



UNIVERSITY OF CALCUTTA

Notification No. CSR/ 12 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 28.05.2018 (vide Item No.14) approved the Syllabi of different subjects in Undergraduate Honours / General / Major courses of studies (CBCS) under this University, as laid down in the accompanying pamphlet:

List of the subjects

<u>Sl. No.</u>	<u>Subject</u>	<u>Sl. No.</u>	<u>Subject</u>
1	Anthropology (Honours / General)	29	Mathematics (Honours / General)
2	Arabic (Honours / General)	30	Microbiology (Honours / General)
3	Persian (Honours / General)	31	Mol. Biology (General)
4	Bengali (Honours / General /LCC2 /AECC1)	32	Philosophy (Honours / General)
5	Bio-Chemistry (Honours / General)	33	Physical Education (General)
6	Botany (Honours / General)	34	Physics (Honours / General)
7	Chemistry (Honours / General)	35	Physiology (Honours / General)
8	Computer Science (Honours / General)	36	Political Science (Honours / General)
9	Defence Studies (General)	37	Psychology (Honours / General)
10	Economics (Honours / General)	38	Sanskrit (Honours / General)
11	Education (Honours / General)	39	Social Science (General)
12	Electronics (Honours / General)	40	Sociology (Honours / General)
13	English ((Honours / General/ LCC1/ LCC2/AECC1)	41	Statistics (Honours / General)
14	Environmental Science (Honours / General)	42	Urdu (Honours / General /LCC2 /AECC1)
15	Environmental Studies (AECC2)	43	Women Studies (General)
16	Film Studies (General)	44	Zoology (Honours / General)
17	Food Nutrition (Honours / General)	45	Industrial Fish and Fisheries – IFFV (Major)
18	French (General)	46	Sericulture – SRTV (Major)
19	Geography (Honours / General)	47	Computer Applications – CMAV (Major)
20	Geology (Honours / General)	48	Tourism and Travel Management – TTMV (Major)
21	Hindi (Honours / General /LCC2 /AECC1)	49	Advertising Sales Promotion and Sales Management –ASPV (Major)
22	History (Honours / General)	50	Communicative English –CMEV (Major)
23	Islamic History Culture (Honours / General)	51	Clinical Nutrition and Dietetics CNDV (Major)
24	Home Science Extension Education (General)	52	Bachelor of Business Administration (BBA) (Honours)
25	House Hold Art (General)	53	Bachelor of Fashion and Apparel Design – (B.F.A.D.) (Honours)
26	Human Development (Honours / General)	54	Bachelor of Fine Art (B.F.A.) (Honours)
27	Human Rights (General)	55	B. Music (Honours / General) and Music (General)
28	Journalism and Mass Communication (Honours / General)		

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 4th June, 2018

Paul
4/6/18
(Dr. Santanu Paul)
Deputy Registrar

UNIVERSITY OF CALCUTTA



Syllabus for B.Sc.(Hons.)Geology

**Six Semester Course Under
Choice Based Credit System**

Semester-wise Courses for B.A./B.Sc. (Honours)

	Sem-1	Sem-2	Sem-3	Sem-4	Sem-5	Sem-6
Core Course (CC)	2TH+2P/TU CC-1 & 2	2TH+2P/TU CC-3&4	3TH+3P/TU CC-5,6 &7	3TH+3P/TU CC-8, 9 & 10	2TH+2P/TU CC-11 & 12	2TH+2P/TU CC-13&14
Generic Elective (GE)	1TH+1P/TU GE-1	1TH+1P/TU GE-2	1TH+1P/TU GE-3	1TH+1P/TU GE-4		
Discipline Specific Elective (DSE)					2TH+2P/TU DSE-A(1) B(1)	2TH+2P/TU DSE- A(2) B(2)
Ability Enhancement Compulsory Course (AECC)	1TH+0P/TU AECC-1	1TH+0P/TU AECC-2				
Skill Enhancement Course (SEC)			1TH+0P/TU SEC-A(1)	1TH+0P/TU SEC-B(2)		
Total No. of Courses and Marks	4 ×100 =400	4 ×100 =400	5 ×100 =500	5 ×100 =500	4 ×100 =400	4 ×100 =400
Total Credits	20	20	26	26	24	24

TH= Theory P= Practical TU=Tutorial

- ❖ CC/GE/ DSE : Each Theory and Practical Course have 4 and 2 Credits respectively/ Each Theory and Tutorial Course have 5 and 1 Credit(s) respectively
- ❖ GE: Covering two subjects with two courses each; any subject in any semester; CC of a different subject in General course is to be treated as GE for Honours Course
- ❖ DSE/SEC: Group (A & B) for specified semesters
- ❖ AECC/SEC : Each Course has 2 Credits
- ❖ AECC-1: Communicative English / MIL; AECC-2: Environmental Studies

YEAR	SEME STER	COURS E TYPE	COURSE NAMES WITH CODE	CREDIT POINTS	EQUIVALENT MARKS					TOTAL CREDIT POINTS
					Theory	Practical	Internal Assessment	Attendance	TOTAL	
1ST YEAR	I	CC	GEL-A-CC-1-1-TH: EARTH SYSTEM SCIENCE	4	50		10	10	100	20
			GEL-A-CC-1-1-P: EARTH SYSTEM SCIENCE	2		30				
		CC	GEL-A-CC-1-2-TH: MINERAL SCIENCE	4	50		10	10	100	
			GEL-A-CC-1-2-P: MINERAL SCIENCE	2		30				
		AECC	AECC1: Communicative English	2	80		10	10	100	
		GE	GE1: Theory	4	50		10	10	100	
	GE1: Practical		2		30					
	II	CC	GEL-A-CC-2-3-TH: ELEMENTS OF GEOCHEMISTRY	4	50		10	10	100	20
			GEL-A-CC-2-3-P: ELEMENTS OF GEOCHEMISTRY	2		30				
		CC	GEL-A-CC-2-4-TH: STRUCTURAL GEOLOGY	4	50		10	10	100	
			GEL-A-CC-2-4-P: STRUCTURAL GEOLOGY	2		30				
		AECC	AECC2: Environmental Studies	2	80		10	10	100	
GE		GE2: Theory	4	50		10	10	100		
	GE2: Practical	2		30						
2ND YEAR	III	CC	GEL-A-CC-3-5-TH: IGNEOUS PETROLOGY	4	50		10	10	100	26
			GEL-A-CC-3-5-P: IGNEOUS PETROLOGY	2		30				
		CC	GEL-A-CC-3-6-TH: SEDIMENTARY PETROLOGY	4	50		10	10	100	
			GEL-A-CC-3-6-P: SEDIMENTARY PETROLOGY	2		30				
		CC	GEL-A-CC-3-7-TH: PALEONTOLOGY	4	50		10	10	100	
			GEL-A-CC-3-7-P: PALEONTOLOGY	2		30				
		GE	GE3: Theory	4	50		10	10	100	
			GE3: Practical	2		30				
	SEC-A	GEL-A-SEC-A-(3- 1)/(3-2)-P	2		80	10	10	100		
	IV	CC	GEL-A-CC-4-8-TH: METAMORPHIC PETROLOGY	4	50		10	10	100	26
			GEL-A-CC-4-8-P: METAMORPHIC PETROLOGY	2		30				
		CC	GEL-A-CC-4-9-TH: STRATIGRAPHIC PRINCIPLES AND INDIAN STRATIGRAPHY	4	50		10	10	100	
			GEL-A-CC-4-9-P: STRATIGRAPHIC PRINCIPLES AND INDIAN STRATIGRAPHY	2		30				
		CC	GEL-A-CC-4-10-TH: PHANEROZOIC STRATIGRAPHY OF INDIA	4	50		10	10	100	
GEL-A-CC-4-10-P: PHANEROZOIC STRATIGRAPHY OF INDIA			2		30					
SEC-B		GEL-A-SEC-B-(4- 1)/(4-2)-P	2		80	10	10	100		
GE		GE4: Theory	4	50		10	10	100		
	GE4: Practical	2		30						
YEAR	SEME STER	PAPER	COURSE NAMES WITH CODE	CREDIT POINTS	EQUIVALENT MARKS					TOTAL CREDIT

										POINTS
					Theory	Practical	Internal Assessment	Attendance	TOTAL	
3RD YEAR	V	CC	GEL-A-CC-5-11-TH: ECONOMIC GEOLOGY	4	50		10	10	100	24
			GEL-A-CC-5-11-P: ECONOMIC GEOLOGY	2		30				
		CC	GEL-A-CC-5-12-TH: ENGINEERING GEOLOGY	4	50		10	10	100	
			GEL-A-CC-5-12-P: ENGINEERING GEOLOGY	2		30				
		DSE-A	GEL-A-DSE-A-(5- 1)/(5-2)-TH	4	50		10	10	100	
			GEL-A-DSE-A-(5- 1)/(5-2)-P	2		30				
		DSE-B	GEL-A-DSE-B-(5- 1)/(5-2)-TH	4	50		10	10	100	
			GEL-A-DSE-B-(5- 1)/(5-2)-P	2		30				
	VI	CC	GEL-A-CC-6-13-TH: HYDROGEOLOGY	4	50		10	10	100	24
			GEL-A-CC-6-13-P: HYDROGEOLOGY	2		30				
		CC	GEL-A-CC-6-14-TH: GEOMORPHOLOGY, REMOTE SENSING AND GIS	4	50		10	10	100	
			GEL-A-CC-6-14-P: GEOMORPHOLOGY, REMOTE SENSING AND GIS	2		30				
		DSE-A	GEL-A-DSE-A-(6- 1)/(6-2)-TH	4	50		10	10	100	
			GEL-A-DSE-A-(6- 1)/(6-2)-P	2		30				
DSE-B		GEL-A-DSE-B-(6- 1)/(6-2)-TH	4	50		10	10	100		
		GEL-A-DSE-B-(6- 1)/(6-2)-P	2		30					
TOTAL									2600	140

Note

1. AEC courses are not included in the gradation
2. Geology Hons Students must opt GE courses of other subject of equivalent credit. GE must cover two different subjects with two courses each, any subject in any semester. CC of General course of the chosen subjects is to be treated as GE for Honours course.
3. DSE and SEC choice must be group specific to each semester.
4. At least 50 lectures of an hour duration should be allotted for 4 credit theoretical course and 2 credit practical course.

CORE COURSE: GEOLOGY

Paper –GEL-A-CC-1-1-TH
[4 CREDITS]
EARTH SYSTEM SCIENCE

Unit 1: Earth as a Planet

Branches of Earth Sciences.

General characteristics and origin of the Universe, Solar System and its planets. The terrestrial and jovian planets.

Meteorites and Asteroids.

Earth in the solar system - origin, size, shape, mass, density, rotational and revolution parameters.

Origin of atmosphere, ocean and life.

Unit 2: Solid Earth, Hydrosphere, Atmosphere and Biosphere

Mechanical layering of the Earth: lithosphere, asthenosphere, mantle and core.

Earthquake and earthquake belts: seismic waves and internal constitution of the Earth.

Volcanoes and volcanism, distribution of volcanoes.

Concept of isostasy.

Formation of core, mantle, crust, atmosphere, hydrosphere and biosphere.

Convection in Earth's core and production of its magnetic field.

Geothermal gradient and internal heat of the Earth.

Unit 3: Cosmic abundance of elements

Distribution of elements in solar system and in Earth.

Composition of the Earth. General concepts about geochemical cycles.

Properties of common elements in Earth.

Concepts of geochemical cycles.

Unit 4: Hydrosphere and Atmosphere

Oceanic current system and effect of Coriolis force.

Concepts of eustasy.

Land-sea interaction: Wave erosion and beach processes.

Atmospheric circulation.

Weather and climatic changes.

Unit 5: Plate Tectonics

Historical development of the concept of continental drift and plate tectonics.

Plates and plate boundaries.

Geodynamic elements of Earth: mid oceanic ridges, trenches, transform faults and island arcs.

Plate tectonics: mountain belts and rift valleys.

Unit 6: Soil

Soils: types, soil profile, processes of formation of soil.

Unit 7: Understanding the past from Stratigraphic records

Nature of stratigraphic records.

Fundamental laws of stratigraphy: laws of superposition and faunal succession.

Absolute and relative time in Geology. Concept of time and geological time scale

Concept of radiometric dating. Radiometric dating of rocks and minerals: U-Pb, Pb-Pb, K-Ar, Rb-Sr, Sm-Nd methods. Dating igneous and sedimentary rocks.
Concepts of neptunism, plutonism, uniformitarianism, and catastrophism.
Geological time scale.

Paper –GEL-A-CC-1-1-P
[2 CREDITS]
EARTH SYSTEM SCIENCE

Study of major geomorphic features and their relationships with outcrops through maps and physiographic models.
Detailed study of topographic sheets and preparation of physiographic description of an area.
Study of soil profile of a specific area.
Distribution of major lithostratigraphic units of India.
Global distribution of cratons, mobile belts and major sedimentary basins. Distribution of cratons, mobile belts and major sedimentary basins in India
Calculation of Richter magnitude from P and S wave interval data.
Study of minerals in hand specimens (Silicates: olivine, garnet, andalusite, sillimanite, kyanite, staurolite, beryl, tourmaline, pyroxene, tremolite, hornblende-actinolite, serpentine, talc, muscovite, biotite, quartz, feldspar, nepheline, zeolite, asbestos; Quartz varieties: chert, chalcedony, agate, jasper, amethyst, rock crystal.
Other minerals: pyrite, chalcopyrite, galena, sphalerite, barite and gypsum, magnetite, haematite, pyrolusite and psilomelane, corundum, ilmenite, chromite, bauxite; fluorite, calcite, dolomite, apatite, graphite)
Study of rocks in hand specimens

Suggested Readings

Duff, P. M. D. and Duff, D. (Eds.) (1993). Holmes' principles of physical geology. Taylor and 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.

Paper –GEL-A-CC-1-2-TH
[4 CREDITS]
MINERAL SCIENCE

Unit 1: Crystallography

Concept of crystal and crystalline matter. Internal order in crystal.
Crystal structure; elementary ideas about crystal morphology in relation to internal structures.
Crystal parameters and indices; form and zone.
Stereographic projection of crystal faces, Crystal symmetry, classification of crystals into systems. Lattice theory and 32 point groups. International symbol of point groups.

Unit 2: Atomic arrangements and Mineral structure

Atomic arrangements: unit cell, CCP, FCC and HCP.
Ionic radius and coordination, Pauling's rules. Solid Solution, polymorphism, pseudomorphism.
Atomic structure of silicate minerals.

Unit 3: Rock forming minerals

Minerals - definition and classification, physical and chemical properties.
Chemical classification of minerals.
Composition of common oxides, carbonates, sulphides and sulphates, phosphates.
Composition of common rock-forming minerals – internal atomic structure, pyroxene, amphibole, and mica groups.

Unit 4: Crystal Optics

Nature of light and optical behaviour of crystals.

Introduction to petrological microscope.

Theory of light propagation in isotropic, uniaxial, and biaxial crystals.

Principles of orthoscopic and conoscopic studies of minerals under optical microscope.

Paper –GEL-A-CC-1-2-P

[2 CREDITS]

MINERAL SCIENCE

Study of the symmetry of crystals. Stereographic projection of crystals.

Derivation of structural formulae based on composition.

Study of optical properties of common rock-forming minerals: quartz, orthoclase, microcline, plagioclase, perthite, nepheline, olivine, orthopyroxene, clinopyroxene, hornblende, staurolite, garnet, muscovite, biotite, calcite, chlorite, epidote, kyanite, sillimanite, tourmaline, zircon, sphene, zoisite, apatite.

Determination of scheme of pleochroism and extinction angles of hornblende

Suggested Readings

Klein, C., Dutrow, B., Dwight, J., and Klein, C. (2007). The 23rd Edition of the Manual of Mineral Science (after James D. Dana). J. Wiley and Sons.

Verma, P. K. (2010). Optical Mineralogy (Four Colour). Ane Books Pvt Ltd.

Deer, W. A., Howie, R. A., and Zussman, J. (1996). An Introduction to Rock-Forming Minerals. Prentice Hall.

Nesse, W. D. (2011). Introduction to Optical Mineralogy (Fourth Edition). Oxford University Press.

Putnis, A. (1992). Introduction to Mineral Sciences. Cambridge University Press.

Paper –GEL-A-CC-2-3-TH

[4 CREDITS]

ELEMENTS OF GEOCHEMISTRY

Unit 1: Basic Concepts

The periodic table.

Chemical bonding, states of matter and atomic environment of elements.

Geochemical classification of elements.

Cosmic abundance of elements in earth and meteorites.

Unit 2: Layered Structure of Earth and Geochemistry

Composition of crust: Continental and Oceanic.

Composition of mantle: depleted mantle and enriched mantle.

Composition of core.

Bulk chemical Composition of the Earth.

Isotope geology – radiogenic and stable isotopes in Earth materials.

Principles of radioactive dating(Rb-Sr method).

Unit 3: Element transport

Abundance of elements in river and ocean water

Constancy of elemental composition of ocean water

Concept of ionic and redox potential and pH

Aqueous geochemistry- basic concepts and speciation in solutions, Eh, pH relations.

Factors controlling chemical sedimentation.

Unit 4: Geochemistry of solid Earth

Geochemical variability of magma and its products. Melting processes.

Unit 5: Geochemical behaviour of selected Elements during Magmatic Fractionation

Si, Al, K, Na, Ca, Fe, Mg, Ti.

Paper –GEL-A-CC-2-3-P
[2 CREDITS]
ELEMENTS OF GEOCHEMISTRY

Geochemical variation diagrams and its interpretations: bivariate and trivariate plots to delineate the control of different compositional variables: Harker variation diagram, AFM diagram, MgO diagram. Chemical variation diagrams based on major elements: the alkali-lime index, iron enrichment index, aluminum saturation index and alkalinity index diagrams.

Reference Books

- Mason, B. (1986). Principles of Geochemistry. 3rd Edition, Wiley, New York.
Rollinson, H. (2007). Using geochemical data – evaluation, presentation and interpretation. 2nd Edition. Publisher Longman Scientific and Technical.
Walther, J. V. (2009). Essentials of geochemistry. Jones and Bartlett Publishers.
Albarède, F. (2003). Geochemistry: an introduction. Cambridge University Press.
Faure, Gunter and Teresa M. Mensing (2004). Isotopes Principles and Applications. Wiley India Pvt. Ltd

Paper –GEL-A-CC-2-4-TH
[4 CREDITS]
STRUCTURAL GEOLOGY

Unit 1: Basic Structural Elements

Diastrophic and non-diastrophic structures.
Structural elements: planar and linear structures, concept of strike and dip, trend and plunge, rake/pitch.
Application of primary sedimentary and igneous structure in structural geology. Unconformity and its types, recognition of unconformity.
Concept of scale of observation of structures.
Topographic maps. Outcrop patterns of different structures.

Unit 2: Stress and Strain in Rocks

Basic concept of rock deformation. Concept of Stress. Concept of strain: Homogeneous and inhomogeneous strain, Rotational and irrotational strain in rocks. Strain ellipsoids of different types and their geological significance. Flinn and Ramsay's diagram.
Concept of brittle and ductile deformation.

Unit 3: Folds

Fold morphology; Geometric classification of folds; elementary idea on mechanism of folding-buckling, bending, flexural slip and flow folding. Relation of foliation and lineation with folds.

Unit 4: Foliation and Lineation

Morphological features of foliations and lineations. Tectonic significance of foliation and lineation. Brief idea of origin of foliation.

Unit 5: Fractures and faults

Basic idea of shear zone. Faults and joints.

Geometric classification of faults. Anderson's dynamic analysis of faulting.

Effects of faulting on the outcrops.

Criteria for recognition of faults. Geometry of pinch and swell and boudin structure.

Paper –GEL-A-CC-2-4-P

[2 CREDITS]

STRUCTURAL GEOLOGY

Basic idea of topographic maps. Topographic sheets of various scales. Interpretation of topographic maps.

Interpretation of geological maps with unconformity, fault, fold and igneous bodies. Construction of structural cross section.

Stereographic projections of planes and lines.

True dip and apparent dip problems, 3-point problems, fold problems, fault problems and their solutions through stereographic projection methods.

Reference Books

Davis, G. R. (1984). Structural Geology of Rocks and Region. John Wiley

Billings, M. P. (1987). Structural Geology, 4th edition. Prentice-Hall.

Ragan, D. M. (2009). Structural Geology: an introduction to geometrical techniques (4th Ed). Cambridge University Press (For Practical)

Twiss, R. J. and Moores, E. M. (2007) Structural Geology. Second Edition. W. H. Freeman and Company.

Fossen, H. (2010). Structural Geology. Cambridge University Press.

Marshak, S. and Mitra, G. (1988). Basic Methods in Structural Geology. Prentice Hall.

Paper –GEL-A-CC-3-5-TH

[4 CREDITS]

IGNEOUS PETROLOGY

Unit 1: Introduction to Igneous Petrology

Modes of magma generation in the crust and upper mantle.

Physical properties of magma - temperature, viscosity, density and volatile content. Modes of emplacement of igneous rocks: volcanic, hypabyssal, plutonic.

Unit 2: Forms of Igneous rock bodies

Mode of occurrence of Igneous rocks.

Forms of igneous rocks.

Unit 3: Texture and Microstructure of Igneous rocks

Crystallinity, granularity, shapes and mutual relations of grains; nucleation and growth of igneous minerals.

Description of the following textures and microstructures with their occurrence in different rocks - panidiomorphic, hypidiomorphic, allotriomorphic, porphyritic, vitrophyric, poikilitic, ophitic, sub-ophitic, intergranular, intersertal, pilotaxitic, trachytic, graphic, granophyric, rapakivi, orbicular, corona, perthitic, myrmekitic, variolitic, speherulitic and spinifex, vesicular, amygdaloidal.

Unit 4: Classification of Igneous rocks

Bases of classification of igneous rocks: mineralogical, textural, chemical, chemico-mineralogical and associational. Norm and mode. Standard classification schemes – Shand, Hatch and Wells, and IUGS. TAS diagram for volcanic rocks. Outline of CIPW classification.

Composition and texture of important igneous rocks: granitoids, pegmatite, syenite, monzonite, diorite, norite, gabbro, anorthosite, dolerite, pyroxenites, peridotite, lamprophyres, carbonatite, rhyolite, andesite, dacite, basalt, komatiite.

Unit 5: Phase Diagrams

Phase rule and its application to eutectic, peritectic and solid solution system. Phase equilibria in the following binary and ternary systems, and their petrogenetic significance: diopside – anorthite, forsterite – silica, albite – anorthite, albite – orthoclase, diopside – albite – anorthite, forsterite – diopside – silica and nepheline - kalsilite – silica.

Unit 6: Petrogenesis of Igneous rocks

Magmatic processes; crystal settling in magma, magma convection, crystal mush theory, igneous cumulates, diversity of igneous rocks

Petrogenesis of felsic and mafic igneous rocks: granitoids, basalt, anorthosite, alkaline rocks, ultramafic rocks.

Unit 7: Magmatism in different tectonic settings

Fundamental ideas of magmatism in different tectonics settings.

Paper –GEL-A-CC-3-5-P

[2 CREDITS]

IGNEOUS PETROLOGY

Study of important igneous rocks in thin sections: granite, granodiorite, diorite, syenite, nepheline syenite, gabbro, anorthosite, peridotite, pyroxenite, basalt, andesite, trachyte, rhyolite, dacite.

Norm calculation of silica saturated igneous rocks.

Plotting of mode in IUGS classification of plutonic rocks (Streckeisen diagram).

Reference Books

Philpotts, A. and Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.

Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson. Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.

Raymond, L. A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks. McGraw-Hill Science Engineering.

Myron G. Best (2001). Igneous and Metamorphic Petrology.

Cox, K. G. and Bell. J. D. (1979). The Interpretation of Igneous Rocks. Springer/Chapman and Hall.

Bose M. K. (1997). Igneous Petrology.

Frost B. R. and Frost C. D (2014). Essentials of Igneous and Metamorphic Petrology. Cambridge University Press.

Paper –GEL-A-CC-3-6-TH

[4 CREDITS]

SEDIMENTARY PETROLOGY

Unit 1: Introduction to Sedimentology

Scope of sedimentology, origin of sediments, classification of sedimentary rocks based on composition and texture.

Unit 2: Granulometry: Textural parameters of clastic sediments

Grain size: concept and size scale; particle shape and fabric; sedimentary textures. grain size analyses and environmental connotation

Unit 3: Basic Hydraulics and Sedimentary Structures: sediment transport mechanism

Fluid flow: flow rheology, fluid gravity flow, sediment gravity flow, flow regime, laminar and turbulent flow, particle entrainment in fluid flow.

Mass flow: types and deposits

Sedimentary structure: primary and penecontemporaneous deformation structures, biogenic structures.

Paleocurrent analysis: data acquisition, methodology, different palaeocurrent patterns.

Unit 4: Sedimentary rocks

Siliciclastic rocks: components and classification(s) of conglomerates, sandstones, mudrocks.

General introduction to carbonate rocks, BIF, chert;

Components and classifications of limestone, dolomites and dolomitisation.

Unit 5: Sedimentary environments

Classification, sedimentary facies.

Facies models for glacier, meandering, fluvial, deltaic, and shelf depositional settings

Unit 6: Diagenesis

Concepts of diagenesis

Stages of diagenesis: diagenetic changes in sand and carbonate deposits, lithification.

Paper –GEL-A-CC-3-6-P

[2 CREDITS]

SEDIMENTARY PETROLOGY

Identification of sedimentary structures in hand specimens.

Statistical analysis of particle size distribution.

Paleocurrent analysis.

Petrographic study of clastic and non-clastic rocks in thin sections.

Reference Books

Allen, J.R.L. (1985). Principles of Physical Sedimentology. George Allen and Unwin, London.

Prothero, D. R. and Schwab, F. (2004). Sedimentary geology. Macmillan.

Tucker, M. E. (2001). Sedimentary Petrology, Third Edition Blackwell Science.

Collinson, J. D. and Thompson, D. B. (1988). Sedimentary structures. Unwin- Hyman, London.

Nichols, G. (2009). Sedimentology and Stratigraphy. Second Edition. Wiley Blackwell.

Folk, R. L. (1974). Petrology of Sedimentary Rock. Hemphill Publishing Company, Austin, Texas.

Paper –GEL-A-CC-3-7-TH

[4 CREDITS]

PALEONTOLOGY

Unit 1: Fossilization and fossil record

Nature and importance of fossil record; Fossilization processes and modes of preservation

Unit 2: Taxonomy and Species concept

Species concept with special reference to paleontology, Taxonomic hierarchy Theory of organic evolution interpreted from fossil record

Unit 3: Invertebrates

Brief introduction to important invertebrate groups (Mollusca and Brachiopoda) and their biostratigraphic significance
Significance of ammonites in Mesozoic biostratigraphy and their paleobiogeographic implications
Functional adaptation in trilobites and ammonoids.
Origin of invertebrates and major steps in their evolution.

Unit 4: Vertebrates

Origin of vertebrates and major steps in vertebrate evolution.
Mesozoic reptiles with special reference to origin diversity and extinction of dinosaurs
Evolution of horse and intercontinental migrations.
Human evolution.

Unit 5. Introduction to Paleobotany, Gondwana Flora

Introduction to Ichnology.

Unit 6: Application of fossils in Stratigraphy

Biozones, index fossils, correlation
Role of fossils in sequence stratigraphy
Fossils and paleoenvironmental analysis
Fossils and paleobiogeography, biogeographic provinces, dispersals and barriers
Paleoecology – fossils as a window to the evolution of ecosystems

Paper –GEL-A-CC-3-7-P

[2 CREDITS]

PALEONTOLOGY

Study of fossils showing various modes of preservation
Study of morphological characters of various invertebrates, vertebrates and plant fossils
Elementary exercise on functional morphology of bivalves

Reference Books

Raup, D. M., Stanley, S. M., Freeman, W. H. (1971) Principles of Paleontology
Clarkson, E. N. K. (2012) Invertebrate paleontology and evolution 4th Edition by Blackwell Publishing.
Benton, M. (2009). Vertebrate paleontology. John Wiley & Sons.
Shukla, A. C., & Misra, S. P. (1975). Essentials of paleobotany. Vikas Publisher
Armstrong, H. A., & Brasier, M.D. (2005) Microfossils. Blackwell Publishing.

Paper –GEL-A-CC-4-8-TH

[4 CREDITS]

METAMORPHIC PETROLOGY

Unit 1: Metamorphism: Controls and Types

Definition of metamorphism. Factors controlling metamorphism, Types of metamorphism – contact, regional, fault zone metamorphism, impact metamorphism.
Causes of metamorphism and concept of metamorphic P-T-t paths.

Unit 2: Metamorphic Facies and Grades. Metamorphic Structures and Textures

Index minerals, metamorphic zones and isograds. Structure and textures of metamorphic rocks.
Concept of metamorphic facies and grade.
Mineralogical phase rule of closed and open system.
Composition-paragenesis diagrams. ACF, AKF and AFM diagrams.
Metamorphic products of pelitic, carbonate and mafic igneous rocks.

Unit 3: Metamorphic reactions. Metamorphism and deformation.

Progressive and retrogressive metamorphism.
Prograde and retrograde metamorphic minerals reactions.
Relationship between metamorphism and deformation.

Unit 4: Migmatites and their origin

Metasomatism and role of fluids in metamorphism.
Brief idea of crustal anatexis. Migmatites and its origin.
Metamorphic differentiation.

Unit 5: Metamorphic rock associations and Plate Tectonic settings

Regional occurrence and tectonic significance of metamorphic rocks: metamorphism along convergent plate margins, in continent-continent collisions, in rifting terrains and sea floor metamorphism.
Metamorphic belts of India.

Paper –GEL-A-CC-4-8-P

[2 CREDITS]

METAMORPHIC PETROLOGY

Hand specimen study of following metamorphic rocks: slate, phyllite, schist, gneiss, amphibolite, charnockite, khondalite, mafic granulite, marble.
Textural and mineralogical study of following metamorphic rocks in thin sections: slate, varieties of schists, gneiss, amphibolite, charnockite, khondalite, mafic granulite, eclogite, marble, high Mg-Al granulites.
Graphical plots of metamorphic mineral assemblages using chemographic diagrams (ACF and AKF) in greenschist and amphibolite facies.

Reference Books

Philpotts, A. and Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.
Raymond, L. A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks. McGraw-Hill Science Engineering.
Yardley, B. W. D. (1989). An introduction to metamorphic petrology. Longman Scientific and Technical, London.
Spear F. S. (1993). Metamorphic phase equilibria and Pressure-Temperature-Time paths. Mineralogical Society of America. Monograph.

Paper –GEL-A-CC-4-9-TH

[4 CREDITS]

STRATIGRAPHIC PRINCIPLES AND INDIAN STRATIGRAPHY

Unit 1: Principles of stratigraphy

Fundamentals of litho-, bio- and chrono-stratigraphy
Introduction to concepts of dynamic stratigraphy (chemostratigraphy, seismic stratigraphy, sequence stratigraphy, magnetostratigraphy)

Unit 2: Code of stratigraphic nomenclature

International Stratigraphic Code – development of a standardized stratigraphic nomenclature.
Concepts of Stratotypes. Global Stratotype Section and Point (GSSP).
Principles of stratigraphy and principles of Precambrian stratigraphy

Unit 3: Facies concept in stratigraphy

Walther's Law of Facies.

Unit 4: Paleogeography

Concept of paleogeographic reconstruction

Unit 5: Physiographic and tectonic subdivisions of India

Brief introduction to the physiographic and tectonic subdivisions of India.

Unit 6: Precambrian Stratigraphy

Introduction to Indian Shield

Concept of Archean nucleus: Dharwar and Singhbhum

Introduction to Proterozoic basins of India.

Geology of Vindhyan and Cudappah basins of India

Paper –GEL-A-CC-4-9-P

[2 CREDITS]

STRATIGRAPHIC PRINCIPLES AND INDIAN STRATIGRAPHY

Study of geological map of India and identification of major Precambrian stratigraphic units.

Drawing of various paleogeographic maps of Precambrian time

Study of different Proterozoic and Pangea supercontinent reconstructions.

Reference Books

Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers, Delhi

Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley

Ramakrishnan, M. & Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological society of India, Bangalore.

Valdiya, K. S. (2010) The making of India, Macmillan India Pvt. Ltd.

Paper –GEL-A-CC-4-10-TH

[4 CREDITS]

PHANEROZOIC STRATIGRAPHY OF INDIA

Unit 1: Phanerozoic Stratigraphy of India

Paleozoic Succession of Kashmir and its correlatives from Spiti Stratigraphy

Structure of Gondwana basins.

Mesozoic stratigraphy of India: Triassic successions of Spiti, Jurassic of Kutch, Cretaceous successions of Cauvery basins

Cenozoic stratigraphy of India: Kutch basin, Siwalik successions, Assam and Andaman basins.

Stratigraphy and structure of Krishna-Godavari basin, Cauvery basin, Bombay offshore basin, Kutch and Saurashtra basins

Unit 2: Volcanic provinces of India

Deccan, Rajmahal, Sylhet Trap

Unit 3: Stratigraphic boundaries

Important Stratigraphic boundaries in India: Precambrian-Cambrian boundary, Permian-Triassic boundary, Cretaceous-Paleogene boundary

Paper –GEL-A-CC-4-10-P

[2 CREDITS]

PHANEROZOIC STRATIGRAPHY OF INDIA

Study of geological map of India and identification of major Phanerozoic stratigraphic units.

Drawing of various paleogeographic maps of Phanerozoic time

Stratigraphic correlation of Phanerozoic stratigraphic units in geological map of India.

Reference Books

Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers, Delhi

Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley

Ramakrishnan, M. & Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological society of India, Bangalore.

Valdiya, K. S. (2010) The making of India, Macmillan India Pvt. Ltd.

Paper –GEL-A-CC-5-11-TH

[4 CREDITS]

ECONOMIC GEOLOGY

Unit 1: Ores and Gangues

Ores, protor, gangue minerals, tenor, grade and lodes. Hypogene and supergene ore deposits, epigenetic and syngenetic mineral deposits; mineral beneficiation

Resources and reserves- economic and academic definitions.

Unit 2: Mineral deposits and Classical concepts of Ore formation

Mineral occurrence, mineral deposit and ore deposit.

Historical concepts of ore genesis: Man's earliest vocation- mining.

Mineral deposits and their litho-tectonic environments.

Metallogenic provinces and epochs.

Unit 3: Structure and texture of ore deposits

Concordant and discordant ore bodies.

Endogenous processes: magmatic concentration, skarns, greisens, and hydrothermal deposits.

Exogenous processes: weathering products and residual deposits, oxidation and supergene enrichment, placer deposits.

Unit 4: Ore grade and Reserve

Assessment of ore grade and reserve, reserve estimation.

Unit 5: Metallic and Nonmetallic ores

Important deposits of India including atomic minerals: study of geologic set up, mode of occurrence, mineralogy and genesis of the following ore deposits in India: iron ore in Singhbhum and Karnataka, Manganese of Central India, copper of Malanjkhand, lead-zinc of Zawar area, uranium of Singhbhum.

Non-metallic and industrial rocks and minerals in India.

Introduction to gemstones.

Paper –GEL-A-CC-5-11-P

[2 CREDITS]

ECONOMIC GEOLOGY

Hand sample identification of important ores and nonmetallic minerals.

Study of microscopic properties of ore forming minerals (oxides and sulphides).

Preparation of maps: distribution of important ores and other economic minerals in India.

Reference Books

Guilbert, J.M. and Park Jr. C.F. (1986). The Geology of Ore deposits. Freeman and Co.

Bateman, A.M. and Jensen, M.L. (1990). Economic Mineral Deposits. John Wiley.
Evans, A.M. (1993). Ore Geology and Industrial minerals. An Introduction. (Third Edition). Blackwell Publishing.
Robb, L. J. (2005). Introduction to ore forming processes. Wiley.
Deb, S. (1980). Industrial minerals and rocks of India. Allied Publishers.
Sarkar, S.C. and Gupta, A. (2014). Crustal Evolution and Metallogeny in India. Cambridge Publications.
Mookherjee A. (1999). Ore Genesis A Holistic approach. Allied Publishers Pvt. Ltd.
Stanton, R. L. (1972). Ore Petrology. Mcgraw_Hill Book company.

Paper –GEL-A-CC-5-12-TH

[4 CREDITS]

ENGINEERING GEOLOGY

Unit 1:Introduction

Role of Engineering geologists in planning, design and construction of major man-made structural features.

Unit 2: Site investigation

Site investigation and characterization.

Unit 3: Foundation

Foundation treatment; Grouting, Rock Bolting and other support mechanisms.

Unit 4: Intact Rock and Rock Mass properties

Rock aggregates; significance as construction material.

Unit 5: Rock Quality Designation (RQD)

Concept, mechanism and significance of: Rock Structure Rating (RSR) Rock Mass Rating (RMR) Tunneling Quality Index (Q) Geological, Geotechnical and Environmental considerations for dams and reservoirs.

Unit 6: Tunnels

Tunneling methods.

Unit 7: Landslides

Causes, factors and corrective/preventive measures.

Unit 8: Earthquakes

Corrective/preventive measures. Mitigating the damage caused by earthquake.

Paper –GEL-A-CC-5-12-P

[2 CREDITS]

ENGINEERING GEOLOGY

Computation of reservoir area, catchment area, reservoir capacity and reservoir life.
Merits, demerits and remedial measures based upon geological cross sections of project sites.
Computation of Index properties of rocks.
Computation of RQD, RSR, RMR, and 'Q'.

Reference Books

Krynin, D.P. and Judd W.R. (1957). Principles of Engineering Geology and Geotechnique. McGraw Hill (CBS Publ).
Johnson, R.B. and De Graf, J.V. (1988). Principles of Engineering Geology, John Wiley.
Goodman, R.E. (1993). Engineering Geology: Rock in Engineering constructions. John Wiley and Sons, New York.
Waltham, T. (2009). Foundations of Engineering Geology (3rd Edn.). Taylor and Francis.
Bell: F.G. (2006). Basic Environmental and Engineering Geology. Whittles Publishing.
Bell, .F.G (2007). Engineering Geology. Butterworth-Heineman.

Paper –GEL-A-CC-6-13-TH

[4 CREDITS]

HYDROGEOLOGY

Unit 1: Introduction and basic concepts

Scope of hydrogeology and its societal relevance

Hydrologic cycle: precipitation, evapo-transpiration, run-off, infiltration and subsurface movement of water.

Rock properties affecting groundwater, Vertical distribution of subsurface water

Types of aquifer, aquifer parameters, anisotropy and heterogeneity of aquifers

Unit 2: Groundwater flow

Darcy's law and its validity

Intrinsic permeability and hydraulic conductivity

Groundwater flow rates and flow direction

Laminar and turbulent groundwater flow

Unit 3: Groundwater provinces

Groundwater provinces of India and West Bengal

Unit 4: Groundwater chemistry

Physical and chemical properties of water and water quality

Sea water intrusion in coastal aquifers

Unit 5: Groundwater management

Surface and subsurface water interaction

Groundwater level fluctuations

Basic concepts of water balance studies, recharge and discharge

Rainwater harvesting and artificial recharge of groundwater

Paper –GEL-A-CC-6-13-P

[2 CREDITS]

HYDROGEOLOGY

Water potential zones of India (map study).

Graphical representation of chemical quality data and water classification (C-S and Trilinear diagrams)

Simple numerical problems related to: determination of permeability in field and laboratory,

Reference Books

Todd, D. K. 2006. Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.

Davis, S. N. and De Weist, R.J.M. 1966. Hydrogeology, John Wiley & Sons Inc., N.Y.

Karanth K.R., 1987, Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co. Ltd.

Paper –GEL-A-CC-6-14-TH

[4 CREDITS]

GEOMORPHOLOGY, REMOTESENSING ANDGIS

Unit 1: Introduction

Introduction to geomorphology; relationship between the landforms and the properties of earth material and different kind of processes.

Endogenic and exogenic processes.

Unit 2

Geoid, topography, hypsometry, major morphological features of the earth surface.

Large scale topography - plate tectonics overview, large scale mountain ranges (with emphasis on Himalayas).

Unit 3

Surficial processes and geomorphology; weathering and associated landforms.

Landforms produced by glacial, periglacial processes, fluvial processes, aeolian processes, coastal processes.

Landforms associated with igneous activities.

Unit 4

Endogenic-exogenic interactions; rates of uplift and denudation; tectonics and drainage development; sea-level change; long-term landscape development.

Landform dating techniques.

Unit 5: Photogeology

Types and acquisition of aerial photographs; scale and resolution; principles of stereoscopy, relief displacement, vertical exaggeration and distortion.

Elements of air photo interpretation.

Identification of sedimentary, igneous and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms.

Unit 6: Remote Sensing

Concepts in Remote Sensing.

Sensors and scanners.

Satellites and their characteristics.

Data formats- Raster and Vector.

Unit 7: Digital Image Processing

Image classification

Unit 8: GIS and GPS

Datum, Coordinate systems and projection systems.

Concepts of GPS.

Integrating GPS data with GIS.

Applications of GPS in earth system sciences.

Paper –GEL-A-CC-6-14-P

[2 CREDITS]

GEOMORPHOLOGY, REMOTESENSING ANDGIS

Reading topographic maps. Preparation of topographic profile.

Preparation of longitudinal profile of a river. Calculating stream length gradient index.

Morphometry of a drainage basin. Interpretation of geomorphic processes from the geomorphology of the area.

Aerial photo interpretation: identification of sedimentary, igneous and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms.

Reference Books

Roberts S. Anderson and Suzzane P. Anderson (2010). *Geomorphology – The Mechanism and Chemistry of landscapes*. Cambridge University Press.

M. A. Summerfield (1991). *Global Geomorphology*. Willey and Sons.

R G Huggett. *Fundamentals of Geomorphology* (3rd ed.). Routledge.

Demers, M.N., 1997. *Fundamentals of Geographic Information System*, John Wiley & sons. Inc.

Hoffmann-Wellenhof, B., Lichtenegger, H. and Collins, J., 2001. *GPS: Theory & Practice*, Springer Wien New York.

Jensen, J.R., 1996. *Introductory Digital Image Processing: A Remote Sensing Perspective*, Springer- Verlag.

Lillesand, T. M. & Kiefer, R.W., 2007. *Remote Sensing and Image Interpretation*, Wiley.

Richards, J.A. and Jia, X., 1999. *Remote Sensing Digital Image Analysis*, Springer-Verlag.

DISCIPLINE SPECIFIC ELECTIVE

DSE- A

Paper – GEL-A-DSE-A-5-1-TH

[4 CREDITS]
TECTONICS

Unit 1: Introduction

Continents and oceans. Continental and oceanic crust. Internal processes of earth. Ophiolites. Palaeomagnetism. Concept of lithosphere and asthenosphere. Physical character of lithosphere and asthenosphere. Concept of plate. Plate tectonic system. Concept of hot spot and plumes.

Unit 2: Historical Perspective: Continental Drift, Sea Floor Spreading and Plate Tectonics

Wegener's Continental drift hypothesis and its evidences. Continental position in the past. Sea-floor spreading theory and its evidences. Magnetic time scale. Palaeomagnetism and motion of plates.

Unit 3: Plate and Plate boundaries

Plates: physical character of plates. Macro and micro plates. Plate boundaries: types, character, Identification of boundaries. Motion along plate boundaries. Triple points. Kinematics of plate motion. Rate of plate motion. Volcanic arcs, island arcs, trenches, accretionary prisms, oceanic ridges, transform faults. Magmatism in oceanic ridges and in subduction zones.

Unit 4: Plate Tectonics: Past and Present

Plate tectonics model and its evidences. Distribution of plates in the Earth. Reconstruction of plates - supercontinent. Supercontinents and their breakup and assembly. Assembly and breakup of Pangaea. Wilson cycle. Driving mechanisms of plates. Plate tectonics and mantle convection.

Paper – GEL-A-DSE-A-5-1-P

[2 CREDITS]
TECTONICS

Geometry of plate tectonics: Vector solutions in 2D and 3D of plate movements
Problems of plate movements - Rotations on sphere

Reference Books

Kearey, p., Klepeis, K. A., and Vine, F. J. (2009). Global Tectonics. Third edition. Wiley-Blackwell, Oxford.
Condie, K.C. (1997). Plate Tectonics and Crustal Evolution. Fourth edition. Butterworth-Heinemann.
Moore, E. M. and Twiss, R. J. (1995). Tectonics. W. H. Freeman, New York.

Paper – GEL-A-DSE-A-5-2-TH

[4 CREDITS]
EXPLORATION GEOLOGY

Unit 1: Mineral Resources

Resource reserve definitions, Mineral resources in industries – historical perspective and present, A brief overview of classification of mineral deposits with respect to processes of formation in relation to exploration strategies.

Unit 2: Prospecting and Exploration

Principles of mineral exploration, Prospecting and exploration- conceptualization, methodology and stages, Sampling, subsurface sampling including pitting, trenching and drilling, Geochemical exploration.

Unit 3: Evaluation of data

Evaluation of sampling data
Mean, mode, median, standard deviation and variance

Unit 4: Drilling and Logging

Core and non-core drilling
Planning of bore holes and location of boreholes on ground
Core-logging

Unit 5: Reserve estimations and Errors

Principles of reserve estimation, density and bulk density
Factors affecting reliability of reserve estimation
Reserve estimation based on geometrical models (square, rectangular, triangular and polygon blocks)
Regular and irregular grid patterns, statistics and error estimation

Paper – GEL-A-DSE-A-5-2-P

[2 CREDITS]

EXPLORATION GEOLOGY

Identification of anomaly
Concept of weighted average in anomaly detection
Geological cross-section
Models of reserve estimation

Reference Books

Clark, G.B. 1967. Elements of Mining. 3rd Ed. John Wiley & Sons.
Arogyaswami, R.P.N. 1996 Courses in Mining Geology. 4th Ed. Oxford-IBH.
Moon, C.J., Whateley, M.K.G., Evans, A.M., 2006, Introduction to Mineral Exploration, Blackwell Publishing.

Paper – GEL-A-DSE-A-6-1-TH

[4 CREDITS]

EARTH AND CLIMATE**Unit 1: Climate system: Forcing and Responses**

Components of the climate system.

Climate forcing, Climate controlling factors.
Feedbacks in climate system (positive and negative).

Unit 2: Heat budget of Earth

Incoming solar radiation, receipt and storage of heat transformation.
Earth's heat budget. Interactions amongst various sources of earth's heat.

Unit 3: Atmosphere – Hydrosphere

Layering of atmosphere and atmospheric Circulation.
Atmosphere and ocean interaction and its effect on climate.
Surface and deep circulation.
Sea ice and glacial ice.

Unit 4: Response of biosphere to Earth's climate

Climate change: natural vs. anthropogenic effects.
Future perspectives.
Brief introduction to archives of climate change.
Brief introduction to palaeoclimate.
Palaeoclimate data from India.

Unit 5: Orbital cyclicity and climate

Milankovitch cycles and variability in the climate.
Glacial-interglacial stages
The last glacial maximum (LGM)
Pleistocene Glacial-Interglacial cycles.

Unit 6: Monsoon

Mechanism of monsoon.
Monsoonal variation through time.
Factors associated with monsoonal intensity.
Effects of monsoon.

Paper – GEL-A-DSE-A-6-1-P

[2 CREDITS]

EARTH AND CLIMATE

Study of distribution of major climatic regimes of India on map
Distribution of major wind patterns on World map
Numerical exercises on interpretation of proxy records for palaeoclimate

Reference Books

Rudiman, W.F., 2001. Earth's climate: past and future. Edition 2, Freeman Publisher.
Rohli, R.V., and Vega, A.J., 2007. Climatology. Jones and Bartlett
Lutgens, F., Tarbuck, E., and Tasa, D., 2009. The Atmosphere: An Introduction to Meteorology. Pearson Publisher
Aguado, E., and Burt, J., 2009. Understanding weather and Climate. 5th Edition, Pearson Publisher
Dorothy Merritts, Kirsten Menking and Andrew deWet, 2014. Environmental Geology: An Earth Systems Science Approach. Edition 2, W.H.Freeman and Co Ltd

Paper – GEL-A-DSE-A-6-2-TH

[4 CREDITS]

EARTH SURFACE PROCESSES

Unit 1: Introduction to earth surface processes

Historical development in concepts, terrestrial relief, scales in geomorphology,

Unit 2: Energy flow and relative energy of surface processes.

Weathering and formation of soils, karst and speleology, slope and catchment erosion processes, fluvial, aeolian, glacial, peri-glacial and coastal processes and resultant landforms, , Water and sediment flux in river systems, Morphometric analysis of drainage basin and geomorphology-hydrology relationship.

Unit 3: Rates and changes in surface processes

Techniques for measuring rates of processes: sediment budgeting, rock magnetism, isotope geochemical tracers, cosmogenic nuclides, OSL & C-14 dating

Unit 4: Controlling factors (tectonics, climate, sea level changes and anthropogenic) and surface processes

Climate change and geomorphic response of fluvial systems of arid and humid regions

Geomorphic response to tectonics, sea level/base level change, anthropogenic affects

Introduction to Anthropocene

Unit 5: Geomorphic concepts in cause-effect relationship

Spatial & temporal scales, geomorphic system, connectivity, buffering, magnitude-frequency concept, time lag, sensitivity, equilibrium, threshold, non-linearity & complexities

Mega geomorphology and process interrelationship

Surface processes and natural hazards; Applied aspects of geomorphology; Introduction to planetary geomorphology.

Paper – GEL-A-DSE-A-6-2-P

[2 CREDITS]

EARTH SURFACE PROCESSES

Mapping of different landforms and interpretation of surface processes

Exercises on hill slope development, fluvial channel, sediment erosion and transport, sediment budgeting, aggradation and degradation events, drainage basin, drainage morphometry

Basic exercises on computation of rate for different surface processes

Reference Books

Alien, P.A., 1997. *Earth Surface Processes*, Blackwell publishing.

Bloom, A.L., 1998. *Geomorphology: A Systematic Analysis of Late Cenozoic Landforms*, Pearson Education.

Bridge, J.S. and Demicco, R.V., 2008. *Earth Surface Processes, Landforms and Sediment Deposits*, Cambridge University Press.

Esterbrook, D.J., 1992. *Surface Processes and Landforms*, MacMillan Publ.

Kale, V.S. and Gupta A 2001 *Intoduction to Geomorphology*, Orient Longman Ltd.

Leeder, M. and Perez-Arlucea M 2005 *Physical processes in earth and environmental sciences*, Blackwell' publishing.

Summerfield M A 1991 *Globe Geomorphology* Prentice Hall.

Willcock, P.R., Iverson R M (2003) *Prediction in geomorphology* ' AGU Publication.

DSE- B

Paper – GEL-A-DSE-B-5-1-TH

[4 CREDITS]

FUEL GEOLOGY

Unit 1: Coal

Definition and origin of Coal

Basic classification of coal

Fundamentals of Coal Petrology - Introduction to lithotypes, microlithotypes and macerals in coal

Proximate and Ultimate analysis

Unit 2: Coal as a fuel

Coal Bed Methane (CBM): global and Indian scenario

Unit 3: Petroleum

Chemical composition and physical properties of crudes in nature

Origin of petroleum

Unit 4: Petroleum Reservoirs and Traps

Reservoir rocks: general attributes

Classification of reservoir rocks - clastic and chemical.

Hydrocarbon traps: definition, anticlinal theory and trap theory

Classification of hydrocarbon traps - structural, stratigraphic and combination

Time of trap formation and time of hydrocarbon accumulation.

Cap rocks - definition and general properties.

Unit 5: Other fuels

Gas Hydrate

Nuclear Fuel

Paper – GEL-A-DSE-B-5-1-P

[2 CREDITS]

FUEL GEOLOGY

Study of hand specimens of coal

Reserve estimation of coal

Reference Books

Chandra D. (2007). Chandra's Textbook on applied coal petrology. Jijnasa Publishing House.

Shelly R. C. (2014). Elements of Petroleum geology: Third Edition, Academic Press

Bjorlykke, K. (1989). Sedimentology and petroleum geology. Springer-Verlag.

Bastia, R., & Radhakrishna, M. (2012). Basin evolution and petroleum prospectivity of the continental margins of India (Vol. 59). Newnes.

Paper – GEL-A-DSE-B-5-2-TH
[4 CREDITS]
EVOLUTION OF LIFE THROUGH TIME

Unit 1: Life through ages

Fossils and chemical remains of ancient life.
Geological Time Scale with emphasis on major bio-events.
Fossilization processes and modes of fossil preservation.
Exceptional preservation sites- age and fauna

Unit 2: Geobiology

Biosphere as a system, processes and products
Biogeochemical cycles
Abundance and diversity of microbes, extremophiles
Microbes-mineral interactions, microbial mats

Unit 3: Origin of life

Possible life sustaining sites in the solar system, life sustaining elements and isotope records
Archean life: Earth's oldest life, Transition from Archean to Proterozoic, the oxygen revolution and radiation of life
Precambrian microfossils – The garden of Ediacara
The Snow Ball Earth Hypothesis

Unit 4: Paleozoic Life

The Cambrian Explosion.
Biomineralization and skeletalization
Origin of vertebrates and radiation of fishes
Origin of tetrapods - Life out of water
Early land plants and impact of land vegetation

Unit 5: Mesozoic Life

Life after the largest (P/T) mass extinction, life in the Jurassic seas
Origin of mammals
Rise and fall of dinosaurs
Origin of birds; and spread of flowering plants

Unit 6: Cenozoic Life

Aftermath of end Cretaceous mass extinction – radiation of placental mammals
Evolution of modern grasslands and co-evolution of hoofed grazers
Rise of modern plants and vegetation
Back to water – Evolution of Whales

Unit 7: The age of humans

Hominid dispersals and climate setting
Climate Change during the Phanerozoic - continental break-ups and collisions
Plate tectonics and its effects on climate and life
Effects of life on climate and geology

Paper – GEL-A-DSE-B-5-2-P
[2 CREDITS]
EVOLUTION OF LIFE THROUGH TIME

Study of modes of fossil preservation
Study of fossils from different stratigraphic levels
Exercises related to major evolutionary trends in important groups of animals and plants

Reference Books

Stanley, S.M., 2008 Earth System History
Jonathan I. Lumine W.H. Freeman Earth-Evolution of a Habitable World, Cambridge University Press.
Canfield, D.E. & Konhauser, K.O., 2012 Fundamentals of Geobiology Blackwell
Cowen, R., 2000 History of Life, Blackwell

Paper – GEL-A-DSE-B-6-1-TH
[4 CREDITS]
FIELD GEOLOGY AND GRAND VIVA

Unit 1: Grand viva

Viva-voce on all topics covered under six semester course curricula

Paper – GEL-A-DSE-B-6-1-P
[2 CREDITS]
FIELD GEOLOGY AND GRAND VIVA

7-day fieldwork

Preparation of a Geological map of a small area with folded/faulted beds.
Interrelation between different structural elements and their interpretations.
Visit to one underground/open crust mine: mining operation, surface geological expression of mining site Visit to dam site
Report writing.

Paper – GEL-A-DSE-B-6-2-TH
[4 CREDITS]
INTRODUCTION TO GEOPHYSICS

Unit 1: Geology and Geophysics

Interrelationship between geology and geophysics, Role of geological and geophysical data in explaining geodynamical features of the earth.

Unit 2: General and Exploration geophysics

Different types of geophysical methods - gravity, magnetic, electrical and seismic; their principles and applications

Concepts and Usage of corrections in geophysical data

Unit 3: Geophysical field operations

Different types of surveys, grid and route surveys, profiling and sounding techniques

Scales of survey, Presentation of geophysical data

Unit 4: Application of Geophysical methods

Regional geophysics, oil and gas geophysics, ore geophysics, groundwater geophysics, engineering geophysics

Unit 5: Geophysical anomalies

Correction to measured quantities, geophysical, anomaly, regional and residual (local) anomalies, factors controlling anomaly, and depth of exploration

Unit 6: Integrated geophysical methods

Ambiguities in geophysical interpretation, planning and execution of geophysical surveys

Paper – GEL-A-DSE-B-6-2-P

[2 CREDITS]

INTRODUCTION TO GEOPHYSICS

Anomaly and background- Graphical method

Study and interpretation of seismic reflector geometry

Problems on gravity anomaly

Reference Books

Outlines of Geophysical Prospecting - A manual for geologists by Ramachandra Rao, M.B., Prasaranga, University of Mysore, Mysore, 1975.

Exploration Geophysics - An Outline by Bhimasarikaram V.L.S., Association of Exploration Geophysicists, Osmania University, Hyderabad, 1990.

Dobrin, M.B. (1984) An introduction to Geophysical Prospecting. McGraw-Hill, New Delhi.

Telford, W. M., Geldart, L. P., & Sheriff, R. E. (1990). *Applied geophysics* (Vol. 1). Cambridge university press.

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

SKILL ENHANCEMENT COURSE

SEC-A

Paper –GEL-A-SEC-A-3-1-P

[2 CREDITS]

FieldWork

7-days fieldwork

Topographic sheet: methods of naming. Features, scale. Map reading.

Use of topographic sheets in field. Marking location in topographic sheet using physical features and bearing.

Identification of rock types in field.

Identification of primary and secondary structures in field.

Clinometer and Brunton compass: use of the instruments in measuring geological data in field. Techniques of measurement of orientation data in field.

Litholog measurement

Recording field data in maps and notebooks.

Report writing.

Paper –GEL-A-SEC-A-3-2-P

[2 CREDITS]

FieldWork

7-days fieldwork

Visit to any mineral deposit

Mode occurrence of ore, Ore mineralogy

Ore-Host rock interrelation

Ore formation process

Basic techniques of surveying, concept of outcrop mapping

Report writing.

SEC-B

Paper –GEL-A-SEC-B-4-1-P

[2 CREDITS]

FieldWork

7-day fieldwork

Map reading and geological mapping
stratigraphic and biogeographic correlation using fossils
Preparation of a geological map of a small area with homoclinal or gently folded beds.
Stereographic plots of orientation data and their interpretation.
Report writing.

Paper –GEL-A-SEC-B-4-2-P

[2 CREDITS]

FieldWork

7-day fieldwork

Field training along Phanerozoic basin of India
Documentation of stratigraphic details in the field
Collection of sedimentological, stratigraphic and paleontological details and their representation
Facies concept and its spatio-temporal relation (Walther's Law) and concept of facies distribution
atbasinal-scale
Fossils sampling techniques and their descriptions
Report writing.

UNIVERSITY OF CALCUTTA



Syllabus for B.Sc.(General) Geology

Six Semester Course Under

Choice Based Credit System

Semester-wise Courses for B. Sc. (General)

	Sem-1	Sem-2	Sem-3	Sem-4	Sem-5	Sem-6
Core Course (CC)	3TH+3P/TU CC-1	3TH+3P/TU CC-2	3TH+3P/TU CC-3	3TH+3P/TU CC-4		
Discipline Specific Elective (DSE)					3TH+3P/TU DSE-A (1A+2A+3A)	3TH+3P/TU DSE-B (1B+2B+3B)
Ability Enhancement Compulsory Course (AECC)	1TH+0P/TU AECC-1	1TH+0P/TU AECC-2				
Skill Enhancement Elective (SEC)			1TH+0P/TU SEC-A	1TH+0P/TU SEC-B	1TH+0P/TU SEC-A	1TH+0P/TU SEC-B
Total No. of Courses and Marks	4 × 100 =400	4 × 100 =400	4 × 100 =400	4 × 100 =400	4 × 100 =400	4 × 100 =400
Total Credits	20	20	20	20	20	20

TH= Theory P= Practical TU=Tutorial

- ❖ CC/DSE : Each Theory and Practical Course have 4 and 2 Credits respectively/ Each Theory and Tutorial Course have 5 and 1 Credit(s) respectively
- ❖ CC : 4 courses each from 3 subjects (one course from each subject under each semester)
- ❖ DSE : 2 courses each from 3 subjects (one course from each subject under each semester)
- ❖ AECC/SEC : Each Course has 2 credits
- ❖ AECC-1 : Communicative English/ MIL; AECC-2: Environmental Studies
- ❖ SEC: 4 courses; two courses each from two subjects
- ❖ DSE/SEC : Group (A & B) for specified semesters

YEAR	SEME STER	COURSE	COURSE NAMES WITH CODE	CREDIT POINTS	EQUIVALENT MARKS					TOTAL CREDIT POINTS
					Theory	Practical	Internal Assessment	Attendance	TOTAL	
1ST YEAR	I	CC	GEL-G-CC-1-1-TH / GEL-A-GE-1-1-TH: PHYSICAL and STRUCTURAL GEOOY	4	50		10	10	100	20
			GEL-G-CC-1-1-P / GEL-A-GE-1-1-P: PHYSICAL and STRUCTURAL GEOOY	2		30				
		AECC	AECC-1: Communicative English	2	80		10	10	100	
		CC	Subject2-G-CC-1-1-TH + Subject2-G-CC-1-1- P	6					100	
		CC	Subject3-G-CC-1-1-TH + Subject3-G-CC-1-1-P	6					100	
	II	CC	GEL-G-CC-2-2-TH / GEL-A-GE-2-2-TH: CRYSTALLOGRAPHY and MINERALOGY	4	50		10	10	100	20
			GEL-G-CC-2-2-P / GEL-A-GE-2-2-P: CRYSTALLOGRAPHY and MINERALOGY	2		30				
		AECC	AECC-2: Environmental Studies	2	80		10	10	100	
		CC	Subject2-G-CC-2-2-TH + Subject2-G-CC-2-2-P	6					100	
		CC	Subject3-G-CC-2-2-TH + Subject3-G-CC-2-2-P	6					100	
2ND YEAR	III	CC	GEL-G-CC-3-3-TH / GEL-A-GE-3-3-TH: PETROLOGY	4	50		10	10	100	20
			GEL-G-CC-3-3-P / GEL-A-GE-3-3-P: PETROLOGY	2		30				
		SEC-A	GEL-G-SEC-A-3-1-TH / Subject 2-G-SEC-A- X- X-TH / Subject3-G-SEC-A- X-X-TH	2	80		10	10	100	
		CC	Subject2-G-CC-3-3-TH + Subject2-G-CC-3-3-P	6					100	
		CC	Subject3-G-CC-3-3-TH + Subject3-G-CC-3-3-P	6					100	
	IV	CC	GEL-G-CC-4-4-TH / GEL-A-GE-4-4-TH: STRATIGRAPHY and PALAEONTOLOGY	2	80		10	10	100	20
			GEL-G-CC-4-4-P / GEL-A-GE-4-4-P: STRATIGRAPHY and PALAEONTOLOGY	4	50					
		SEC-B	GEL-G- SEC-B- 4-1 -TH/ Subject 2-G-SEC-B- X-X -TH / Subject3-G-SEC-B- X-X -TH	2		30			100	
		CC	Subject2-G-CC-4-4-TH + Subject2-G-CC-4-4-P	6					100	
		CC	Subject3-G-CC-4-4-TH + Subject3-G-CC-4-4-P	6					100	

YE AR	SEME STER	COURSE	COURSE NAMES WITH CODE	CREDIT POINTS	EQUIVALENT MARKS					TOTAL CREDIT POINTS
					Theory	Practical	Internal	Attendance	TOTAL	
3RD YEAR	V	DSE-A	GEL-G-DSE-A- 5-1-TH	4	50		10	10	100	20
			GEL-G-DSE-A- 5-1-P	2		30				
		SEC-A	GEL-G-SEC-A- 5-2-TH / Subject 2-G-SEC-A- X-X-TH / Subject3-G-SEC-A- X-X-TH	2	80		10	10	100	
		DSE-A	Subject2-G-DSE-A- X-X-TH + Subject2-G-DSE-A- X-X-P	6					100	
		DSE-A	Subject 3-G-DSE-A- X-X-TH + Subject 3-G-DSE-A- X-X-P	6					100	
	VI	SEC-B	GEL-G-SEC-B-6-2-TH / Subject 2-G-SEC-B- X-X-TH / Subject3-G-SEC-B- X-X-TH	2	80		10	10	100	20
		DSE-B	GEL-G-DSE-B- 6-1-TH	4	50		10	10	100	
			GEL-G-DSE-B-6-1-P	2		30				
		DSE-B	Subject 2-G-DSE-B- X-X-TH + Subject 2-G-DSE-B- X-X -P	6					100	
		DSE-B	Subject 3-G-DSE-B- X-X-TH + Subject 3-G-DSE-B- X-X -P	6					100	
					TOTAL			2400	120	

Note:

1. SEC / DSE choice from two subjects and must be group specific
2. AEC courses are not included in the gradation
3. At least 50 lectures of an hour duration should be allotted for 4 credit theoretical course and 2 credit practical course.

CORE COURSES

Paper – GEL-G-CC-1-1-TH / GEL-A-GE-1-1-TH

[4 credits]

PHYSICAL and STRUCTURAL GEOLOGY

Unit-I: Introduction to geology and its scope, Earth and solar system: origin, size, shape, mass, density and its atmosphere.

Unit-II: A brief account of various theories regarding the origin and age of the earth; Brief idea of interior of earth and its composition.

Unit-III: Weathering and erosion: factors, types and their effects;

Unit-IV: Earthquakes: nature of seismic waves, their intensity and magnitude scale; Origin of earthquake; Volcanoes: types, products and causes of volcanism;.

Unit-V: Introduction to Structural Geology; contours, topographic and geological maps; Elementary idea of bed, dip and strike; Outcrop, effects of various structures on outcrop. Clinometer/Brunton compass and its use.

Unit-VI: Elementary idea of types of deformation; Folds: nomenclature and types of folds;

Unit-VII: Faults: nomenclature, geometrical and genetic classifications, normal, thrust and slip faults;

Unit-VIII: definition, kinds and significance of joints and unconformity.

Paper – GEL-G-CC-1-1-P / GEL-A-GE-1-1-P

[2 credits]

PHYSICAL and STRUCTURAL GEOLOGY

• Physical Geology:

Study of important geomorphological models; Reading topographical maps of the Survey of India; Identification of geomorphic features.

• Structural Geology:

Study of clinometers/Brunton compass; Identification of different types of folds/faults from block models; Exercises on structural problems: preparation of cross section profile from a geological map.

Books Recommended:

1. Arthur Holmes, 1992. Principles of Physical Geology. Chapman and Hall, London.
2. Miller, 1949. An Introduction to Physical Geology. East West Press Ltd.
3. Spencer, E.V., 1962. Basic concepts of Physical Geology. Oxford & IBH.
4. Mahapatra, G.B., 1994. A text book of Physical geology. CBS Publishers.
5. Billings, M.P., 1972. Structural Geology. Prentice Hall.
6. Davis, G.R., 1984. Structural Geology of Rocks and Region. John Wiley
7. Hills, E.S., 1963. Elements of Structural Geology. Farrold and Sons, London.
8. Singh, R. P., 1995. Structural Geology, A Practical Approach. Ganga Kaveri Publ., Varanasi.

Paper – GEL-G-CC-2-2-TH / GEL-A-GE-2-2-TH
[4 credits]

CRYSTALLOGRAPHY and MINERALOGY

Unit-I: Crystals and their characters:

Unit-II: Crystal form, face, edge, solid angle; Interfacial angle and their measurements; Crystallographic axes and angles.

Unit-III: Crystal parameters, Weiss and Miller system of notations;

Unit-IV: Symmetry elements and description of normal class of Isometric, Tetragonal, Hexagonal, Trigonal, Orthorhombic, Monoclinic and Triclinic systems.

Unit-V: Introduction to Mineralogy, Definition and characters of mineral;

Unit-VI: Common physical properties of minerals; Chemical composition and diagnostic physical properties of minerals such as: Quartz, Orthoclase, Microcline, Hypersthene, Hornblende, Garnet, Muscovite, Biotite, Chlorite, Olivine, Epidote, Calcite.

Unit-VII: Polarizing microscope, its parts and functioning; Ordinary and polarized lights; Common optical properties observed under ordinary, polarized lights and crossed nicols.

Unit-VIII: Optical properties of some common rock forming minerals (Quartz, Orthoclase, Microcline, Olivine, Augite, Hornblende, Muscovite, Biotite, Garnet, Calcite).

Paper – GEL-G-CC-2-2-P / GEL-A-GE-2-2-P
[2 credits]

CRYSTALLOGRAPHY and MINERALOGY

• **Crystallography:**

Study of symmetry elements of normal class of Isometric, Tetragonal, Hexagonal, Trigonal, Orthorhombic, Monoclinic and Triclinic systems.

• **Mineralogy:**

Study of physical properties of minerals mentioned in theory course. Use of polarizing microscope; Study of optical properties of common rock forming minerals mentioned in theory course.

Books Recommended:

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

Paper – GEL-G-CC-3-3-TH / GEL-A-GE-3-3-TH

[4 credits]

PETROLOGY

Igneous Petrology

Unit-I: Magma: definition, composition, types and origin; Forms of igneous rocks; textures of igneous rocks.

Unit-II: Reaction principle; Differentiation and Assimilation; Crystallization of unicomponent and bicomponent (mix-crystals); Bowen's reaction series.

Unit-III: Mineralogical and chemical classification of igneous rocks:.

Unit-IV: Detailed petrographic description of Granite, Granodiorite, Rhyolite, Syenite, Phonolite, Diorite, Gabbro.

Sedimentary Petrology

Unit-V: Processes of formation of sedimentary rocks; Classification, textures and structures of sedimentary rocks;

Unit-VI: Petrographic details of important siliciclastic and carbonate rocks such as - conglomerate, breccia, sandstone, greywacke, shale, limestones.

Metamorphic Petrology

Unit-VII: Process and products of metamorphism; Type of metamorphism. Factors, zones and grade of metamorphism; Textures, structures and classification of metamorphic rocks.

Unit-VIII: Petrographic details of some important metamorphic rocks such as - slate, schists, gneiss, quartzite, marble.

Paper – GEL-G-CC-3-3-P / GEL-A-GE-3-3-P

[2 credits]

PETROLOGY

• Igneous Petrology:

Identification of rocks: On the basis of their physical properties in hand specimen; and optical properties in thin sections.

• Sedimentary and metamorphic Petrology:

Identification of sedimentary and metamorphic rocks both in hand specimen and thin sections.

Books Recommended:

1. Turner, F.J. & Verhoogen, J., 1960, Igneous & Metamorphic petrology. McGraw Hill Co.
2. Bose, M.K., 1997. Igneous petrology. World press
3. Tyrell, G. W., 1989. Principles of Petrology. Methuren and Co (Students ed.).
4. Ehlers, WG, and Blatt, H., 1987. Petrology, Igneous, Sedimentary and Metamorphic rocks, CBS Publishers
5. Moorhouse, WW., 1969. The study of rocks in thin sections. Harper and sons.
6. Friedman & Sanders, 1978. Principles of Sedimentology. John Wiley and sons.
7. Pettijohn, F.J., 1975. Sedimentary rocks, Harper & Bros. 3rd Ed.
8. Prasad, C., 1980. A text book of sedimentology.
9. Sengupta. S., 1997. Introduction to sedimentology. Oxford-IBH.

10. Turner, F.J., 1980. Metamorphic petrology. McGraw Hill.
11. Mason, R., 1978. Petrology of Metamorphic Rocks. CBS Publ.
12. Winkler, H.G.C., 1967. Petrogenesis of Metamorphic Rocks. Narosa Publ.

Paper – GEL-G-CC-4-4-TH / GEL-A-GE-4-4-TH

[4 credits]

STRAIGRAPHY and PALAEONTOLOGY

Unit I: Definition, Principle of stratigraphy; Geological Time Scale and stratigraphic classification; Physiographic division of India.

Unit II: Study of following Precambrian succession: Dharwar, Cuddapha, Vindhyan and Delhi Supergroups; Brief idea of Palaeozoic succession of northwestern Himalaya; Triassic of Spiti; Mesozoic type seccession of Kutch and Rajasthan; Cretaceous of Tiruchirapalli;

Unit III: Study of following type localities: Gondwana and Deccan Trap.

Unit IV: Palaeogene-Neogene sequences of northwest Himalaya and Assam.

Unit-V: Palaeontology: definition, Fossils: definition, characters, binomial nomenclature in taxonomy, mode of preservation, condition of fossilization and significance of fossils;.

Unit VI: Morphology and geological distribution of brachiopods, pelecypods, cephalopods.

Unit VII: Morphology and geological distribution of trilobite, echinoidea.

Unit VIII: Evolutionary history of horse; Morphology, distribution and significance of Gondwana flora.

Paper – GEL-G-CC-4-4-P / GEL-A-GE-4-4-P

[2 credits]

STRAIGRAPHY and PALAEONTOLOGY

I. Morphological characters, systematic position and age of fossil genera pertaining to brachiopods, pelecypods, cephalopods, trilobite and Echinacea.

II. Preparation of lithostratigraphic maps of India showing distribution of important geological formations.

Books Recommended:

1. Wadia, D., 1973. Geology of India. Mc Graw Hill Book co.
2. Krishnan, M.S., 1982. Geology of India and Burma, 6th Edition. CBS Publ.
3. Ravindra Kumar, 1985. Fundamentals of Historical Geology & Stratigraphy of India. Wiley Eastern.
4. Shrock, R.R. & Twenhoffel, W.H., 1952. Principles of Invertebrate Paleontology. CBS Publ.
5. Swinerton, HH., 1961. Outlines of Paleontology. Edward Arnold Publishers
6. Jain, P.C. & Anantharaman, M.S., 1983. Paleontology: Evolution & Animal Distribution. Vishal Publ.
7. Lehmann, U., 1983. Fossil Invertebrate. Cambridge Univ. Press.
8. Rastogi, 1988. Organic evolution. Kedrnath and Ramnath Publ.

DISCIPLINE SPECIFIC ELECTIVE

DSE- A

Paper – GEL-G-DSE-A-5-1-TH

[4 CREDITS]

ECONOMIC GEOLOGY and HYDROLOGY

Unit-I: Concept of ore and ore deposits, ore minerals and gangue minerals; Tenor of ores; Metallic and non-metallic ore minerals; Strategic, Critical and essential minerals.

Unit-II: Processes of formation of ore deposits; Magmatic, contact metasomatic, hydrothermal, sedimentation,.

Unit-III: Study of important metallic (Cu, Pb, Zn Mn, Fe, Au, Al) and non-metallic (industrial) minerals (gypsum, magnesite, mica).

Unit-IV: Distribution of coal and petroleum in India;

Unit-V: Definition of hydrogeology, Hydrological cycle;

Unit-VI:Hydrological parameters - Precipitation, evaporation, transpiration and infiltration.

Unit-VII: Origin of groundwater; Vertical distribution of groundwater; Types of aquifers; Water bearing properties of rocks - Porosity and Permeability; specific yield, specific retention.

Unit-VIII: Surface and subsurface geophysical and geological methods of ground water exploration; Groundwater provinces of India.

Paper – GEL-G-DSE-A-5-1-P

[2 CREDITS]

ECONOMIC GEOLOGY and HYDROLOGY

I) Economic Geology:

Study of ore and economic minerals in hand specimen; Preparation of maps showing distribution of important metallic and non-metallic deposits and important coal and oil fields of India.

II) Hydrology:

Study of hydro-geological models, Estimation of porosity and permeability from the given data; Preparation and interpretation of water table maps.

Books Recommended:

1. Brown, C. and Dey, A.K.1955. Indian Mineral Wealth. Oxford Univ.
2. Gokhale, K.V.G.K. and Rao, T.C., 1983. Ore Deposits of India. East West Press Pvt. Ltd.
3. Jense, M.L. and Bateman A.M., 1981. Economic Mineral Deposits. John Wiley and Sons.
4. Krishnaswamy, S., 1979. India's Minerals Resources. Oxford and IBH Publ.
5. Deb, S., 1980. Industrial minerals and Rocks of India. Allied Publishers Pvt. Ltd.

6. Umeshwar Prasad, 2003. Economic Geology. CBS Publishers and distributors.
7. Sharma, N.L. and Ram, K.V.S., 1972. Introduction to India's Economic Minerals, Dhanbad.
8. Karanth, K. R., 1989. Hydrogeology. Tata McGraw Hill Publ.
9. Raghunath, H. M., 1990. Groundwater. Wiley Eastern Ltd.
10. Subramaniam, V., 2000. Water-Kingston Publ. London.

Paper – GEL-G-DSE-A-X-X-TH

NATURAL HAZARDS AND DISASTER MANAGEMENT

[4 CREDITS]

Unit 1: The Lithosphere and Related Hazards

Atmospheric Hazards, Hydrosphere and Related Hazards

Unit 2: Concepts of disaster

Types of disaster: natural and manmade - cyclone, flood, land slide, land subsidence, fire and earthquake,

tsunami and volcanic eruption

Unit 3: Tectonics and Climate, Meteorite Impacts

Issues and concern for various causes of disasters

Disaster management, mitigation, and preparedness

Techniques of monitoring and design against the disasters

Management issues related to disaster

Paper – GEL-G-DSE-A-X-X-P

NATURAL HAZARDS AND DISASTER MANAGEMENT

[2 CREDITS]

Hazard Zonation Mapping : Study of maps of natural hazards.

Remote-sensing and GIS applications in real time disaster monitoring

Reference Books

Bell, F.G., 1999. Geological Hazards, Routledge, London.

Bryant, E., 1985. Natural Hazards, Cambridge University Press.

Smith, K., 1992. Environmental Hazards. Routledge, London.

Subramaniam, V., 2001. Textbook in Environmental Science, Narosa International

DSE- B

Paper – GEL-G-DSE-B-6-1-TH

[4 CREDITS]

ELEMENTS OF APPLIED GEOLOGY

Unit-I: Engineering properties of rocks and Soils.

Unit-II: Soil and Soil groups of India.

Unit-III: Dam, Types and their geological and environmental considerations; Geological problem of reservoirs.

Unit-IV: Tunnels: geology, structure, seepage problem and role of water table;

Unit-V: Landslides: classification, causes and preventative measures.

Unit-VI: Mineral exploration: Elementary idea of geological and geophysical prospecting.

Unit-VII: Elementary idea of mining.

Unit-VIII: Environmental considerations for mining.

Paper – GEL-G-DSE-B-6-1-P

[2 CREDITS]

ELEMENTS OF APPLIED GEOLOGY

Engineering properties and identification of building stones. Identification of various models of landslide, tunnel and dam. Study of soil profiles.

Books Recommended:

1. Valdiya, K.S., 1987. Environmental Geology – Indian Context. Tata McGraw Hill.
2. Rajendran S., 2007. Mineral Exploration : Recent Strategies.
3. Dobrin, M.B. & Savit, CH., 1988. Introduction to Geophysical Prospecting, McGraw-Hill.
4. Arogyaswamy, R.N.P., 1973. Courses in Mining Geology. Oxford and IBH Publ.
5. Parasins, D.S., 1997. Principles of applied geophysics. Chapman Hall.
6. Krynine D.P. and Judd W.R., 1957. Principles of Engineering Geology & Geotechnics. McGraw-Hill Book
7. Kesavulu, N.C., 2009. A text book of engineering geology. Macmillan P publishing India Ltd.
8. Crozier. M.J., 1989. Landslides: causes, consequences and environment. Academic Press.
9. Readman, J.H., 1979. Techniques in Mineral exploration. Applied Science Publishres.
10. Bell, F.G., 1983. Fundamentals of Engineering Geology. Butterworth and Co.

Paper – GEL-G-DSE-B-X-X-TH

INTRODUCTION TO SUSTAINABILITY

[4 CREDITS]

Unit 1: Introduction to Sustainability; basic concepts

Human Population – Past and Future trends

Unit 2: Ecosystems

Extinctions and Tragedy of Commons

Climate and Energy

Water Resources and Agriculture

Unit 3: National Resources Accounting

Environmental Economics and Policy

Measuring Sustainability

Systems interconnectivity among Primary Sustainability challenges

Sustainability Solutions: Some examples

Paper – GEL-G-DSE-B-X-X-P

INTRODUCTION TO SUSTAINABILITY

[2 CREDITS]

Study of Climatic maps, ecological maps, natural resources maps.

Reference Books

Rogers, P.P., K. F. Jalal, and J.A. Boyd. 2007. An Introduction to Sustainable Development. Earthscan Publishers, 416 pp.

Brown, L. 2009. Plan B 4.0. Norton Publishers, New York. (The entire book is available in pdf format: http://www.earthpolicy.org/images/uploads/book_files/pb4book.pdf)

**SKILL ENHANCEMENT COURSE
SEC-A**

Paper – GEL-G-SEC-A-3-1-TH

[2 CREDITS]

FIELD GEOLOGY

Students will be required to carry out 03 days field work in a suitable geological area to study the elementary aspects of field geology and submit a report thereon.

Paper – GEL-G-SEC-A-5-2-TH

[2 CREDITS]

GEOMORPHOLOGY and GEOTECTONICS

Unit-I: Basic principles of Geomorphology, geomorphological cycles, weathering and erosion; Geomorphic mapping- tools and techniques.

Unit-II: Epigene/exogenic processes: degradation and aggradation. Hypogene/endogenic processes; Diastrophism and volcanism, Extraterrestrial processes; Geological work of wind, glacier, river, underground water and ocean.

Unit-III: Earth as a dynamic system. Elementary idea of continental drift, sea-floor spreading and mid-oceanic ridges. Paleomagnetism and its application.

Unit-IV: Plate Tectonics: the concept, plate margins, orogeny, deep sea trenches, island arcs and volcanic arcs.

Books Recommended:

1. Allen, P., 1997. Earth Surface Processes. Blackwell
2. Bloom, A.L., 1998. Geomorphology: A systematic Analysis of Late Cenozoic Landforms (3rd Edition). Pearson Education, Inc.
3. Keary, P. and Vine, F.J., 1997. Global Tectonics. Blackwell and crustal evolution. Butterworth-Heinemann.
4. Kale, V.S. and Gupta, A., 2001. Introduction to Geomorphology. Orient Longman Ltd.
5. Moores, E and Twiss. R.J., 1995. Tectonics. Freeman.
6. Patwardhan, A. M., 1999. The Dynamic Earth System. Prentice Hall.
7. Summerfield, M.A., 2000. Geomorphology and Global tectonic. Springer Verlag.
8. Valdia, K.S., 1988. Dynamic Himalaya. Universities Press, Hyderabad.
9. WD Thornbury, 2002. Principles of Geomorphology. CBS Publ. New Delhi.

SEC-B**Paper – GEL-G-SEC-B-4-1-TH****[2 CREDITS]****GEOCHEMISTRY**

Unit-I: Introduction to geochemistry: basic knowledge about crystal chemistry. Types of chemical bonds, coordination number; Colloids in geological systems, ion exchanges and geological evidence for earlier colloids; Elementary idea of Periodic Table.

Unit-II: Cosmic abundance of elements; Composition of the planets and meteorites; Geochemical evolution of the earth and geochemical cycles;

Unit-III: Gold Schmidt's geochemical classification of elements; Distribution of major, minor and trace elements in igneous, metamorphic and sedimentary rocks.

Unit-IV: Elements of geochemical thermodynamics; Isomorphism and polymorphism; Isotope geochemistry.

Books Recommended:

1. Hoefs, J., 1980. Stable Isotope Geochemistry. Springer-Verlag.
2. Klein, C. and Hurlbut, C.S., 1993. Manual of Mineralogy. John Wiley and Sons, New York.
3. Krauskopf, K.B., 1967. Introduction to Geochemistry. McGraw Hill.
4. Mason, B. and Moore, C.B., 1991. Introduction to Geochemistry. Wiley Eastern.
5. Rollinson, H.R., 1993. Using geochemical data: Evaluation, Presentation, and Interpretation. Longman.

Paper – GEL-G-SEC-B-6-2-TH**[2 CREDITS]****PHOTO GEOLOGY and REMOTE SENSING**

Unit-I: Elementary idea about photogeology: electro-magnetic spectrum, types & geometry of aerial photographs; factors affecting aerial photography; types of camera, film and filters; factors affecting scale;

Unit-II: Fundamentals of remote sensing; remote sensing systems; remote sensing sensors; signatures of rocks, minerals and soils. Application of remote sensing in geoscience and geomorphological studies.

Unit-III: Types of Indian and Foreign Remote Sensing Satellites, Digital image processing; fundamental steps in image processing; elements of pattern recognition and image classification.

Unit-IV: Introduction to Geographic Information System (GIS); components of GIS; product generation in GIS; tools for map analysis; integration of GIS with remote sensing.

Books Recommended:

1. Bhatta, B., 2008. Remote Sensing and GIS. Oxford, New Delhi.
2. Gupta, R.P., 1990. Remote Sensing Geology. Springer Verlag.
3. Lilleasand, T.M. and Kiffer, R.W., 1987. Remote Sensing and Image Interpretation. John Wiley.
4. Pandey, S.N., 1987. Principles and Application of Photogeology. Wiley Eastern, New Delhi.
5. Sabbins, F.F., 1985. Remote Sensing – Principles and Applications. Freeman.
6. Siegal, B.S. and Gillespie, A.R., 1980. Remote Sensing in Geology. John Wiley.
7. Rampal K.K. 1999. Hand book of aerial photography and interpretation. Concept publication.