PRESCRIBED SYLLABUS

FOR CBCS

GEOLOGY NON-HONOURS

SEMESTER-WISE COURSES

Submitted to

ডিব্রুগড় বিশ্ববিদ্যালয়
Dibrugarh University

Submitted by
Department of Applied Geology, Dibrugarh University

SEMESTER WISE DISTRIBUTION OF COURSES IN B. ScNON-HONOURS IN GEOLOGY (CBCS)

Semester	Core Course (14)	AECC (2)	SEC (2)	DSE (4)
I	DSC1A DSC2A DSC3A			
II	DSC1B DSC2B DSC3B			
III	DSC1C DSC2C DSC3C		SEC 1.1	
IV	DSC1D DSC2D DSC3D		SEC 2.1	
V			SEC 1.2	DSE 1A DSE 2A DSE 3A
VI			SEC 2.2	DSE 3B DSE 4B DSE 3B

GENERAL STRUCTURE: CORE COURSES DISCIPLINE SPECIFIC CORE DSC (14Courses)

Semester	Core Course
I	DSC 1A: Introduction to Geology
	DSC 2A: Crystallography and Mineralogy
	DSC-3A: Geochemistry and Optical Mineralogy
II	DSC 1B: Thermodynamics and Igneous Petrology
	DSC 2B: Sedimentary and Metamorphic Petrology
	DSC-3B: Palaeontology
III	DSC 1C: Structural Geology and Tectonics
	DSC 2C: Surveying and Engineering Geology
	DSC-3C: Economic Geology
IV	DSC 1D: Geomorphology, Remote Sensing and GIS
	DSC 2D:Principles of Stratigraphy and Indian Stratigraphy
	DSC 3D: Coal and Petroleum

General Structure:Skill EnhancementCourse - SEC (2 Courses) (As per recommendations)

Semester	Paper Structure	Papers available for selection
III	SEC 1.1 (2c)	• Skills of basic Geological field studies
IV	SEC 1.2 (2c)	• Skills of advanced Geological field studies
V	SEC 2.1 (2c)	• Skills of Geological Field studies in igneous and metamorphic terrain
VI	SEC 2.2 (2c)	• Project Work

General Structure:Discipline Specific Elective - DSE (4 Courses)

Semester	Paper	Papers available for selection
V	DSE-1A	1. Geological Exploration
	DSE-2A	2. Geoinformatics
	DSE-3A	3. Fluvial Geomorphology 4. Environmental Geology
VI	DSE-1B	5. Mining Geology
	DSE-2B	6. Structural Geology
	DSE-3B	7. Hydrogeology 8. Earth and Climate

SEMESTER WISE DISTRIBUTION OF COURSES IN B. Sc NON- HONOURS IN GEOLOGY (CBCS)

Sem	Core Course(12)	Course code	AECC (2)	SEC (2)	Course code	DSE (6)	Course code
I	DSC1A	GEOG101T4 GEOG101P2	AECC(1)				
	DSC2A	GEOG102T4 GEOG102P2	AECC(2)				
	DSC3A	GEOG103T4 GEOG103P2					
II	DSC1B	GEOG201T4 GEOG201P2					
	DSC2B	GEOG202T4 GEOG202P2					
	DSC3B	GEOG203T4 GEOG203P2					
III	DSC1C	GEOG301T4 GEOG301P2		SEC-1.1	GEOGSEC301T2		
	DSC2C	GEOG302T4 GEOG302P2					
	DSC3C	GEOG303T4 GEOG303P2					
IV	DSC1D	GEOG401T4 GEOG401P2		SEC-2.1	GEOGSEC401T2		
	DSC2D	GEOG402T4 GEOG402P2					
	DSC3D	GEOG403T4 GEOG403P2					
V				SEC-1.2	GEOGSEC501T2	DSE1A	GEOGDSE501AT4 GEOGDSE501AP2
						DSE2A	GEOGDSE502AT4 GEOGDSE502AP2
						DSE3A	GEOGDSE503A1T4 GEOGDSE503A1P2 / GEOGDSE503A2T4 GEOGDSE503A2P2
VI				SEC-2.2	GEOGSEC501T2	DSE1B	GEOGDSE601BT4 GEOGDSE601BP2
						DSE2B	GEOGDSE602BT4 GEOGDSE602BP2
						DSE3B	GEOGDSE603B1T4 GEOGDSE603B1P2 / GEOGDSE603B2T4 GEOGDSE603B2P2

1st SEMESTER (B.Sc. Non-Honours Geology)

Course	Paper code	Title of the Course	Credit			Marks Distribution				
			Th	Prac	Total	Theory		Practical		Total
						End Sem	In- Sem	End Sem	In- Sem	
DSC1A	GEOG101T4	Introduction to Geology	4		6	48	12			100
	GEOG101P2			2				32	8	
DSC2A	GEOG102T4	Crystallography and Mineralogy	4		6	48	12			100
	GEOG102P2			2				32	8	
DSC3A	GEOG103T4	Geochemistry and optical mineralogy	4		6	48	12			100
	GEOG103P2			2				32	8	
	Total				18					300

2nd SEMESTER (B.Sc. Non-Honours Geology)

Course	Paper code	Title of the Course	Credit			Marks Distribution				
			Th	Prac	Total	Theory		Practical		Total
						End Sem	In- Sem	End Sem	In- Sem	
DSC1B	GEOG201T4	Thermodynamics and Igneous petrology	4		6	48	12			100
	GEOG201P2			2				32	8	
DSC2B	GEOG202T4	Sedimentary and metamorphic petrology	4		6	48	12			100
	GEOG202P2			2				32	8	
DSC3B	GEOG203T4	Palaeontology	4		6	48	12			100
	GEOGG203AP2			2				32	8	
	Total				18					300

3rd SEMESTER (B.Sc. Non-Honours Geology)

Course	Paper code	Title of the Course	Credit			Marks Distribution				
			Th	Prac	Total	Theory		Practical		Total
						End Sem	In- Sem	End Sem	In- Sem	
DSC1C	GEOG301T4	Structural geology and tectonics	4		6	48	12			100
	GEOG301P2			2				32	8	
DSC2C	GEOG302T4	Surveying and engineering geology	4		6	48	12			100
	GEOG302P2			2				32	8	
DSC3C	GEOG302T4	Economic geology	4		6	48	12			100
	GEOG302P2			2				32	8	
SEC1.1	GEOGSEC301T2	Skills of basic Geological field studies	2		2	24	6			30
	TOTAL				20					330

4th SEMESTER (B.Sc. Non-Honours Geology)

Course	Paper code	Title of the Course	Credit			Marks Distribution				
			Th	Prac	Total	Theory		Practical		Total
						End Sem	In- Sem	End Sem	In- Sem	
DSC1D	GEOG401T4	Geomorphology, Remote sensing and GIS	4		6	48	12			100
	GEOG401P2			2				32	8	
DSC2D	GEOG402T4	Principles of Stratigraphy and Indian stratigraphy	4		6	48	12			100
	GEOG402P2			2				32	8	
DSC3D	GEOG403T4	Coal and petroleum	4		6	48	12			100
	GEOG403P2			2				32	8	
SEC2.1	GEOGSEC401T2	Skills of advanced Geological field studies	2		2	24	6			30
	TOTAL				20					330

5th SEMESTER (B.Sc. Non-Honours Geology)

Course	Paper code	Title of the Course	Credit			Marks Distribution				
			Th	Prac	Total	Theory		Practical		Total
						End Sem	In-Sem	End Sem	In-Sem	
SEC1.2	GEOGSEC501T2	Skills of Geological Field studies in igneous and metamorphic terrain	2		2	24	6			30
DSE1A	GEOGDSE501AT4	Geological Exploration	4		6	48	12			100
	GEOGDSE501AP2			2				32	8	
DSE2A	GEOGDSE502AT4	Geoinformatics	4		6	48	12			100
	GEOGDSE502AP2			2				32	8	
DSE3A	GEOGDSE503A1T4	Fluvial geomorphology	4		6	48	12			100
	GEOGDSE503A1P2			2				32	8	
	GEOGDSE503A2T4	Environmental Geology	4		6	48	12			
	GEOGDSE503A2P2			2				32	8	
Total					20					330

6th SEMESTER (B.Sc. Non-Honours Geology)

Course	Paper code	Title of the Course	Credit			Marks Distribution				
			Th	Prac	Total	Theory		Practical		Total
						End Sem	In- Sem	End-Sem	In-Sem	
SEC2.2	GEOGSEC601T2	Project work	2		2	24	6			30
DSE1B	GEOGDSE601BT4	Mining Geology	4		6	48	12			100
	GEOGDSE601BP2			2				32	8	
DSE2B	GEOGDSE602BT4	Structural Geology	4		6	48	12			100
	GEOGDSE602BP2			2				32	8	
DSE3B	GEOGDSE603B1T4	Hydrogeology	4		6	48	12			100
	GEOGDSE603B1P2			2				32	8	
	GEOGDSE603B2T4	Earth and climate	4			48	12			
	GEOGDSE603B2P2			2				32	8	
Total					20					330

1st Semester: Discipline Specific Core (DSC) Course
DSC-1A: Introduction to Geology
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSC-1A: GEOG101T4: Introduction to Geology (Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *The Science of geology is dedicated for the study of earth and deals with all the features of earth's surface along with their origin, composition, structure and inhabitants of the earth.*

Unit 1: Solar System and Earth

(L: 3 T: 1) 4 classes (Marks: 8)

- Solar system, planets, earth and moon, planetary orbital and rotational characteristics of earth, gravity, magnetic field, theories of origin, age of earth, evolution of life on earth. Interior of the Earth: core, mantle and crust.

Unit 2: Principles of Geology

(L: 3 T: 1) 4 classes (Marks: 6)

- Various branches of geology, minerals and rocks, rock forming minerals, igneous, metamorphic and sedimentary rocks and minerals.
- Uniformitarianism, actualism, catastrophism
- Rock cycle

Unit 3: Earth's Exogenic Processes

(L: 5 T: 1) 6 classes (Marks: 10)

- Activities of running water, wind, gravity, ice and sea waves, rock weathering and erosion, soil profile and classification, geomorphic environments associated with fluvial, glacial, coastal, volcanic and desertic environments, physiographical divisions of Indian subcontinent.

Unit 4: Earth's Dynamics &Edogenic Processes

(L: 5 T: 1) 6 classes (Marks: 8)

- Concept of plate tectonics, sea-floor spreading and continental drift, mid oceanic ridges and transform faults volcanic and island arcs,trenches,origin of oceans, continents, mountains and rift valleys and earthquake belts.

Unit 5: Genesis of Rock

(L: 5 T: 1) 6 classes (Marks: 8)

- Volcanoes: types, types of lava and lava flow
- Magma: composition, physical and chemical properties of magma, intrusive igneous bodies
- Sedimentary environment, clastic and non-clastic.
- Metamorphism, metamorphic rocks, metasomatism.

Unit 5: Introduction to Paleontology

(L: 5 T: 1) 6 classes (Marks: 8)

- Brief idea about palaeontology, palynology, palaeobotany and palaeozoology
- Fossils, fossil taxonomy and nomenclature, modes of preservation of fossils, types of fossil. Application of fossil in geological science.

DSC-1A: GEOG101P2: Introduction to Geology (Practical)
Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

- Study of minerals in hand specimen: quartz, feldspar, mica, olivine, amphibole, gypsum, calcite**(10 Marks)**
- Study of rocks in hands specimen: sandstone, shale, limestone, rhyolite, basalt, granite, gabbro, gneiss, schist, marble **(8 Marks)**
- Study of geomorphic models**(5 Marks)**
- Study of Geological maps**(5 Marks)**
- Note Book **(2 Marks)**
- Viva Voce **(2 Marks)**

SUGGESTED READINGS:

1. Thompson G.R.R., Turk J. (1997) *Introduction to Physical Geology*. Brooks Cole.
2. Tarbuck, E. J. &Lutgens, F. K. (1998). *Earth: An Introduction to Physical Geology*. Pearson
3. Duff, P. M. D., & Duff, D. (Eds.). (1993). *Holmes' principles of physical geology*. Taylor &Francis.
4. Emiliani, C. (1992). *Planet earth: cosmology, geology, and the evolution of life and environment*. Cambridge University Press.

1st Semester: Discipline Specific Core (DSC) Course
DSC-2A: Crystallography and Mineralogy
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSC-2A: GEOG102T4: Crystallography and Mineralogy (Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *Use and utility of mineral science in industry is learnt from this subject. In crystallography, one can find how to determine the arrangement of atoms in the crystalline solids and in mineralogy, one can know in detail about the minerals, the basic building blocks of earth material.*

Unit 1: Crystallography (L: 13 T: 2) 15 *classes* (Marks: 20)

Crystalline and non-crystalline matter, geometrical nature of order of crystal,crystal face, edge and solid angle, Laws of constancy of interfacial angles, axial systems and axial ratio
Crystal symmetry operations, direction and planes in crystal structures,point group and space group symmetry,Classification of crystals into systems and classes of symmetry
Study of the symmetry, forms, stereograms and examples of crystal/mineral of the important crystal classes
Crystal growth and twinning, different types of crystal twins, causes of twinning and twin laws

Unit 2: Mineralogy (L: 18 T: 2)20 *classes* (Marks: 28)

Native elements, mineraloids, minerals, physical and chemical properties

Physical properties of minerals:Colour, luster, streak, density, sp.gr. and hardness; Moh's scale of hardness and determination of hardness of minerals. Cleavage, parting and fracture: their definition and mineral examples. From and Habit of minerals; types, examples and use in identification

Classification of minerals: study of important minerals of silicate and non-silicate groups.

GE1: GEOG102P2: Crystallography and Mineralogy (Practical)
Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

Practical 1: Identification of crystal models**(4 Marks)**

Practical 2: Study of crystals and symmetry elements of given crystal-models. **(6 Marks)**

Practical 3: Study and stereographic projections of crystal models. **(6 Marks)**

Practical 4: Study and identification of minerals in hand specimen**(6 Marks)**

Practical 5: Study of rock forming minerals**(6 Marks)**

Note Book **(2 Marks)**
Viva Voce **(2 Marks)**

SUGGESTED READINGS:

1. Klein, C., Dutrow, B., Dwight, J., & Klein, C. (2007). The 23rd Edition of the Manual of MineralScience (after James D. Dana). J. Wiley & Sons.
2. Kerr, P. F. (1959). Optical Mineralogy. McGraw-Hill.
3. Verma, P. K. (2010). Optical Mineralogy (Four Colour). Ane Books Pvt Ltd.
4. Deer, W. A., Howie, R. A., &Zussman, J. (1992). An introduction to the rock-formingminerals (Vol. 696). London: Longman.

1st Semester: Discipline Specific Core (DSC) Course
DSC-3A: Geochemistry and Optical Mineralogy
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSC-3A: GEOG103T4: Geochemistry and Optical Mineralogy (Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *Geochemistry helps in understanding the compositional heterogeneity and geochemical processes that take place in the earth. It is the basic tool used in the geochemical exploration of economic mineral deposits. The knowledge of optical mineralogy is very important for identification of minerals and ores.*

Unit 1: Concepts of Geochemistry (L: 13 T: 2) 15 *classes* (Marks: 24)

The periodic table, states of matter and atomic environment of elements, geochemical classification of elements
Composition of different Earth reservoirs and the nuclides and radioactivity.Conservation of mass, isotopic and elemental fractionation. Concept of radiogenic isotopes in geochronology and isotopic tracers
The solid Earth – geochemical variability of magma and its products, Meteorites
Geochemical distribution and mobility of elements, Chromatography, Aqueous geochemistry- basic concepts and speciation in solutions, Eh, pH relations
Geochemical behavioursof selected elements like Si, Al, K, Na .

Unit 2: Optical Mineralogy (L: 18 T: 2) 20 *classes* (Marks: 24)

Natural light, ordinary and polarized light, polarization of light and polaroids, refractive index and relief, becke line and its use, double refraction, birefringence, behavior of isotropic and anisotropic mineral, pleochroism and pleochroic scheme, interference colour, extinction, polarizing microscope, interference figure, optic sign and determination of optic sign.

Study of important rock forming mineral groups/species, their classification, physical and optical characters and paragenesis : 1) Quartz 2) Feldspar 3) Mica 4) Amphibole 5) Pyroxene 6) Olivine 7) Garnet 8) Chlorite 9) Calcite 10) Feldspathoids.

DSC-3A: GEOG103P2: Geochemistry and Optical Mineralogy (Practical)
Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

Practical 1: Identification and understanding of different parts of petrological microscope. **(7 Marks)**
Practical 2: Preparation of slides. **(7 Marks)**
Practical 2: Identification of rock-forming minerals under petrological microscope. **(7 Marks)**
Practical 3: Study of interference figure and determination of optic signs from mineral oriented sections. **(7 Marks)**
Note Book **(2 Marks)**
Viva Voce **(2 Marks)**

SUGGESTED READINGS:

1. Mason, B. (1986) Principles of Geochemistry. 3rd Edition, Wiley New York.
2. Walther, J. V. (2009). Essentials of geochemistry. Jones & Bartlett Publishers.
3. Faure, Gunter and Teresa M. Mensing (2004). Isotopes: Principles andApplications,Wiley India Pvt. Ltd
4. Klein, C., Dutrow, B., Dwight, J., & Klein, C. (2007). The 23rd Edition of the Manual of MineralScience (after James D. Dana). J. Wiley & Sons.
5. Kerr, P. F. (1959). Optical Mineralogy. McGraw-Hill.

2ND Semester: Discipline Specific Core (DSC) Course
DSC-1B: Thermodynamics and Igneous Petrology
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSC-1B: GEOG201T4: Thermodynamics and Igneous Petrology (Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *The primary objective of learning thermodynamics is to know in detail about heat and temperature and their relationship to energy and work and that of igneous petrology is to understand the process of magma generation, evolution and volcanism. This subject also deals with interaction of plate tectonics, magma generation and ore localizatio*n.

Unit 1: Thermodynamics (L: 8 T: 2) 10 *classes* (Marks: 20)

Energy and Matter, Types of Energy, Transformation of Energy
Thermodynamic systems and boundaries, Laws of Thermodynamics
Concept of Heat and Temperature
Conversion between temperature Scale
Thermodynamic properties: state functions
Concept of entropy, enthalphy, activity, chemical potential, chemical equilibrium and equilibrium constants
Concept of free energy, component, phase and degrees of freedom
Phase rule for closed and open system
Phase diagrams

Unit 2: Igneous Petrology (L: 22 T: 3) 25 *classes* (Marks: 28)

General idea of igneous petrology, generation of magma, physical properties, composition & chemical properties, primary and magma derivatives, classification of magma
Concept of component, equilibrium, phase, degrees of freedom, phase rule: general idea, phase rule for open and closed systems, phase diagrams: one, two and three component systems, congruent and incongruent melting
Reaction principles, Evolution of Magma, Magmatic differentiation, Mixing and Assimilation, Role of volatiles in magma, Rock association (consanguinity)
Textures, structures and mode of occurrences of igneous rocks, Petrographical significances of igneous rocks.
Textural and IUGS Classification of igneous rocks
Petrogenesis of Igneous rocks: Petrogenesis of Felsic and Mafic igneous rocks, Komatiites, Granitoides, Basalt, Gabbros, Alkaline rocks, kimberlites and lamproites, Sylhet trap and AborVolcanics.

Formation of economic deposits from igneous processes

DSC-1B: GEOG201P2: Thermodynamics and Igneous Petrology(Practical)
Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

Practical 1: Identification and study of igneous rocks in hand specimens**(10 Marks)**
Practical 2: Identification and study of igneous rocks in thin sections**(10 Marks)**
Practical 3: Identification of economic minerals derived from igneous processes**(8 Marks)**
Note Book **(2 Marks)**
Viva Voce **(2 Marks)**

SUGGESTED READINGS:

1. Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. CambridgeUniversity Press.
2. Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
3. Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation.
4. Raymond, L. A. (2002). Petrology: the study of igneous, sedimentary, and metamorphic rocks.McGraw-Hill Science Engineering.
5. McBirney, A. R. (1984). Igneous Petrology. San Francisco (Freeman, Cooper & Company) andOxford (Oxford Univ. Press),
6. Myron G. Best (2001). Igneous and Metamorphic Petrology,
7. K. G. Cox, J. D. Bell. (1979). The Interpretation of Igneous Rocks. Springer/Chapman & Hall.
8. Bose M.K. (1997). Igneous Petrology.
9. G W Tyrrell. (1926). Principles of Petrology. Springer

2ND Semester: Discipline Specific Core (DSC) Course
DSC-2B: Sedimentary and Metamorphic Petrology
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSC-2B: GEOG202T4: Sedimentary and Metamorphic Petrology(Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *The major objective of learning sedimentary petrology is to know the process of formation of sediments and their transformation to sedimentary rock as well as their characteristics and classifications.*
Metamorphic petrology deals with the dynamic processes of the earth that has affected the pre-existing rocks. This subject also helps us to understand ore localization and genesis.

Unit 1: Sedimentary Petrology (L: 18 T: 2) 20 *classes* (Marks: 24)

Weathering and erosion of rocks, transportation of weathered rock via air, water, ice and gravity, residual sediments, source and provenance, sedimentary basins

Textural properties of sedimentary rocks- concept of size, grade scale, sphericity, roundness and fabric. Sedimentary textures, structures and environment, sedimentary structures

Textural and genetic classification of clastic and non-clastic rocks

Diagenesis: compaction, cementation, lithifaciation, authigenesis, replacement and recrystallisation;

Concept of sedimentary facies, depositional environments,

Petrogaphic description of the following rock types: Sandstones (Arenite, Arkose and Wacke), siltstone, shale, limestone, dolomite, breccia, conglomerate and evaporate.

Formation of economic deposits from sedimentary processes

Unit 2: Metamorphic Petrology (L: 18 T: 2) 20 *classes* (Marks: 24)

Metamorphism, types of metamorphism, mechanism of metamorphic transformation

Index minerals, metamorphic zones and isograde, facies and grade

Structure and textures of metamorphic rocks

Relationship between metamorphism and deformation, Metamorphic mineral reactions (prograde and retrograde)

Regional metamorphism of argillaceous, calcareous and basic rocks, Metasomatism and role of fluids in metamorphism

Descriptive petrography of the following rocks: Slate, phyllite, schist, blue schists, gneiss, quartzite, marble, amphibolite, granulite, hornfels, eclogites, khasi greenstone, charnockite and khondalite**.**

Formation of economic deposits from metamorphic and metasomatic processes

DSC-2B: GEOG202P2: Sedimentary and Metamorphic Petrology (Practical)
Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

Practical 1: Identification and study of sedimentary rocks in hand specimens**(10 Marks)**
Practical 2: Identification and study of metamorphic rocks in thin sections**(18 Marks)**
Note Book **(2 Marks)**
Viva Voce **(2 Marks)**

SUGGESTED READINGS:

1. Prothero, D. R., & Schwab, F. (2004). Sedimentary geology. Macmillan.
2. Tucker, M. E. (2006) Sedimenary Petrology, Blackwell Publishing.
3. Collinson, J. D. & Thompson, D. B. (1988) Sedimentary structures, Unwin- Hyman, London.
4. Nichols, G. (2009) Sedimentology and Stratigraphy Second Edition. Wiley Blackwell1.
5. Philpotts, A., & Ague, J. (2009). *Principles of igneous and metamorphic petrology*. CambridgeUniversity Press.
6. Winter, J. D. (2014). *Principles of igneous and metamorphic petrology*. Pearson.
7. Rollinson, H. R. (2014). *Using geochemical data: evaluation, presentation, interpretation*.
8. Raymond, L. A. (2002). *Petrology: the study of igneous, sedimentary, and metamorphic rocks*.McGraw-Hill Science Engineering.
9. Yardley, B. W., & Yardley, B. W. D. (1989). An introduction to metamorphic petrology.Longman Earth Science Series.

2ND Semester: Discipline Specific Core (DSC) Course
DSC-3B: Palaeontology
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSC-3B: GEOG203T4: Palaeontology(Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *Paleontology deals with identification, classification and taxonomic description of past life forms as fossils. It aids in the reconstruction of paleoclimate, paleo bathymetry and paleogeography. It is very much used as a tool of hydrocarbon exploration.*

Unit 1:

(L: 28 T: 2) 30 *classes* (Mark 5)

Palaeontology: definition, branches, allied subjects, scopes and applications of palaeontology. Fossil: definition, types, process of fossilization, mode of preservation

Unit 2:

(L: 28 T: 2) 30 *classes* (Mark 10)

Nomenclature of fossil: two fold system of nomenclature, types of specimens (Prototype, Neotype, Lectotype etc.)Taxonomy and Species concept: Species concept with special reference to paleontology, Taxonomic hierarchy Theory of organic evolution interpreted from fossil record

Unit 3:

(L: 28 T: 2) 30 *classes* (Mark 8)

Vertebrate fossils: Palaeozoic and Mesozoic vertebrate organisms, origin diversity and extinction of dinosaurs. Evolution of horse, Human evolution.

Unit 4:

(L: 28 T: 2) 30 *classes* (Mark 10)

Brief introduction to important invertebrate groups: Foraminifera, Brachiopoda, Pelecypoda, Gastropoda, Chephalopoda, Trilobita, Echinoidea and Anthozoa and their biostratigraphic significance

Unit 5:

(L: 28 T: 2) 30 *classes* (Mark 5)

Gondwana Flora of India.

Unit 6:

(L: 28 T: 2) 30 *classes* (Mark 10)

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

DSC-3B: GEOG203P2: Palaeontology(Practical)
Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

Practical 1: Study of fossils showing various modes of preservation**(10 Marks)**

Practical 2: Study of diagnostic morphological characters, systematic position, stratigraphic position and age of various invertebrate, vertebrate and plant fossils**(18 Marks)**

Note Book **(2 Marks)**
Viva Voce **(2 Marks)**

SUGGESTED READINGS

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

3rd Semester: Discipline Specific Core (DSC) Course
DSC-1C: Structural Geology and Plate Tectonics
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSC-1C: GEOG301T4: Structural Geology and Plate Tectonics (Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *The primary goal of structural geology is to uncover the history of deformation in the rocks. The deformation of the lithospheric rocks by tectonic forces can be learned through this subject. Structural geology also helps to understand the geodynamics of regional to global dimension.*

Unit 1: Structural Geology **(L: 18 T: 2) 20 *classes* (Marks: 30)**

Deformation in rocks: stress and strain in rocks, type of stress and strain, strain ellipses,

Effects of topography on structural features, topographic and structural maps; importance representativefactors of the map, concept of planar and linear structures; dip and strike;

Study of components, morphology, classification and occurrences of deformational features: fold, joint-fracture, faults, lineation and foliation

Role of structural features for the development of typical topographical landscapes, economic mineral reserves and in accumulation of oil and natural gas

Unit 2: Tectonics **(L: 14 T: 1) 15 *classes* (Marks: 18)**

Concept of tectonic plates, continental and oceanic crust, boundaries between lithosphere and mantle, divergent, convergent and transform plate boundaries, important features associated with different plate boundaries

Theories of development of concept of plate tectonics, continental drifting, formation of ocean

Role of tectonic activities in rock deformation, development of structural features and typical landforms,

DSC-1C: GEOG301P2: Structural Geology and Plate Tectonics(Practical)
Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

Practical 1: study of structural maps**(8 Marks)**
Practical 2: use of compass**(6 Marks)**
Practical 3: 3 point problems of structural geology**(8 Marks)**
Practical 4: stereo projections of beds, fold, fault, lineation etc. **(6 Marks)**
Note Book **(2 Marks)**
Viva Voce **(2 Marks)**

SUGGESTED READINGS:

1. Davis, G. R. (1984) Structural Geology of Rocks and Region. John Wiley
2. Billings, M. P. (1987) Structural Geology, 4th edition, Prentice-Hall.
3. Park, R. G. (2004) Foundations of Structural Geology.Chapman& Hall.
4. Pollard, D. D. (2005) Fundamental of Structural Geology. Cambridge University Press.
5. Ragan, D. M. (2009) Structural Geology: an introduction to geometrical techniques (4th Ed).
Cambridge University Press (For Practical)
6. Lahee F. H. (1962) Field Geology. McGraw Hill

3rd Semester: Discipline Specific Core (DSC) Course
DSC-2C: Surveying and Engineering Geology
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSC-2C: GEOG302T4: Surveying and Engineering Geology (Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *Surveying andEngineering geology provides geological and geotechnical recommendations, analysis, and design associated with human development and various types of civil structural construction.*

Unit 1: Surveying (L: 9 T: 1) 10 *classes* (Marks: 20)

The Great Trigonometrical Survey of India, Geodetic and Plane Surveying, Datum, Control Points, Horizontal and Vertical Controls, Geoid, Azimuth and bearing, Triangulation and Traversing.

Surveying with Compass, Chain and Plane Table Surveying, GPS and its use in surveying

Level, Types of levels and Methods of Levelling

Geology vs. Engineering, Role of Engineering geologists in planning, design and construction ofmajor man-made structural features.Geological Field Investigation for engineering project.Reconnaissance study, Detail Site Investigation and Characterization and Regional Scale Study.

Unit 2: Engineering Geology (L: 18 T: 2) 20 *classes* (Marks: 28)

Role and duties of geologist in engineering project: surveying, leveling, reconnaissance study, detail study, design and layout of engineering project, determining viability and risk, use of local construction materials

Intact Rock and Rock Mass properties, Rock Quality Designation (RQD), Rock Structure Rating (RSR), Rock Mass Rating (RMR)

Geological, Geotechnical and Environmental considerations for Dams and Reservoirs, Tunnels and Tunneling Methods.

Preventive measures for: landslides, earthquakes, structural disturbances.
Case histories related to Indian Civil Engineering Projects

DSC-2C: GEOG302P2: Surveying and Engineering Geology (Practical)
Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

Practical 1: Use of compass for determining forward, backward bearing and azimuths
(7 Marks)

Practical 2: Surveying with compass, chain and plate table
(7 Marks)

Practical 3: Computation of reservoir area, catchment area, reservoir capacity and reservoir life.
(7 Marks)

Practical 4: Computation of Index properties of rocks.
(2 Marks)

Note Book **(2 Marks)**
Viva Voce **(2 Marks)**

SUGGESTED READINGS:

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

3rd Semester: Discipline Specific Core (DSC) Course
DSC-3C: Economic Geology
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSC-3C: GEOG303T4: Economic Geology (Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *Economic geology is the study of the formation and extraction of earth materials that have economic potential in the society. It helps us to understand the genesis, occurrences and distribution of mineral resources and its uses a raw material in mineral based industries.*

(L: 28 T: 2) 30 *classes* (Marks 48)

Definition of ore, ore minerals, gangue and tenor
Morphology of mineral deposit
Controls on ore localization
Processes of formation of Mineral deposit: volcanogenic, orthomagmatic, hydrothermal, supergene enrichment, sedimentary deposits, residual deposits, alluvial deposits, metasomatic alteration

Origin, occurrence and distribution in India and uses of the economic minerals/ores of aluminium, chromium, copper, gold, lead, zinc, iron, manganese and atomic minerals.

Deposits of minerals used as abrasives, refractories and in ceramics, cement, fertilizer, glass industries and their occurrences especially in N.E. India.

Origin and occurrence of coal and petroleum and their distribution in India with special reference of N.E. India.

National Mineral Policy.Strategic, Essential and Critical minerals of India.

DSC-3C: GEOG303P2: Economic Geology(Practical)
Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

Study and identification of economic minerals	**(8 Marks)**
Identification of set of Industrial Minerals	**(8 Marks)**
Ore Reserve Estimation	**(12 Marks)**
Note Book	**(2 Marks)**
Viva Voce	**(2 Marks)**

SUGGESTED READINGS:

1. Guilbert, J.M. and Park Jr., C.F. (1986) The Geology of Ore deposits. Freeman & Co.
2. Bateman, A.M. and Jensen, M.L. (1990) Economic Mineral Deposits. John Wiley.
3. Evans, A.M. (1993) Ore Geology and Industrial minerals. Wiley
4. Laurence Robb. (2005) Introduction to ore forming processes. Wiley.
5. Gokhale, K.V.G.K. and Rao, T.C. (1978) Ore deposits of India their distribution and processing,
Tata-McGraw Hill, New Delhi.
6. Deb, S. (1980) Industrial minerals and rocks of India. Allied Publishers.
7. Sarkar, S.C. and Gupta, A. (2014) Crustal Evolution and Metallogeny in India. Cambridge Publications.

3rd Semester: Skill Enhancement Course (SEC)
SEC-1.1: Skills of basic Geological Field Studies
Total Mark: 30 (24+8), Total Credit: 2

SEC-1.1: GEOGSEC301T2: Skills of basic Geological Field Studies
Credit 2: Marks 30 (End-sem24+ In-sem6) 24 Hours

Objectives: *The purpose of basic geological field studies is the skill enhancement to enable us the basic field techniques and procedures*.

(L: 18 T: 2) 20 *classes* (Mark 24)

Use of base map/topographic sheet in field, tracing data from base map/toposheet, bearing (front andback) and pacing, map reading, distance, height and pace approximation, reading contours and topography

Identification of rock types in field; structures and texture of rocks, Use of hand lense

Basic field measurement techniques: dip and strike, trend, plunge, rake

Collection of rock samples from field

SUGGESTED READINGS:

1. Lahee, F.H. 1916. Field Geology.
2. Compton, R.R, 1985. Geology in the Field.

4th Semester: Discipline Specific Core (DSC) Course
DSC-1D: Geomorphology, Remote Sensing and GIS
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSC-1D: GEOG401T4: Geomorphology, Remote Sensing and GIS (Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *Geomorphology is the scientific study of the origin and evolution of landforms and bathymetric features created by physical, chemical or biological processes operating at or near the Earth's surface.*
Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with them. Remote sensing and GIS are used as tools for geological investigation and various other purposes.

Unit 1: Geomorphology (L: 19 T: 1) 20 *classes* (Marks: 15)

Endogenic and Exogenic processes, geomorphic cycle,
Surficial Processes and geomorphology, Weathering and Erosion, activities of running water, wind, ice, gravity and sea waves, Soil, Soil Profile and its classification. Mass movement and debris flow processes.
Landforms of: Fluvial, Glacial, Aeolian, Coastal and Volcanic Environments.
Overview of Indian Geomorphology

Unit 2: Remote Sensing (L: 9 T: 1) 10 *classes* (Marks: 18)

Photogeology, aerial photographs; scale and resolution, air photo interpretation: identification of sedimentary, igneous and metamorphic rocks and various aeolian, glacial, fluvial and marine landforms
Remote Sensing: definition, applications, sensors and scanners, satellites and their characteristics, data formats- raster and vector, Indian remote sensing satellites, satellite data products
Application of Remote Sensing in Geological Science

Unit 3: Geographical Information System (L: 8 T: 2) 10 *classes* (Marks: 15)

Geographic Information System, Components of GIS, working mechanism of GIS, GIS Data types: Raster and Vector Data, Point Data, Line Data, Polygonal Data, Datum, Coordinate systems and Projection systems. Georeferencing. Spatial data models and data editing
General idea about of Global Positioning System (GPS) of America, Indian Regional Navigation Satellite System (IRNSS) and Indian Navigation System NAVIC

DSC-1D: GEOG401P2: Geomorphology, Remote Sensing and GIS (Practical)
Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

Practical 1: Study of landforms from given geomorphic model/image/map**(7 Marks)**

Practical 2: Interpretation of aerial photo/satellite image**(14 Marks)**

Practical 3: Use of GPS**(7 Marks)**

Note Book **(2 Marks)**
Viva Voce **(2 Marks)**

SUGGESTED READINGS:

1. Robert S. Anderson and Suzzane P. Anderson (2010): Geomorphology - The Mechanics and
Chemistry of Landscapes.Cambridge University Press.
2. M.A. Summerfield (1991) Global Geomorphology.Wiley & Sons.
3. Demers, M.N., 1997. *Fundamentals of Geographic Information System,* John Wiley & sons. Inc.
4. Hoffmann-Wellenhof, B., Lichtenegger, H. and Collins, J., 2001. *GPS: Theory & Practice*, Springer Wien New York.
5. Jensen, J.R., 1996. *Introductory Digital Image Processing: A Remote Sensing Perspective*, Springer- Verlag.
6. Lillesand, T. M. & Kiefer, R.W., 2007. *Remote Sensing and Image Interpretation*, Wiley.
7. Richards, J.A. and Jia, X., 1999. *Remote Sensing Digital Image Analysis*, Springer-Verlag.

4th Semester: Discipline Specific Core (DSC) Course
DSC-2D: Principles of Stratigraphy and Indian Stratigraphy
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSC-2D: GEOG402T4: Principles of Stratigraphy and Indian Stratigraphy (Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: ***T****he principles of stratigraphy help us to understand the order of superposition of rocks in space and time. Indian stratigraphy helps us to know distribution of different stratigraphic horizons in India and their significance*.

Unit 1: Principles of Stratigraphy (L: 13 T: 2) 15 *classes* (Marks: 16)

Principles of stratigraphy: Fundamentals of litho-, bio- and chrono-stratigraphy

Codes of stratigraphic nomenclature: International Stratigraphic Code – development of a standardized stratigraphic nomenclature. Concepts of Stratotypes. Brief introduction to the concepts of lithostratigraphy, biostratigraphy, chronostratigraphy

Walther's Law of Facies. Concept of paleogeographic reconstruction

Unit 2: Stratigraphy of India (L: 18 T: 2) 20 *classes* (Marks: 32)

Physiographic and tectonic subdivisions of India

Stratigraphy, distribution and economic importances of: Dharwar, Vindhyan, Cudappah, Delhi supergroups,
Gondwana of Indian subcontinent

Triassic successions of Spiti, Jurassic of Kutch, Mesozoic rocks of NE India
Volcanic provinces of India: Deccan, Rajmahal, Sylhet Trap
Siwalik successions, Tertiary of Meghalaya and Assam-Arakan basins.

DSC-2D: GEOG402P2: Principles of Stratigraphy and Indian Stratigraphy (Practical)
Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

Practical 1: Study of geological map of India and identification of major stratigraphic units.
(14 Marks)
Practical 2: Study of rocks in hand specimens from known Indian stratigraphic horizons
(14 Marks)

Note Book **(2 Marks)**
Viva Voce **(2 Marks)**

SUGGESTED READINGS:

1. Krishnan, M. S. (1982) Geology of India and Burma, CBS Publishers, Delhi
2. Doyle, P. & Bennett, M. R. (1996) Unlocking the Stratigraphic Record. John Wiley
3. Ramakrishnan, M. &Vaidyanadhan, R. (2008) Geology of India Volumes 1 & 2, Geological
society of India, Bangalore.
4. Valdiya, K. S. (2010) The making of India, Macmillan India Pvt. Ltd

4th Semester: Discipline Specific Core (DSC) Course
DSC-3D: Coal and Petroleum
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSC-3D: GEOG403T4: Coal and Petroleum(Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *The purpose of learning coal and petroleum geology is to know in detail about their formation, properties, occurrences, distribution, extraction and uses.*

Unit 1: Coal

(L: 13 T: 2)15 classes (Marks: 24)

Coal: definition, type, formation, origin and occurrences
Application of coal as fossil fuel
Distribution of coal in space and time
Chemical composition, Proximate and ultimate composition, calorific value
Rank & Grade of coal
Distribution of coal in India with special reference to NE India
Introduction to coal bed methane

Unit 2: Petroleum

(L: 13 T: 2)15 classes (Marks: 24)

Introduction to petroleum, natural gas and petroleum bearing shale sediments
Process of formation of petroleum, maturation and migration, mode of occurrences
Distribution of petroleum in time and space
Geological conditions in favour of formation and accumulation of petroleum
Physical properties and chemical composition
Gas hydradates, Shale gas and shale oil
Oil-Gas bearing territories of India with special reference to NE India

DSC-3D: GEOG403P2: Coal and Petroleum(Practical)
Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

Physical identification of types of coal**(8 Marks)**

Study of petroleum basin of India from given map**(10 Marks)**

Study of seismic profiles to identify possible lithological/structural features**(10 Marks)**

Note Book **(2 Marks)**

Viva Voce **(2 Marks)**

SUGGESTED READINGS:

1. Chandra D. (2007). Chandra's Textbook on applied coal petrology. Jijnasa Publishing House.
2. Shelly R. C. (2014). Elements of Petroleum geology: Third Edition, Academic Press
3. Bjorlykke, K. (1989). Sedimentology and petroleum geology.Springer-Verlag.
4. Bastia, R., &Radhakrishna, M. (2012). Basin evolution and petroleum prospectivity of the continental margins of India (Vol. 59). Newnes.
5. Leverson, A.L. (2006) Geology of Petroleum.

4th Semester: Skill Enhancement Course (SEC)
SEC-2.1: Skill of Advanced Geological Field Studies
Total Mark: 30 (24+8), Total Credit: 2

SEC-2.1: GEOGSEC401T2: Skill of Advanced Geological Field Studies
Credit 2: Marks 30 (End-sem24+ In-sem6) 24 Hours

Objectives: *The purpose of basic geological field studies is the skill enhancement to enable us the basic field techniques and procedures.*

(L: 18 T: 2) 20 *classes* (Mark 24)

Geological mapping, stratigraphic correlation

Primary (scalars and vectors) and secondary structures (linear and planar)

Determination of lithological contacts, unconformities, fault-shear zones

Study of rock structures: genetic and deformational

Procedure of oriented sample collection

Stereoplots of linear and planar structures, orientation analyses

SUGGESTED READINGS:

1. Lahee, F.H. 1916. Field Geology.
2. Compton, R.R, 1985. Geology in the Field.

5th Semester: Skill Enhancement Course (SEC)
SEC-1.2: Skills of basic Geological Field Studies
Total Mark: 30 (24+8), Total Credit: 2

SEC-1.2: GEOGSEC301T2: Skills of Geological Field Investigation
Credit 2: Marks 30 (End-sem24+ In-sem6) 24 Hours

Objectives: *The purpose of geological field investigation is the skill enhancement to enable us the basic field techniques and procedures.*

(L: 18 T: 2) 20 *classes* (Mark 24)

Field transect in any Precambrian terrain

Study of craton ensemble including basic intrusive suites

Precambrian sedimentary basin

Basement-Cover relation in: a. fold belts, b. sedimentary successions

SUGGESTED READINGS:

1. Lahee, F.H. 1916. Field Geology.
2. Compton, R.R, 1985. Geology in the Field.

5TH Semester: Discipline Specific Elective (DSE) Course
DSE-1A: Exploration Geology
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSE-1A: GEOGDSE501AT4: Exploration Geology (Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *Aims to study the mineral resources of the earth, its prospect, reserve estimation and different exploration technique.*

Unit 1: Mineral Resources(L: 5)5 *classes* (Marks: 8)

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(L: 9 T: 1) 10 *classes* (Marks: 12)

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(L: 5) 5 *classes* (Marks: 8)

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

Unit 4: Drilling and Logging (L: 9 T: 1) 10 *classes* (Marks: 12)

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

Unit 5: Reserve estimations and Errors (L: 4 T: 1) 5 *classes* (Marks: 8)

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

DSE -1A: GEOGDSE501AP2: Exploration Geology (Practical)
Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

1. Identification of anomaly**(7 Marks)**
2. Concept of weighted average in anomaly detection **(7 Marks)**
3. Geological cross-section**(7 Marks)**
4. Models of reserve estimation**(7 Marks)**
5. Note Book **(2 Marks)**
6. Viva Voce **(2 Marks)**

SUGGESTED READINGS:

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

5TH Semester: Discipline Specific Elective (DSE) Course
DSE-2A: Geoinformatics
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSE -2A: GEOGDSE502AT4: Geoinformatics(Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *Through this subject one can learn how to apply information technology to address the problems of geosciences*.

(L: 33 T: 2) *35classes* (Marks 48)

Introduction to geoinformatics: application of information technology in geological science, advantage and disadvantages of geoinformatics, scopes and prospects in the geoinformatics

Cartography, Remote Sensing, Geographical Information System, realtime, online and offline monitoring of earth

Introduction to information technology: hardware and software of computer, personal computer, workstation computer and super computer, FLOPS, components and peripherals of computer system

Operating system, programming language, introduction to HTML, C++, C# and ActionScript

Geographical information system: GIS data types: raster and vector data, point data, line data and polygonal data, georeferncing, Digital Elevation Model

DSE -2A: GEOGDSE502AP2: Geoinformatics(Practical)
Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

Simple programming in C++, C# and ActionScript**(8 Marks)**

Raster and Vector data processing and analyses**(10 Marks)**

Spatial analyses of DEM**(10 Marks)**

Note Book **(2 Marks)**

Viva Voce **(2 Marks)**

SUGGESTED READINGS:

1. Principles of geoinformatics by .R.K. Gupta and SubhashChander.
2. Geoinformatics by Saiful Islam.

5TH Semester: Discipline Specific Elective (DSE) Course
DSE-3A: Fluvial Geomorphology
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSE -3A1: GEOGDSE503A1T4: Fluvial Geomorphology (Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *Fluvial geomorphology is the scientific study of the form and function of streams and the interactions between streams and the landscapes around them.*

Weathering of rock and transportation of weathered material through running water
Water Cycle, surface and subsurface runoff, permanent, sessional and temporal flow of water

(L: 5) 5 *classes* (Marks: 5)

Stream flow, classification of streams

(L: 2) 2 *classes* (Marks: 4)

Drainage system: drainage basin, basinal area, network of streams, stream ordering
Stream morphology, morphometric parameters and their signifincances

(L: 5) 5 *classes* (Marks: 8)

Stream patterns, controls over the development of stream patterns

(L: 5) 5 *classes* (Marks: 6)

Landforms associated with fluvial processes, waterfall, rapids, alluvial fans, flood plain features, delta
Avulsion, River Capturing, Channel bar and islands, Bank Erosion

(L: 4 T: 1) 5 *classes* (Marks: 8)

Estuaries, lagoons and lakes, outwash plains
Drainage system of North East India

(L: 5) 5 *classes* (Marks: 6)

Major drainage system of Indian Subcontinents

Flood, Palaeoflood, Flood Monitoring, Disaster and Mitigation, Preparedness for flood condition

(L: 4 T: 1) 5 *classes* (Marks: 7)

Significance of fluvial processes in gradational change in earth surface, determination of structural features and in exploration of economic deposits

(L: 3) 3 *classes* (Marks: 4)

DSE -3A1: GEOGDSE503A1P2: Fluvial Geomorphology(Practical)
Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

Tracing of drainage network and demarcation of drainage basin**(10 Marks)**

Morphometrical analyses of a particular drainage system**(10 Marks)**

Demarcation of areas vulnerable to flood from DEM**(8 Marks)**

Note Book **(2 Marks)**

Viva Voce **(2 Marks)**

SUGGESTED READINGS:

1. Robert S. Anderson and Suzzane P. Anderson (2010): Geomorphology - The Mechanics and
Chemistry of Landscapes.Cambridge University Press.
2. M.A. Summerfield (1991) Global Geomorphology.Wiley & Sons.
3. Demers, M.N., 1997. *Fundamentals of Geographic Information System*, John Wiley & sons. Inc.
4. Knighton, D. (1998) Fluvial forms and processes: A new perspective. Amold Pubs.
5. Richards. K. (2004) Rivers: Forms and processes in alluvial channels. Balckburn Press.
6. Bryirely and Fryirs (2005) Geomorphology and river management. Blackwell Pub.,
7. Julien, P.Y. (2002) River Mechanics. Cambridge University Press.
8. Robert, A. (2003) River Processes: An introduction to fluvial dynamics. Arnold Publications.

5TH Semester: Discipline Specific Elective (DSE) Course
DSE-3A: Environmental Geology
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSE -3A2: GEOGDSE503A2T4: Environmental Geology(Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *Through environmental geology one can learn how to manage geological and hydrogeological resources such as fossil fuels, minerals, surface and ground water as well as land use. It also deals with natural and artificial hazards as well as pollution.*

Introduction to Environmental Geology: Cosmic, Galactic and Physical Environments of Earth.Natural and man-made activities and their effects on the Physical Environment of Earth

2 classes **(Marks: 4)**

Natural resource, energy, radiation from terrestrial and extra-terrestrial objects, solar flare, solar wind, electric charge, magnetism, ecological units, habitats

5 *classes* (Marks: 5)

Water on Earth: surface and subsurface water, ocean, streams, lakes, atmospheric water Climate and Weather, El Nino-La Nina Oscillations, Tide, Estuaries, Lagoons and Delta

8 *classes* (Marks: 15)

Gradational Processes: Weathering and erosion, activities of running water, moving ice, coastal activities, wind activities

5 *classes* (Marks: 5)

Natural hazards: volcanic eruptions, release of poisonous gas and fluids, rainfall, floods, landslides, coastal erosions, earthquake and mitigation.

5 *classes* (Marks: 5)

Artificial hazards: urbanization, sanitary, septic tanks, open-cast and underground mining, drilling, industrial and radioactive waste disposal

5 *classes* (Marks: 5)

Pollution of ground water and surface water, marine pollution, pollution from agricultural practices

5 *classes* (Marks: 5)

Environmental protection-legislative measures in India

2 *classes* (Marks: 4)

DSE -3A2: GEOGDSE503A2P2: Environmental Geology(Practical)
Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

Study of Environmental impacts of rapid urbanization, agriculture, industrialization and mining from field visit and preparation of report

Presentation**(10 Marks)**

Report**(18 Marks)**

Viva Voce **(2 Marks)**

SUGGESTED READINGS:

1. Geomorphology and Environment by Savindra Singh, H.S. Sarmah and Sunil Kumar Dev.
2. Environmental Geology by C.W. Montgomery.

SEC-2.2: Project Work
Total Mark: 30 (24+8), Total Credit: 2

SEC-1.2: GEOGSEC301T2:Project Work
Credit 2: Marks 30 (End-sem24+ In-sem6) 24 Hours

Objectives: *The purpose of this project work to provide skill regarding techniques and procedures used in geological studies.*

Project Work **Marks: 30 (End Sem 24+ In Sem 6) (2 Credits)**
(Small Dissertation Work**)**

Presentation**(10 Marks)**

Report**(18 Marks)**

Viva Voce **(2 Marks)**

DSE-1B: Mining Geology
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSE-1B: GEOGDSE601BT4: Mining Geology (Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *Through this applied science one can learn the development of a defined mineral resource with the help of combine principles of economic geology and mining engineering.*

(L: 28 T: 2)30 *classes* (Marks 48)

Ore, gangue, tenor
Development of mining technology in human history
Ancient techniques of mining of iron, gold, copper, alumninium and coal

General idea on the exploration of economic deposit, estimation of volume and reserve of the ore deposit

Mining terminologies used in surface and sub-surface mining

Classification of mining methods

Selection of mining technique from the structure of ore, lithology of host and orientation of ore deposit

Description of alluvial, surface (open-cast) and subsurface mining methods and discussion on tools used

Mine safety measures, lining: types and needs, ventilation of air, water and electricity, transportation of workers

DSE -1B: GEOGDSE601BP2: Mining Geology(Practical)

Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

Estimation of volume of overburden, ore body**(8 Marks)**

Estimation of reserve**(12 Marks)**

Modeling of ore deposits from given geological map**(8 Marks)**

Note Book **(2 Marks)**

Viva Voce **(2 Marks)**

SUGGESTED READINGS:

1. Clark, G.B. 1967. Elements of Mining.3rd Ed. John Wiley & Sons.
2. Arogyaswami, R.P.N. 1996 Courses in Mining Geology. 4th Ed. Oxford-IBH.

DSE-2B: Structural Geology
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSE-2B: GEOGDSE602BT4: Structural Geology (Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *The primary goal of structural geology is to uncover the history of deformation in the rocks. The deformation of the lithospheric rocks by tectonic forces can be learnt through this subject. Structural geology also helps to understand the geodynamics of regional to global dimension. Structural control on ore localization and landscape evolution are learnt through this subject. Application of structural geology in the engineering geology project is enormous*.

Relation between the geological structure and topography. Outcrop patterns of different structures
Concept of stress and strain.Brittle and ductile behaviors of rocks. Stress-strain relationships for different substances

(L: 8, T:2) 10 *classes* (Marks: 10)

Folds: Definition, terminologies, classifications (geometric, genetic and morphological)
Faults: Definition, terminologies, classification (geometric and genetic). Recognition of faults in the field.
Foliations: Definition, terminologies and classification
Lineations: Definition, terminologies and classification
Joints: Definition, terminologies and classification
Unconformities: Definition, terminologies, types. Recognition of unconformities in the field

(L: 15, T: 5) 20 *classes* (Marks: 28)

Concept of plate tectonics.Types of plate boundaries.Subduction zones, mid oceanic ridges. Island arcs, earthquake and volcanic belts
Structural framework of North East India

(L: 5, T: 3) 8 *classes* (Marks: 10)

DSE -2B: GEOGDSE602BP2: Structural Geology(Practical)

Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

Use of Clinometers and Brunton compass for measurements**(8 Marks)**

Study of contour maps and structural maps and construction of profiles**(10 Marks)**

Three point structural problems and structural projections**(10 Marks)**

Note Book **(2 Marks)**

Viva Voce **(2 Marks)**

SUGGESTED READINGS:

1. Davis, G. R. (1984) Structural Geology of Rocks and Region. John Wiley
2. Billings, M. P. (1987) Structural Geology, 4th edition, Prentice-Hall.
3. Park, R. G. (2004) Foundations of Structural Geology.Chapman& Hall.
4. Pollard, D. D. (2005) Fundamental of Structural Geology. Cambridge University Press.
5. Ragan, D. M. (2009) Structural Geology: an introduction to geometrical techniques (4th Ed).
Cambridge University Press (For Practical)
6. Lahee F. H. (1962) Field Geology. McGraw Hill

DSE-3B: Hydrogeology
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSE-3B: GEOGDSE603B1T4: Hydrogeology (Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *Hydrogeology deals with hydrogeologic cycle, occurrences, movement and distribution of groundwater in different regions and its utility.*

Occurrence and origin of groundwater;

(L: 3) 3 *classes* (Marks: 4)

Hydrologic cycle; Hydrological properties of water bearing formations: porosity, permeability, transmissivity, specific yield, storage coefficient.

(L: 5) 5 *classes* (Marks: 4)

Movement of ground water; types of openings in rocks; types of springs.

(L: 5) 5 *classes* (Marks: 4)

Concept of water table and piezometric surface, free and confined water; Aquifer- different types;

(L: 6 T: 2)8 *classes* (Marks: 14)

Quality of ground water- problems of fluoride and arsenic in ground water;

(L: 4) 4 *classes* (Marks: 4)

Exploration for ground water; Groundwater recharge- concept of safe yield and overdraft.Rainwater harvesting.

(L: 6 T: 1) 7 *classes* (Marks: 14)

Groundwater provinces of India.

(L: 3) 3 *classes* (Marks: 4)

DSE -3B: GEOGDSE603B1P2: Hydrogeology (Practical)
Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

Preparation of water table contour map using supplied water level data and interpretation of the same**(7 Marks)**

Interpretation of supplied water table map**(7 Marks)**

Determination of flow well area from supplied ground level contour and piezometric level contours**(7 Marks)**

Solution of hydrogeological problems using Darcy's equation**(7 Marks)**

Note Book **(2 Marks)**

Viva Voce **(2 Marks)**

SUGGESTED READINGS:

1. Todd, D. K. 2006. Groundwater hydrology, 2nd Ed., John Wiley & Sons, N.Y.
2. Davis, S. N. and De Weist, R.J.M. 1966. Hydrogeology, John Wiley & Sons Inc., N.Y.
3. Karanth K.R., 1987, Groundwater: Assessment, Development and management, Tata McGraw-Hill Pub. Co. Ltd.
3. Gross,M.G., 1977. *Oceanography: A view of the Earth*, Prentice Hall.

6TH Semester: Discipline Specific Elective (DSE) Course
DSE-3B: Earth and climate
Total Mark: 100 (60+40), Total Credit: 6 (4 Th + 2 Pr)

DSE-3B: GEOGDSE603B2T4: Earth and climate(Theory)
Credit 4: Marks 60 (End-sem 48+ In-sem 12) 48 Hours

Objectives: *Aims in study of the earth, its heat budget, its climate, atmosphere and hydrosphere and their changes through time and it effects and responses produce by the biosphere.*

Components of the climate system
Climate system response, response rates and interactions within the climate system

(L: 6) 6*classes* (Marks: 8)

Incoming solar radiation, receipt and storage of heat
Heat transformation

(L: 6) 6*classes* (Marks: 8)

Layering of atmosphere and atmospheric Circulation
Atmosphere and ocean interaction and its effect on climate
Heat transfer in ocean

(L: 6 T: 2) 8*classes* (Marks: 12)

Climate Change: natural vs. anthropogenic effects
Humans and climate change

(L: 6) 6*classes* (Marks: 8)

Milankovitch cycles and variability in the climate
Glacial-interglacial stages
The Last Glacial maximum (LGM)

(L: 6) 6*classes* (Marks: 8)

Mechanism of monsoon
Monsoonal variation through time

(L: 3) 3*classes* (Marks: 4)

DSE -3B: GEOGDSE603B2P2: Earth and climate(Practical)
Credit 2: Marks 40 (End-sem 32+ In-sem 8) 24 Hours

Study of distribution of major climatic regimes of India on map**(8 Marks)**
Distribution of major wind patterns on World map**(8 Marks)**
Preparation of paleogeographic maps (distribution of land and sea) of India during specific geologicaltime intervals**(12 Marks)**
Note Book **(2 Marks)**
Viva Voce **(2 Marks)**

SUGGESTED READINGS:

1. Rudiman, W.F., 2001. Earth's climate: past and future. Edition 2, Freeman Publisher.
2. Rohli, R.V., and Vega, A.J., 2007. Climatology. Jones and Barlatt
3. Lutgens, F., Tarbuck, E., and Tasa, D., 2009. The Atmosphere: An Introduction to Meteorology.
Pearson Publisher
4. Aguado, E., and Burt, J., 2009. Understanding weather