-8*	Hydrogeology	3	1	4	10	25	15	50	3	0	2
S/GEL/806/RDP-1@	Research Project/Dissertation	0	12	12	30	0	120	150	0	0	24
$Total in Semester-VIII [B. Sc. (Honours) in Geology]		**18**	**2**	**20**	**50**	**170**	**30**	**250**			
@Total in Semester-VIII [B. Sc. (Honours with Research) in Geology]		**06**	**14**	**20**	**50**	**50**	**150**	**250**			

***** To be opted by the students having major course of other discipline
$ Exclusively for programme certification of B. Sc. (Honours) with Geology after 4th year
@ Exclusively for programme certification of B. Sc (Honours with Research) with Geology after 4th year

4. Major and Minor Courses

4.1 Department Specific Cores (DSC)

4.1.1 EARTH SYSTEM SCIENCE [S/GEL/101/MJC-1 & S/GEL/102/MN-1]

[4 Credits: Th.-4; Pr.-0]

(i) Course objectives:

The major objectives of the course are to study:
(a) the Earth System as a whole; its origin, structure, composition, resources, history and the nature of processes, which have given rise to its present state,
(b) to study the atmosphere, hydrosphere, and lithosphere, and
(c) tectonism and magmatism of the Earth.

(ii) Course learning outcomes:

Upon completion of this course the students will be able to acquire knowledge on:
(a) the nature of the solid earth, it's outer fluid cover and biosphere,
(b) the actions of the Earth's external and internal processes,
(c) Earth's origin and evolution,
(d) Earth's resources, tectonism and magmatism.

(iii) Course Content:

THEORY
[*60 Hours*]

Unit 1: Introduction to Earth System Science [08 Hours]

Branches of Earth Science and their objectives and applications; General characteristics and origin of the Universe, Solar System and its planets; Terrestrial and jovian planets; Meteorites and Asteroids; Earth in the solar system - origin, size, shape, mass, density, rotational and revolution parameters and age of Earth.

Unit 2: Solid Earth and associated spheres [15 Hours]

Internal structure of the Earth - crust, mantle and core; Major and minor discontinuities in the Earth; Seismic wave velocity inside the Earth; Layering of the Earth based on rheological properties of earth material - lithosphere, asthenosphere, mesosphere and centrosphere; Convection in Earth's core and mantle; Preliminary knowledge of distribution of elements in crust, mantle and core; Earth's magnetic field; Sources of Earth's internal heat. Pressure and temperature variations with depth within the Earth; Heat flow in Earth; Elementary idea of hydrosphere, atmosphere and biosphere; Rock cycle and geochemical cycle.

Unit 3: Earth's processes **[10 Hours]**

Surface processes: weathering, erosion, mass wasting and deposition; Endogenic and exogenic processes; Geological action of river, wind and glacier; Geomorphological features of Earth: Concept of geoid, topography, hypsometry and bathymetry; Drainage basin and drainage pattern; Formation of soil and soil profile; Palaeosol.

Unit 4: Tectonics and magmatism in the Earth **[15 Hours]**

Elementary idea of the concept of continental drift, sea-floor spreading and plate tectonics; Concept of plates and plate boundaries. Definition of important geodynamic elements of the Earth e.g., Mid Oceanic Ridges (MOR), trenches, transform faults, island arcs, volcanic islands; Oceanic plateau; Origin of mountain belts and rift valleys. Earthquake – its causes and effects; Earthquake belts of the Earth; Scales of measurement of earthquake; Prevention and mitigation of earthquake; Prediction of earthquake; Volcanos - types, products and their distribution, origin; Concept of geodesy and isostasy.

Unit 5: Earth's Resources **[05 Hours]**

A brief introduction of minerals and rocks of economic importance, fossil fuel and nuclear fuel.

Unit 6: Understanding the past histories from geologic records **[07 Hours]**

Brief history of development of concepts of Plutonism and Neptunism. Stratigraphy – its definition and scope; Fundamental laws of stratigraphy - concept of uniformitarianism, laws of superposition and faunal succession Geological time scale; Absolute and relative time in geology; Preliminary concept of geochronology and its application in geological studies.

Suggested Readings

- Duff, P. M. D., & Duff, D. (Eds.). (1993). Holmes' principles of physical geology. Taylor & Francis.
- Emiliani, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.
- Gross, M. G. (1977). Oceanography: A view of the earth.
- Tarback, E. J. and Lutgens, F.K. (2006). Earth Science. Pearson Prentice Hall. New Jersey.
- Grotzinger, J., Jordan, T.H., Press, F and Siever, R. (2007) Understanding Earth (Fifth Edition). W. H. Freeman and company. New York.
- Environmental Science – Earth as a Living Planet. By – Daniel B. Botkin & Edward A. Keller, John Wiley & Sons.

4.1.2 MINERAL SCIENCE [S/GEL/201/MJC-2 & S/GEL/202/MN-2]

[4 Credits: Th.-3; Pr.-1]

(i) Course objectives:

This course aims to focus on:

(a) fundamentals of crystallography, descriptive mineralogy, chemistry and structure of minerals
(b) basic principle of optical mineralogy, and
(c) mesoscopic and microscopic identification of minerals.

(ii) Course learning outcomes:

The study of this course enables to:

(a) describe various physical and optical properties of minerals,
(b) mesoscopic and microscopic identification of minerals
(c) explain different symmetry elements of the crystals and how these relate to crystal systems.

(iii) Course Content:

THEORY

[*45 Hours*]

Unit 1: Crystallography]10 Hours]

Concept of crystalline and amorphous matter; Definition of crystal, Crystal faces and edges; Form and zone; Elementary ideas about crystal morphology in relation to internal structures; Crystal lattice and concept of space group; Classification of crystals into crystal systems and classes; Stereographic projection of crystal faces, symmetry elements and forms; Hermann Mauguin notation.

Unit 2: Atomic arrangements and Mineralogical structure [10 Hours]

Atomic arrangements: Unit cell, CCP, FCC and HCP; Ionic radius and coordination, Pauling's rules. Solid solution; Substitution principles – Goldschmidt's rule of substitution of elements; Partitioning of elements between coexisting phases; Brief idea about isomorphism, polymorphism and pseudomorphism: Elementary concept on principle types of common polymorphic forms of C, SiO_2, $CaCO_3$ and Al_2SiO_5

Unit 3: Rock forming minerals [10 Hours]

Minerals: definition, physical and other properties (density, cleavage, fracture, parting, habit, hardness, streak, tenacity, elasticity, magnetism., radioactivity, fluorescence, piezoelectricity and pyroelectricity); Classification of minerals (based on structures and chemical parameters) with examples of common silicates, oxides, carbonates, sulphides, sulphates and phosphates; Silicate structures and its classification; Major rock forming mineral groups (viz., feldspar, feldspathoids, olivine, pyroxene, amphibole, mica and garnet) – (a) structural formula, (b) members of the mineral groups, (c) structure, and (d) paragenesis.

Unit 4: Optical Mineralogy **[15 Hours]**

Optical behaviour of crystals - isotropic and anisotropic minerals; Uniaxial and biaxial minerals; Relation between crystallographic and optic axes of crystals; Optical microscope; Nicol prism and its principle of construction; Polaroid in microscope; Refractive index/indices of minerals; Pleochroism and pleochroic scheme; Interference and interference colour; Birefringence; Extinction and extinction angle; Optical indicatrix; Study of interference figure, optic sign of uniaxial and biaxial minerals; Variation of optical and physical properties with chemical composition of mineral groups.

PRACTICAL

[*30 Hours*]

Study of the symmetry of crystals. Stereographic projection of normal classes;

Study of physical properties of minerals in hand specimen - (a) quartz, feldspar, olivine, pyroxene, hornblende, actinolite and tremolite, muscovite, biotite, garnet, andalusite, sillimanite, kyanite, staurolite, beryl, tourmaline, serpentine, talc, nepheline, zeolite asbestos, (b) chert, chalcedony, agate, jasper, amethyst (c) pyrite, chalcopyrite, galena, sphalerite barite and gypsum; magnetite, haematite, ilmenite, chromite, pyrolusite and psilomelane, graphite, corundum, bauxite; fluorite, calcite, dolomite, apatite.

Study of optical properties of common rock-forming minerals: quartz, orthoclase, microcline, plagioclase, perthite and antiperthite, nepheline, olivine, orthopyroxene, clinopyroxene, hornblende, actinolite and tremolite, staurolite, garnet, muscovite, biotite, calcite, kyanite, sillimanite and andalusite.

Suggested Readings

- Klein, C., Dutrow, B., Dwight, J., & Klein, C. (2007). The 23rd Edition of the Manual of Mineral Science (after James D. Dana). J. Wiley & Sons.
- Verma, P. K. (2010). Optical Mineralogy (Four Colour). Ane Books Pvt Ltd.
- Deer,W. A., Howie, R. A., & Zussman, J. (1992). An introduction to the rock-forming minerals (Vol. 696). London: Longman.
- Nesse, W. D. (2011). Introduction to Optical Mineralogy (Fourth Edition). Oxford University Press.
- Putnis, A. (1992): Introduction to Mineral Sciences. Cambridge University Press.
- Klein and Hurlbut, Manual of Mineralogy, 21st Edn.

5. Multidisciplinary courses

5.1 INTRODUCTION TO GEOLOGY [S/GEL/103/MD-1]

[3 Credits: Th.-3; Pr.-0]

(i) Course objectives:

This course focusses on:
(a) an overall introduction to different branches of geology,
(b) understanding the processes in action on the earth's surface and interior, and
(c) brief idea of earth's resources, tectonism and magmatism.

(ii) Course learning outcomes:

The learners will acquire:
(a) a comprehensive idea on different branches of geology
(b) knowledge on major parameters of the Earth- it's origin, endogenic and exogenic processes, evolution, resources, tectonism and magmatism,

(iii) Course Content:

THEORY
[*45 Hours*]

Unit 1: Introduction [05 Hours]

Introduction to geology: its scope, different branches, and relationship with other branches of sciences.

Unit 2: Solar System and it's planets [05 Hours]

Solar System: Introduction to various planets - terrestrial and jovian planets. Origin of Earth, it's size, shape, mass, density, rotational and evolutional parameters.

Unit 3: Introduction to the concept of time in geological studies [05 Hours]

Age of the Earth; Geological Time Scale; Life through ages; Basic laws of stratigraphy.

Unit 4: Solid Earth, Hydrosphere, Atmosphere and Biosphere [15 Hours]

Internal structure of the Earth – crust, mantle and core; Major and minor discontinuities within the Earth; Mechanical layering of the Earth-lithosphere, asthenosphere, mesosphere and centrosphere. Elementary idea of formation of atmosphere, hydrosphere and biosphere;

Unit 5: Earth's External and Internal Processes [10 Hours]

Preliminary idea of the plate tectonics; Earthquake and earthquake belts; Volcanoes and its type; Distribution of volcanoes; Surface processes: weathering and erosion; Rock-types and Rock cycle; Various landforms in river valleys, deserts and glaciated region;

Unit 6:-Mineral and Fuel Resources [05 Hours]

Concepts of Minerals; Ore minerals; Preliminary idea about fuel resources and their distribution in India.

Suggested Readings

- Mukherjee Pratip Kumar (1982) A Text book of Geology, The World Press Private Ltd., Calcutta
- Holmes' Principles of Physical Geology. 1992. Chapman & Hall.
- Emiliani, C, 1992. Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press.
- Gross,M.G., 1977. Oceanography: A view of the Earth, Prentice Hall.

5.2 ROCKS AND MINERALS [S/GEL/203/MD-2]

[3 Credits: Th.-3; Pr.-0]

(i) Course objectives:

The aims of the course are to study:

(a) the physical and optical properties of minerals,
(b) classification and mode of occurrences of minerals of rocks, and
(c) structures and textures of rocks.

(ii) Course learning outcomes:

The students will be able:

(a) to identify and classify common minerals and rocks in hand specimens as well as in thin sections.
(b) to build a overall knowledge in mineral science and petrology, which is very essential in geology.

(iii) Course Content:

THEORY
[*45 Hours*]

Unit 1: Mineralogy [20 Hours]

Definitions of minerals Study of crystals; Physical properties of minerals; Optical properties of minerals; Chemical properties of mineral; Classification of minerals based on their chemistry; Origin of minerals; Occurrence of minerals. Introduction to petrological microscope.

Unit 2: Petrology **[25 Hours]**

Rocks-Definitions; Types of rock – igneous, sedimentary and metamorphic;
Igneous Rocks – Modes of occurrence; Structure and texture; Forms of igneous bodies; Magma and it's formation within the Earth, consolidation and emplacement; Classification.
Sedimentary Rocks – Modes of formation; Structure and texture; Classification.
Metamorphic Rocks – Agents of metamorphism; Metamorphic grade; Progressive and retrogressive metamorphism; Concept of metamorphic facies; Structure and texture; Classification

Suggested Readings

- Anthony Philpotts (2013) Earth Materials- Introduction to Mineralogy and Petrology, Cornelis Klein and, Cambridge University Press.
- John Grotzinger and Thomas H. Jordan (2010) Understanding Earth (Sixth Edition), W H. Freeman and company, New York.
- Mukherjee Pratip Kumar (1982) A Text book of Geology, The World Press Private Ltd., Calcutta

6. Skill Enhancement courses

6.1 FIELD GEOLOGY-I (BASIC FIELD TRAINING IN GEOLOGY; S/GEL/104/SEC-1)

[3 Credits: Th.-0; Pr.-3]

(i) Course objectives:

The major objectives are:
(a) to acquaint with the equipment used in the geological fieldwork,
(b) to understand how preliminary surveys are carried out especially in geological terranes through practical training partly in the classroom and partly in field.
(c) systematic recording of field data and writing of field report

(ii) Course learning outcomes:

The learners will be enable to:
(a) use geological equipment,
(b) upgrade and relate the theoretical knowledge of geological aspects to field observations.,
(c) present geological information of an area in terms of a report.

(iii) Course Content:

PRACTICAL

Introduction of field equipment required for geological fieldwork; Concept of scale of maps; Geographical and topographical maps; Topographic map indexing; Reading of topographic sheet: Study of contour pattern and slope interpretation based on contour spacing; Distance, height and pace approximation in the field; Use of clinometer and Brunton compasses: Use of other instruments in measuring geological data in field; Fixing location in topographic sheet

by taking bearing, and using natural and man-made features; features in the rocks. Recording field data in maps and notebooks; Report writing.

6.2 FIELD GEOLOGY-II (STUDY OF MINERALS, ROCKS AND STRUCTURAL ELEMENTS IN THE FIELD; S/GEL/204/SEC-2)

[3 Credits: Th.-0; Pr.-3]

(i) Course objectives:

The course focusses on:

(a) the study of minerals and rocks in the field outcrop, and
(b) identification and measurement of attitude of different planar and linear elements in the rocks.
(c) systematic recording of field data and writing of field report.

(ii) Course learning outcomes:

The learners will be enable to:

(d) upgrade and relate the theoretical knowledge of geological aspects to field observations,
(e) record geological field data systematically, and
(f) present geological information of an area in terms of a report.

(iii) Course Content:

PRACTICAL

Study of different minerals and rocks in the field outcrop; Identification of planar and linear structures in rock outcrops and in hand samples; Identification of primary and secondary (tectonic) structures in field and their use in structural geology; Use of clinometer and Brunton compasses; Measurement of attitude of planar and linear structures in the rocks, use of topographic sheets; Fixing location in the toposheet; Plotting of attitudes of different planar and linear elements in the map. Recording field data in notebooks; Report writing

7. Internship/Apprenticeship

7.1 INTERNSHIP/APPRENTICESHIP 1 [ACS/207/INT-1] [4 Credits]

Internship/apprenticeship/work-based vocational education and training can be carried out especially by students who wish to exit after two semesters or four semesters of study.

8. Programme Outcome

A. **Graduate Attributes**: Some of the characteristic attributes that a graduate should demonstrate:

- **a)** Disciplinary knowledge
- **b)** Communication Skills
- **c)** Critical thinking
- **d)** Problem solving
- **e)** Analytical reasoning
- **f)** Research-related skills
- **g)** Cooperation/Teamwork
- **h)** Scientific reasoning
- **i)** Reflective thinking
- **j)** Information/digital literacy
- **k)** Self-directed learning
- **l)** Multicultural competence
- **m)** Moral and ethical awareness/reasoning
- **n)** Leadership readiness/qualities
- **o)** Lifelong learning

B. **Qualification descriptors:** Qualification descriptors for a bachelor's degree with honours are as follows:

a) Demonstrate (i) a systematic, extensive and coherent knowledge and understanding of an academic field of study as a whole and its applications, and links to related disciplinary areas/subjects of study; including a critical understanding of the established theories, principles and concepts, and of a number of advanced and emerging issues in the field of study; (ii) procedural knowledge that creates different types of professionals related to the disciplinary/subject area of study, including research and development, teaching and government and public service; (iii) skills in areas related to one's specialization and current developments in the academic field of study, including a critical understanding of the latest developments in the area of specialization, and an ability to use established techniques of analysis and enquiry within the area of specialization.

b) Demonstrate comprehensive knowledge about materials, including current research, scholarly, and/or professional literature, relating to essential and advanced learning areas pertaining to the chosen disciplinary areas (s) and field of study, and techniques and skills required for identifying problems and issues relating to the disciplinary area and field of study.

c) Demonstrate skills in identifying information needs, collection of relevant quantitative and/or qualitative data drawing on a wide range of sources, analysis and interpretation of data using methodologies as appropriate to the subject(s) for formulating evidence-based solutions and arguments.

d) Use knowledge, understanding and skills for critical assessment of a wide range of ideas and complex problems and issues relating to the chosen field of study.

e) Communicate the results of studies undertaken in an academic field accurately in a range of different contexts using the main concepts, constructs and techniques of the subject(s) of study.

f) Address one's own learning needs relating to current and emerging areas of study, making use of research, development, and professional materials as appropriate, including those related to new frontiers of knowledge.

g) Apply one's disciplinary knowledge and transferable skills to new/unfamiliar contexts and to identify and analyze problems and issues and seek solutions to real-life problems.

h) Demonstrate subject-related and transferable skills that are relevant to some of the job trades and employment opportunities.

9. Programme Specific Outcome

The student graduating with the degree of B. Sc. Geology (Honours) should be able to:

(i) acquire a fundamental/systematic or coherent understanding of the academic field of geology, its different learning areas and applications in basic geology like mineralogy, petrology, stratigraphy, palaeontology, economic geology, hydrogeology, etc. and its linkages with related interdisciplinary areas/subjects like geography, environmental sciences, physics, chemistry, mathematics, life sciences, atmospheric sciences, remote sensing, computer science, information technology,

(ii) acquire procedural knowledge that creates different types of professionals related to the disciplinary/subject area of geology, including professionals engaged in research and development, teaching and government/public service,

(iii) acquire skills in areas related to one's specialization area within the disciplinary/subject area of geology and current/emerging developments in the field of geosciences,

(iv) demonstrate the ability to use skills in geology and its related areas of technology for formulating and tackling geosciences-related problems and identifying and applying appropriate geological principles and methodologies to solve a wide range of problems associated with geosciences,

(v) recognize the importance of remote sensing and GIS, mathematical modelling/simulation and computing, and the role of approximation and mathematical approaches to describing the physical world,

(vi) plan and execute geology-related experiments or investigations, analyze and interpret data/information collected using appropriate methods, including the use of appropriate software such as programming languages and purpose-written packages, and report accurately the findings of the experiment/investigations while relating the conclusions/findings to relevant theories in geology,

(vii) generate communication skills involving the ability to listen carefully, to read texts and research papers analytically and to present complex information in a concise manner to different groups/audiences of technical or popular nature,

(viii) generate analytical skills involving paying attention to detail and ability to construct logical arguments using correct technical language related to geology and ability to translate them with popular language when needed; ICT skills; personal skills, such as the ability to do geological work both independently and in teams