SHRI GURU RAM RAI UNIVERSITY

[Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC u/s (2f) of UGC Act 1956]

DEPARTMENT OF GEOLOGY

SCHOOL OF BASIC & APPLIED SCIENCES
SHRI GURU RAM RAI UNIVERSITY

Bachelor of Science
OR
Bachelor of Science (Hons.) with Research

Based on NEP

[Exit Options after completion of 01 Year, 02 Years, 03 Years, and 04 Years]

Effective from Academic Session 2023-2024

Patel Nagar, Dehradun, Uttarakhand

COURSE STRUCTURE

Semester Wise Discipline Specific Core

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	DSC-C (Geology)	GELDC101	Physical Geology and Structural Geology	3	0	0	3
		GELDL102	Practical/Lab Course	0	0	2	1
II		GELDC201	Crystallography and Mineralogy	3	0	0	3
		GELDL202	Practical/Labcourse	0	0	2	1
III		GELDC301	Petrology	3	0	0	3
		GELDL302	Practical/Labcourse	0	0	2	1
IV		GELDC401	Stratigraphy	3	0	0	3
		GELDL402	Practical/Labcourse	0	0	2	1
V		GELDC501	Palaeontology	3	0	0	3
		GELDL502	Practical/Labcourse	0	0	2	1
VI		GELDC601	Economic Geology	3	0	0	3
		GELDL602	Practical/Labcourse	0	0	2	1
VII		GELDC701	Advanced Structural Geology	3	0	0	3
		GELDL702	Practical/Lab Course	0	0	2	1
VIII		GELDC801	Geotectonics	3	0	0	3
		GELDL802	Practical/Lab Course	0	0	2	1

Semester Wise Discipline-Specific Elective

Semester	Course Type	Course Code	Course Title	L	T	P	C
V	DSE-C (Geology)	GELDE504	Geochemistry & Geochronology	3	1	0	4
VI		GELDE604	Sedimentology	3	1	0	4
VII		GELDE703	Advanced Mineralogy	3	1	0	4
		GELDE704	Engineering and Disaster Management	3	1	0	4
		GELDE705	Research Methodology	3	1	0	4
VIII		GELDE706	Geological Field	3	1	0	4
		GELDE803	Igneous Petrology	3	1	0	4
		GELDE804	Metamorphic Petrology	3	1	0	4
		GELDE805	Mineral Exploration and Mining Geology	3	1	0	4
		GELDE 806	Intellectual Property Right (IPR)	3	1	0	4

Semester Wise Generic Elective

Semester	Course Type	Course Code	Course Title	L	T	P	C
I		GELGE103	Geohydrology	4	0	0	4

II	**GE-C (Geology)**	GELGE203	Climatology	4	0	0	4
III		GELGE303	Oceanography	4	0	0	4
IV		GELGE403	Environmental Geology	4	0	0	4
V		GELGE503	Fuel Geology	4	0	0	4
VI		GELGE603	Quaternary Geology	4	0	0	4

Semester Wise Ability Enhancement Course

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	**AEC**	AEC-104	Environment Science-I	2	0	0	2
II		AEC-204	Environment Science-II	2	0	0	2
III		AEC-304	English Communication-I	2	0	0	2
IV		AEC-404	English Communication-II	2	0	0	2

Semester Wise Skill Enhancement Course/IAPC

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	**SEC-C/IAPC (GEOLOGY)**	GELSC105	Field Geology	2	0	0	2
II		GELSC205	Remote Sensing and GIS	2	0	0	2
III		GELSC305	Geological Field	2	0	0	2
IV		GELSC405	Laboratory techniques in Geology	2	0	0	2
V		GELSC505	Internship/Apprenticeship / Project/ Community Outreach/ OR MOOC	2	0	0	2
VI		GELSC506	Internship/Apprenticeship / Project/ Community Outreach/ OR MOOC	2	0	0	2

Semester Wise Dissertation

Semester	Course Type	Course Code	Course Title	L	T	P	C
VII	IAPC	GELDT708	Academic Project-I Major core/ Minor elective	0	0	0	6
VIII	IAPC	GELDT808	Academic Project-II Major core/ Minor elective	0	0	0	6

Semester Wise Value Addition Course (VAC)

Semester	Course Type	Course Code	Course Title	L	T	P	C
I	VAC		Choose from the pool of courses offered by the University	0	0	0	2
II	VAC		Choose from the pool of courses offered by the University	0	0	0	2
III	VAC		Choose from the pool of courses offered by the University	0	0	0	2
IV	VAC		Choose from the pool of courses offered by the University	0	0	0	2

PROGRAMME OUTCOMES (POs)

The curricular of the subject of geology are designed keeping in view the following programme outcomes:

PO1	Enabling the students to understand the age, composition, structure, processes, and Evolutionary history of the Earth.
PO2	Enabling the students to identify, locate, explore, judiciously exploit, and manage various Earth resources like minerals, fossil fuel and natural gas, coal, building stones, weathered Crust and soils, underground and surface water etc.
PO3	Correlating the principles and findings of science to the scientific world and apply them in everyday life.
PO4	Enabling the students to understand and assess the potential of natural processes in causing hazards and disasters
PO5	Enabling the students to understand such geological conditions that make the terrain prone to natural and anthropogenic hazards.
PO6	Enabling the students to assess the suitability of terrain for various civil engineering constructions such as dams, reservoirs, bridges, tunnels, roads, railway lines, cable-cars, and buildings etc.
PO7	Enabling the students to formulate and execute guidelines for safe developmental activities in diverse geological terrains.
PO8	Ability to devise and carry out an independent field-based project, including the formulation and testing of hypotheses whilst in the process of carrying out the project.
PO9	Graduates will acquire effective communication skills
PO10	Evolving sustainable solutions for complex problems of the society in general and for public health and safety, cultural, societal and environmental anomalies.
PO11	Develop skills in gathering and interpreting the geological and geophysical data used to gain this understanding and thereby equip students with the foundations for their professional careers or additional study.
PO12	Motivating the students to take up higher studies and research to bringing out new knowledge Yet to be understood the geological aspects of the Earth.

Program Specific Outcome (PSOs)

On successful completion of the B Sc. Geology program students will be able to

PSO1	Acquire a knowledge in the Science of geology as a whole as well as Earth materials, Petrology, Geochemistry, Mineralogy, Hydrology, Natural disaster and Stratigraphy, Structural features, and geomorphic processes and landforms.
PSO2	Apply principles of mathematics, chemistry, and physics to geologic problems
PSO3	Use compasses, survey instruments, and satellite images in geological investigations
PSO4	Develop intellectual ability and geological skills through an appropriate blending of theoretical subject education, practical exercises and field training
PSO5	Attain basic knowledge, training, skills and eligibility degree for various higher academic courses and position in Govt. and private sector.

Discipline Specific Core Courses

Semester- I

Course code	**: GELDC101**				
Course Name	**: Physical and Structural Geology**				
Semester /Year	**: Ist**				
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. This course gives an overall introduction to Geology from topics ranging from the formation of the solar system, internal structure of the earth and, natural hazards of Earthquake and Volcanoes.

2. To learn the concept of Structural geology, Concept of strike and dip, Dipping strata, Brunton compass, major types of fold structures,

3. The geometric and genetic classification of faults, understand the geological significance of joint, unconformity and salt dome

Course Contents

Physical Geology

Unit: 1 Introduction to geology and its scope, origin and structure of Earth and solar system

Unit: 2 Processes of weathering and erosion: factors, types and their effects, principal of geomorphological process, basic concepts of Earthquakes and Volcanoes, theories of Isostacy.

Structural Geology

Unit: 1 Introduction to Structural Geology; contours, topographic and geological maps; Elementary idea of bed, dip, and strike; Clinometer/ Brunton compass and its use,

Unit: 2 Basic concept of deformation; Folds, Fault, Joints, and Unconformity, and other miscellaneous structures.

Text Books:

TB1: Mahapatra, G.B., 1994. A text book of Physical Geology. CBS Publishers.

TB2: Billings, M.P., 1972.Structural Geology. Prentice Hall.

Reference Books:

RB1: Holmes, A & P.L. Duff. (1996). Principles of Physical Geology, 4th revised edition, ELBS, London

RB2: Gokhale, N.W. (1995), Theory of Structural Geology, CBS, Delhi.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Learn and Gain Knowledge to the different component of earth and the evolution of solar system, processes of weathering and erosion, earthquake, volcanoes. Idea of dip, strike, bed, fold, fault and unconformity.
CO2	Develop understanding of about the structure of Earth, Origin of solar system, factors of weathering, erosion, earthquake, volcanoes, elementary idea of stress and strain, fold, fault, unconformity and joints.
CO3	Illustrate the theories of earth, structures, solar system, earthquake, volcanoes, fold, fault, joints and unconformity.
CO4	Correlate various Hypotheses on Origin of Earth, dip and strike, stress and strain, weathering and erosion.
CO5	Measure the dip and strike with the help of clinometer compass/Brunton.
CO6	Write the concept of unconformity, normal, thrust and slip faults.

Course code	:	**GELDL102**			
Course Name	:	**Lab Course based on GELDC101**			
Semester /Year	:	**I**			
		L	**T**	**P**	**C**
		0	**0**	**2**	**1**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To understand the geomorphological models and features.
2. The student is introduced to the basic knowledge relevant to geological maps
3. Practical exercises emphasize the use of compasses, Clinometer and Brunton.

Content

- **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.

Text Books:

TB1: Dr. Harish Kapasya, Publisher: Himanshu Publications.
TB2: R. G. Park, Foundation of Structural Geology, Springer Netherlands, 2nd Edn.2012, ISBN

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Gain knowledge about the geomorphological features.
CO2	Understand maps of geological significance.
CO3	Explain the concept of clinometers/Brunton compass
CO4	Differentiate different types of folds/faults from block models
CO5	Measure the dip and strike with the help of Clinometer compass/Brunton.
CO6	Preparation of cross section profile from a geological map.

Semester- II

Course code	:	**GELDC201**			
Course Name	:	**Crystallography and Mineralogy**			
Semester/Year	:	**II**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. The student is introduced to the different mineral groups emphasizing their properties for megascopic and thin section identification and their distribution in different earth materials.

2. Study Crystallography which is the foundation of mineralogy, inorganic chemistry and material science, to understand the classification of different crystal systems, twinning types and its different law

3. Class lectures and practical, involving the study of crystal models and minerals hand specimens and thin sections

Course Contents

Crystallography

Unit: 1 Crystal form, face, edge, solid angle; Interfacial angle and their measurements; Crystallographic axes and angles, and crystallographic notation.

Unit: 2 Symmetry elements and description of normal class of Isometric, Tetragonal, Hexagonal, Trigonal, Orthorhombic, Monoclinic and Triclinic systems, and basic concept of twinning.

Mineralogy

Unit: 1 Common physical properties of minerals (form, colour, luster, streak, cleavage, fracture, hardness, and specific gravity), and Chemical properties of minerals.

Unit: 2 Classification of silicate structures, Polarizing microscope and its use and Optical properties of minerals.

Text Books:

TB1: Dana, E.S. and Ford, W. E.,2002. A textbook of Mineralogy (Reprints).

TB2: Berry, L.G., Mason, B. and Dietrich, R.V., 1982. Mineralogy. CBS Publ.

TB3: Nesse, D.W.,1986. Optical Mineralogy. McGraw Hill.

Reference Books:

RB1: Read, H.H., 1968.Rutley'sElement of Mineralogy (Rev. Ed.). Thomas Murby and Co.

RB2: Berry and Mason,1961. Mineralogy. W.H. Freeman &Co.

RB3: Kerr, B.F., 1995. Optical Mineralogy. 5thEd. McGraw Hill, New York.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Learn and Gain Knowledge to the different properties of minerals, silicate structure, Polarizing microscope, Optical properties of mineral, Interfacial angle, Crystallographic axes, Miller system of notations, description of normal classes, and twinning.
CO2	To Understand the mode of occurrences and uses of different mineral groups, silicate structures, optical properties of common minerals, description f normal classes of common crystal.
CO3	Differentiate different crystal systems based on symmetry and other properties of crystal and minerals, laws of twinning.
CO4	Measure interfacial angle by using contact goniometer, give different notations in crystal, Explain properties of minerals, Crystallographic axes.

CO5	Distinguish different minerals on the bases of physical properties, optical properties, crystal system on the bases of symmetry.
CO6	Write the concept of Polarizing microscope and twinning.

Course code	**:**	**GELD L 202**			
Course Name	**:**	**Lab Course based on GELDC201**			
Semester /Year	**:**	**II**			
		L	**T**	**P**	**C**
		0	**0**	**2**	**1**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To understand the common rock-forming minerals in hand specimens.

2. To understand the optical properties of minerals.

Course Contents

Crystallography:

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

Mineralogy:

Study of physical and optical properties of common rock forming minerals.

Text Books:

TB1: Rabindra Nath Hota, Practical Approach to Crystallography and Mineralogy, CBS publishers and distributors pvt ltd; 2nd edition (30July 2017).

Reference Books:

RB1: C.D. Gribble, Rutley's Elements of Mineralogy, 27e [Print Replica] Kindle Edition; CBS publishers and distributors pvt ltd; Twenty-seven Edition (1 December 2005).

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Identify common rock-forming minerals in hand specimens.
CO2	Understand common rock-forming minerals in thin section.
CO3	Determination of system and class of crystals based on symmetry elements.
CO4	Analyze the hand specimen and rock slide.
CO5	Compare the hand specimen of minerals on the bases of Physical properties of minerals
CO6	Write the notations in crystal system.

Semester III

Course code	**:**	**GELDC 301**			
Course Name	**:**	**Petrology**			
Semester /Year	**:**	**III**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1.To understanding the textures, structures, classification of Igneous Rock.

2.To understanding the textures, structures, classification of Sedimentary Rock.

3. To understanding the textures, structures, classification of Metamorphic Rock.

Course Contents

Igneous Petrology

Unit: 1 Introduction to petrology, Magma: definition, composition and constitution, types and origin; Forms of igneous rocks, Differentiation and Assimilation; Bowen's reaction principle.

Unit: 2 Classification of igneous rocks, textures, and structure of igneous rocks.

Sedimentary Petrology and Metamorphic Petrology

Unit: 3 Processes of formation of sedimentary rocks; Classification, textures and structures of sedimentary rocks; sedimentary facies.

Unit: 4 Process and products of metamorphism; Type of metamorphism. Factors, zones and grade of metamorphism; Textures and structures of metamorphic rocks.

Text Books:

TB1: Turner, F. J. &Verhoogen, J.,1960, Igneous & Metamorphic petrology. McGraw Hill Co.

TB2: Prasad, C.,1980. A text book of sedimentology

TB3: Mason, R., 1978.Petrology of Metamorphic Rocks. CBS Publ.

Reference Books:

RB1: Pettijohn, F.J.,1975. Sedimentary rocks, Harper& Bros.3rdEd.

RB2: Sengupta. S., 1997.Introduction to sedimentology. Oxford-IBH.

RB3: Moorhouse, WW., 1969.The study of rocks in thin sections. Harper and sons.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Learn and Gain Knowledge of Igneous, Sedimentary and Metamorphic Petrology.
CO2	Understand the formation, texture, structure of Igneous rock, Sedimentary rock and Metamorphic rock.
CO3	Explain the use of Petrography of Igneous, Sedimentary and Metamorphic rock, different structures of rocks, types of Metamorphism.
CO4	Classify the Igneous rock, Sedimentary rock and Metamorphic rock, Crystallization of uni-component and bi-component (mix-crystals); Bowen's reaction principle, Petrography of rocks.
CO5	Distinguish between different type of rocks.
CO6	Write the process of metamorphism, agents of metamorphism, petrography of metamorphic rock, facies concept.

Course code	**:**	**GELDL 302**			
Course Name	**:**	**Lab Course based on GELDC 302**			
Semester /Year	**:**	**III**			
		L	**T**	**P**	**C**
		0	**0**	**2**	**1**

L - Lecture T – Tutorial P – Practical C – Credit

Course Contents

Igneous Petrology:

Identification of rocks: Detailed petrographic description of Igneous rocks in hand specimen and thin section.

Sedimentary and metamorphic Petrology:

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

Text Books:

TB1: Rabindra Nath Hota, Practical Approach to Petrology 2nd Edition, Kindle Edition, CBS publishers and distributors pvt ltd; 2nd edition (11 August 2020).

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Describe microscopic properties of igneous, sedimentary, and metamorphic rocks.
CO2	Compare different type of rocks in hand specimen and thin section.

CO3	Prepare the slides of different types of rocks.
CO4	Distinguish the rock in microscopic and macroscopic level.
CO5	Analyze the thin section of Igneous, Sedimentary rock and Metamorphic Rock.
CO6	Write the Physical properties of rocks in hand specimen.

Semester IV

Course code	**:**	**GELDC 401**			
Course Name	**:**	**Stratigraphy**			
Semester /Year	**:**	**IV**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. This course aims at providing a basic understanding of the various stratigraphic units

2. To understand the concept of Geological Time Scale and Facies concept

3. It aims to provide understanding of the Precambrian geology, stratigraphy, fossil content and the economic resources of the lithounits from the Peninsular India.

Course Contents

Stratigraphy

Unit I: Definition, types of stratigraphy; Geological time scale and stratigraphic classification; Physiographic division of India.

Unit II: Study of following Precambrian succession: Dharwar, Singhbhum, Cuddapha, Vindhyan and Mesozoic type succession of Kutch and Cretaceous of Tiruchirapalli.

Unit III: Gondwana: classification and importance of Gondwana, and Deccan Trap.

Unit IV: Classification of Siwalik succession.

Text Books:

TB1: Wadia, D. N.,1973. Geology of India. McGraw Hill Book co.

TB: Krishnan, M.S.,1982. Geology of India and Burma,6th Edition. CBS Publ.

TB3: Ravindra Kumar,1985. Fundamentals of Historical Geology & Stratigraphy of India. Wiley, Eastern.

Reference Books:

RB1: Principle of Stratigraphy: Dunbar and Roggers, (1964), John Wiley and co, New York

RB3: Stratigraphic Principles and Practices: Weller, J.M, (1962), Harper & Bros, New York.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Learn and Gain Knowledge of fundamentals of stratigraphic principles and various methods of stratigraphic analysis will be provided.
CO2	To understand the concept of Geological Time Scale and Facies concept, Physiographic division of India, succession of Gondwana, Mesozoic, Siwalik.
CO3	Explain about the various age group rocks occurring in India and the boundaries separating them, Geological Time events of The Paleozoic, Gondwana, Triassic, Jurassic and Cretaceous and the Tertiary Group
CO4	The stratigraphic classification from craton, Proterozoic to Phanerozoic succession from India is the goal of this course.
CO5	Compare the stratigraphy succession on the bases of fossils.
CO6	Write the detailed significance of the Siwalik, Pleistocene, Holocene, Himalayas, and Eocene systems.

Course code	**:**	**GELDL 402**			
Course Name	**:**	**Lab Course Based on GELDC 401**			
Semester /Year	**:**	**IV**			
		L	**T**	**P**	**C**
		0	**0**	**2**	**1**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. Be able to locate the resources based on fossils.

2.To learn identify the fossils.

Course Contents

- Preparation of lithostratigraphic maps of India showing distribution of important geological formations.
- Assigning stratigraphy Formations based on fossils.
- Study of specimens representing rock formations of Dehradun.

Text Books:

TB1: Rajeeva Guhey (1 January 2017), Geology: Principles and Practical Manua; New India Publishing Agency.

Reference Books:

RB1: Ramakrishnan, M and Vaidynadhan, R., (1994), Geology of India, Geological Society of India Publication, Bangalore. Vol. I and II.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Describe the stratigraphy sequences of various formation.
CO2	Identify hand specimens representing rock Formations of Dehradun.
CO3	Solve problems in stratigraphic correlation.
CO4	Explain the lithostratigraphic maps of India showing geological formation.
CO5	Discriminate stratigraphy Formations based on fossils
CO6	Write the various stratigraphic horizons in outline map of India

Semester V

Course code	:	**GELDC 501**			
Course Name	:	**Palaeontology**			
Semester /Year	:	**V**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1.To learn about the remains of plants and animals which have been preserved in the earth's crust by natural processes. With these objectives keeping in views of mind it becomes pertinent to understand the basic concepts of Paleontology

2. It would add to their knowledge regarding the basic concept of paleontology using mode and methods of fossil preservation and species identification

3. To learn about the vertebrate paleontology and Paleobotany.

Course Contents

Unit 1: Paleontology, definition, subdivisions and scope, Fossils: definition, characters, mode of preservation, condition of fossilization and significance of fossils, Trace fossils and Ichno-fossils and Index Fossils.

Unit 2: Elementary ideas about origin of life and adaptation to various environments. Systematic classification of organisms.

Unit 3: Invertebrate Paleontology- Morphology, classification, evolutionary trends, and geological distribution of Brachiopods, Lamellibranches, Gastropods, Cephalopods, and Trilobites.

Unit 4: Vertebrate Paleontology: Introduction of Siwalik vertebrate fauna- Equidae, Proboscidea and Hominidae.

Unit 5: Introduction to Paleobotany; fossil record of plants through time; Gondwana Flora.

Text Books:

TB1: Raup, D. M., Stanley, S. M., Freeman, W. H. (1971). Principles of Paleontology.

TB2: Clarkson, E. N. K. (2012). Invertebrate paleontology and evolution 4th Edition by Blackwell Publishing

TB3: Moore, R.C. Lalliker, C.G. and Fischer, A.G. (1952). Text book of Invertebrate Palaeontology.

Reference Books:

RB1: Benton, M. (2009). Vertebrate paleontology. John Wiley & Sons.
RB2: Schrock, Twenhofel and Williams (1953). Principles of Invertebrate Palaeontology. CBS,
RB3: Shukla, A. C. and Misra, S. P. (1975). Essentials of paleobotany. Vikas Publisher.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Learn and gain Knowledge of fossils, conditions and modes for fossilization, Invertebrate, vertebrate Paleontology, paleobotany and Micropaleontology.
CO2	To understand the morphology of the hard parts of different phyllum's and geological time range.
CO3	Explain the origin and evolution of life through geological time and the major evolutionary breakthroughs, and to correlate the evolutionary history with other synchronous geological events.
CO4	Explain the condition of fossilization and significance of fossils, classification of organisms. Distinguish between different phyllum.
CO5	Distinguish between the Upper Gondwana and Lower Gondwana,
CO6	Write the collection techniques of fossils, mode of preservation, types of fossils.

Course code	:	**GELDL 502**			
Course Name	:	**Lab Course based on GELDC 501**			
Semester /Year	:	**V**			
		L	**T**	**P**	**C**
		0	**0**	**2**	**1**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To learn about the Important invertebrate groups (Bivalvia, Gastropoda, Brachiopoda) and their biostratigraphic significance.
2. Be able to get application of fossils in Stratigraphy.

Course Contents

- Morphological characters, systematic position and age of fossil genera pertaining to brachiopods, pelecypods, cephalopods, and trilobite.
- Study of plants fossils.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Gain Knowledge regarding the identification of fossils.
CO2	To identify fossils/casts/shells w.r.t their morphology and geological age.
CO3	To collect the rock sample from the field
CO4	Correlate the formation of rock based on fossils.
CO5	Compare the rock succession based on fossils.
CO6	To identify the Plant fossils and write its uses

Semester VI

Course code	:	**GELDC 601**			
Course Name	:	**Economic Geology**			
Semester /Year	:	**VI**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1.The student is introduced to the basic principles of Economic geology.

2. To learn about the hydrological cycle, origin of ground water and groundwater exploration methods.

Course Contents

Unit: 1 Concept of ore and ore deposits, ore minerals and gangue minerals; Tenor of ores; Metallic and non-metallic ore mineral.

Unit: 2 Processes of formation of ore deposits; Magmatic, Mechanical and residual concentration, contact metasomatic, hydrothermal, sedimentation, oxidation, supergene enrichment.

Unit: 3 Study of important metallic and non-metallic minerals, Strategic, Critical and essential minerals, mineral resources of Uttarakhand.

Text Books:

TB1: Brown, C. and Dey, A.K.1955. Indian Mineral Wealth. Oxford Univ.

TB2: Umeshwar Prasad, 2003. Economic Geology. CBS Publishers and distributors.

Reference Books:

RB1: Krishnaswamy, S., 1979.India's Minerals Resources. Oxford and IBH Publ.

RB2: Sharma, N.L. and Ram, K.V.S., 1972. Introduction to India's Economic Minerals, Dhanbad.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Learn and Gain knowledge of basic principles of economic geology, Processes of formation of ore deposits, metallic minerals, coal, petroleum.
CO2	Understand the economic value of the ores.
CO3	Explain the formation of ore deposits.
CO4	Analyze Demand and supply of ores and Mineral conservation.
CO5	Distinguish between various ore deposits of India.
CO6	Write the concept of metallic and non-metallic minerals.

Course code : GELDL 602				
Course Name : Lab Course based on GELDC 601				
Semester /Year : VI				
	L	T	P	C
	0	0	2	1

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1.To analyze the Ore samples.

2.To learn about the preparation of Ore map.

Course Contents

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.

Text Books:

TB 1: Umeshwar Prasad, 2003. Economic Geology. CBS Publishers and distributors.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Gain Knowledge of samples of ore deposits.
CO2	Understand the distribution of minerals in India.
CO3	Prepare of maps showing distribution of important metallic and non-metallic deposits in India.
CO4	Analyze the samples of economic minerals.
CO5	Compare the different ore minerals.
CO6	Prepare the map of showing important coal and oil fields of India.

Semester -VII

Course code	**: GELDC 701**				
Course Name	**: Advanced Structural Geology**				
Semester /Year	**: VII**				
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. The present course will teach the student how to unravel the underlying deformation processes and mechanisms through an accurate geometric and kinematic analysis of these natural structures.

2. The present course will teach the dynamic instability of the lithosphere, continuous and discontinuous deformation takes place within the rocks in solid or semi-solid state, at different scales, which manifests in a variety of complex structures in these rocks.

Course Content:

Unit1: Definition and scope of structural geology, properties of rocks and factors affecting the behavior of rocks.

Unit2: Theory of stress and strain, Mohr's Circles, strain, and stress ellipsoids.

Unit3: Geometry and Classification of fold & Mechanics of folding, Flexure fold; flexural slip folds, flexural flow folds, passive folds, and distribution of strains in folds.

Unit4: Geometry, Causes and dynamics of faulting: Strike-slip Faults, Normal Faults, Thrust Faults; joints, foliations, unconformities.

Text Books:

TB1: Ghosh, S.K.: Structural Geology, Fundamental and Modern Concepts, Pergamon Press.
TB2: Ramsay J.G. (1967): Folding and fracturing of Rocks, McGraw Hill Pub.
TB3. Ramsay J.G. & Huber, M. I. (1983): The Techniques of Modern Structural Geology-I, Strain Analysis, Academic Press.

Reference Books:

RB1: Turner, F.J.& Weiss, L. E. (1963): Structural analysis of Metamorphic Tectonites, McGraw Hill publ.
RB2: Jain, A, K, advance structural analysis, Nemchand and bros

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	To gain the knowledge and accurate geometric description of the structures observed in natural deformed rocks.
CO2	To understand the basic scope of structural geology, properties of rocks and factors affecting the behavior of rocks.
CO3	To classify the fold, fault, joints and unconformities and other structures
CO4	To analyze kinematics of deformation, theory of stress, strain and stress ellipsoids
CO5	To estimate Strain marker and Measurement of strain in deformed rocks the stresses when rocks go under the deformation by using Mohr's circle
CO6	Write about the Basic idea about petrofabrics and use of Universal stage, cleavage, lineation

Course code	**: GELDL702**				
Course Name	**: Lab Course based on GELDC701**				
Semester /Year	**: VII**				
		L	**T**	**P**	**C**
				2	**1**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To understand the structural problems, Preparation and interpretation of geological maps and sections.

Course Content:

Structural Geology

- Preparation and interpretation of geological maps and sections.
- Structural problems.

Text Books:

TB1. Guhey Rajeev, Geology: Principles and Practical Manual, New India Publishing Agency- Nipa

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	To gain the knowledge of deformation in rocks.
CO2	To understand and preparation and interpretation of geological maps and sections.

CO3	To Understand the concept of folding and faulting.
CO4	To Draw stereographic projection.
CO5	Calculate the strain data from deformed object.
CO6	Preparation of geological cross section on different scales (1:25,000, 50,000 & 1:50,000).

Semester -VIII

Course code	**: GELDC 801**				
Course Name	**: Geotectonics**				
Semester /Year	**: VIII**				
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. The objective of this course is to understand the basic concept of continental drift and supporting evidences, Geomagnetic fields, palaeo-magnatism, polar wander, geomagnetic pole reversal, sea floor spreading.

2. The objective of this course is to understand the basic concept of Plate boundaries, plate motion and dynamics.

3. The objective of this course is to understand the basic concept of Relative plate motion -geodetic measurement, seismology, internal structure of the earth and to understand the geodynamics of Indian plate and evolution of Himalayas

Course Content:

Unit1: Evidence of continental drift, mechanics, objections and present status, Concept of Plate Tectonics.

Unit2: Major tectonic features of the oceanic and continental crust, island arcs, oceanic islands and volcanic arcs, Gravity and magnetic anomalies at mid oceanic ridges, Trenches.

Unit3: Seismic belts of the earth & seismicity and mountain chains, their global distribution and evolution.

Unit4: Sea floor spreading, Palaeo-magnetism, Polar Wandering and reversal of earth's magnetic field.

Text Books:

TB1: Condie Kent, C. (1989): Plate Tectonics and Crustal Evolution.

TB2: W. J. Kious & Robert I.T.: The dynamic of Earth: the story of Plate Tectonics USGS publ.

TB3: Moores, E. & Twiss, R.J.,1995: Tectonics. Freeman publ.

Reference Books:

RB1: Keary, P.&Vine,F. J.1990: Global Tectonics. Blackwell scientific publ.
RB2: Storetvedt, K.N.1997: Our Evolving Planet. Earth History in new perspective.
RB3: Valdiya, K.S.1998: Dynamic Himalaya. Univ. Press.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	To gain the knowledge of the dynamic nature of the Earth processes,
CO2	To understand about the geodynamics of the lithosphere and concept of isostasy, ocean floor spreading, continental drift, plate tectonics.
CO3	To classify the present geophysical and geological evidence for the processes operating in modern tectonic systems
CO4	Distinguished between the major continental features and oceanic features and other tectonic features
CO5	Explain about the seismicity and their global distribution on earths and geodynamics of Indian plate
CO6	Write about the Palaeo magnetism and paleo magnetic maps, polar wandering curve.

Course code	**: GELDL802**				
Course Name	**: Lab Course based : GELDC801**				
Semester /Year	**: VIII**				
		L	**T**	**P**	**C**
		0	**0**	**2**	**1**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are
1. This course will provide the basic understanding of stereographic projection by using the field data.

Course Content:

Geotectonics

- Stereographic presentation of structural data
- Preparation of Stereographic projection.

Text Books:

TB1. Guhey Rajeev, Geology: Principles and Practical Manual, New India Publishing Agency- Nipa

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	To gain the knowledge of plate motion
CO2	To understand the concept of plate tectonics
CO3	To classify different plate boundaries.
CO4	Learn deformation structure in different outcrops.
CO5	Draw the Stereographic presentation of structural data,
CO6	To develop the projection.

Generic Elective Courses

Semester I

Course code	:	**GELGE103**			
Course Name	:	**Geohydrology**			
Semester /Year	:	**I**			
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. The student is introduced to the basic principles of hydrology.

2. To teach the vertical distribution of groundwater, Surface and subsurface geophysical and geological methods of groundwater.

Course Contents

Unit I: Introduction and scope of hydrology, source of water, Hydrologic cycle.

Unit II: Vertical distribution of ground water, Erosion, transportation and depositional features of groundwater.

Unit III: Aquifers and their types, Darcy law of groundwater motion, Erosion, transportation and depositional features of groundwater, water table, Specific Yield and Specific retention.

Unit IV: Surface and sub-surface methods of ground water exploration.

Text Books:

TB1: Todd. D.K, ground water hydrology, wiley pub.

Reference Books:

RB1: Karanth, K. R., 1989. Hydrogeology. Tata Mc Graw Hill Publ.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Learn and Gain knowledge of basic principles of Hydrology, Hydrological cycle, hydrological parameters, origin of earth, geophysical and geological methods of groundwater.
CO2	Understand the Hydrological cycle, origin of groundwater, geophysical methods.
CO3	Explain the water bearing properties of rocks, vertical distribution of groundwater.

CO4	Analyze the concept of surface and subsurface water flow.
CO5	Distinguish between among Aquifers.
CO6	Derive the Darcy's Law; write about geophysical methods, groundwater conditions.

Semester II

Course code	:	**GELGE203**			
Course Name	:	**Climatology**			
Semester /Year	:	**II**			
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1.The student is introduced to the basic principles of Climatology.

2. To teach the cyclone, Anti cyclone, Global warming and climate change.

Course Contents

Unit 1 Definition, nature, scope and branches of climatology, Concept and elements of weather and climate, Composition and structure of atmosphere, lapse rate, vertical and horizontal distribution of temperature.

Unit 2. Earth surface wind system: Doldrums, trade wind belt, prevailing westerlies, polar easterlies, Heat budget, green house effects.

Unit 3 Atmospheric moisture: Humidity and its types, Latent heat, Hydrological cycle, Condensation and its forms, precipitation, and its types.

Unit 4 Cyclones: tropical and temperate, Anti-cyclones and tornados, Global warming, climatic changes through geological time.

Text Books:

TB1: Oliver, J. E. (1993): Climatology: An Atmospheric Science, Pearson Education India, New Delhi.

TB2: Lal D.S. (1997): Climatology; Sharda Pustak Bhavan; Allahabad.

Reference Books:

RB1: Lal D.S. (1997): Climatology; Sharda Pustak Bhavan; Allahabad

RB2: Mather, J. R. (1974): Climatology: Fundamentals and Applications; Mc Craw Hill Book Co., U.S.A.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Learn and Gain knowledge of basic principles of climatology, weather, climate, atmosphere, monsoon, global warming, cyclones and anticyclones.
CO2	Understand the elements of weather and climate, Composition and structure of atmosphere, distribution of air pressure and monsoon.
CO3	Explain the concept of climate change, Cyclone and Anti-cyclone, types of wind, concept of humidity.
CO4	Analyze the concept of surface circulation and concept of mixed layers, Vertical and horizontal distribution of temperature, Anti-cyclones and tornados, Indian monsoon.
CO5	Distinguish between among Cyclones, Anti-cyclones and tornados, Condensation and precipitation, elements of weather and climate.
CO6	Write about Monsoon, types of wind, distribution of temperature, climate change.

Semester III

Course code	:	**GELGE303**			
Course Name	:	**Oceanography**			
Semester /Year	:	**III**			
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1.The student is introduced to the basic principles of Oceanography.

2. To teach the properties of sea water, deep ocean circulation.

Course Contents

Unit: 1 Ocean Floor topography and terminology- Continental Shelf, Continental Slope, Continental Margin, Continental Rise, Submarine Canyons, Mid ocean Ridges, Trenches, and Abyssal Plains.

Unit: 2 Definition and terms, Wave theories, Classification; progressive wave, shallow water

wave, Seismic Sea wave, wind wave, stationary wave, deep and shallow water wave, tide, and types of tides.

Unit: 3 Salinity and chlorinity; temperature; physical properties of sea water, density, conductivity, viscosity, heat budget and residence time of constituents in sea water.

Unit: 4 Ocean circulation, Thermocline and Pycnocline, concept of upwelling, El Nino and deep Ocean circulation.

Text Books:

TB1: David Tolmazin (1985). Elements of Dynamic Oceanography, Allen and Unwin.

TB2: Grant Gross, M. (1977). Oceanography; A view of the Earth, Prentice Hall.

Reference Books:

RB1: Keith Sverdrup et al: Fundamental of Oceanography.
RB2: Alan Trujilo & Harold V. Thurman: Essential of Oceanography.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Learn and Gain knowledge of basic principles of Oceanology, properties of seawater, El Nino and deep Ocean circulation.
CO2	Understand the Methods of measuring properties of seawater, ocean floor topography, residence time in sea water, thermal properties of sea water.
CO3	Explain the concept of El Nino and deep Ocean circulation, wave theories.
CO4	Analyze how our understanding of plate tectonics and evolution of earth comes from the study of the oceans.
CO5	Explain the major physical and chemical properties of sea water, concept of mixed layer, concept of upwelling.
CO6	Write the concept of El Nino, deep Ocean circulation, Wave theories and its classification, Salinity and chlorinity.

Semester IV

Course code	**: GELGE403**				
Course Name	**: Environmental Geology**				
Semester /Year	**: IV**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. The main objective to understand the interaction of humans with the geological environment, familiarize students of challenges of environmental geology in the urban environment, and teach practical contribution that geologists can make in managing human interaction with the physical environment.

Course Content:

Unit: 1 Definition; History of Environmental Geology; Fundamental concept of earth system, Global warming, Ozone, Acid rain and Air pollution.

Unit: 2 Landslide and its types, causes and prevention measures.

Unit: 3 Hazardous Earth Processes: Volcanism, Earthquake, Floods.

Unit: 4 Environmental Geology: an urban concept: Urban Environments; Urban planning and geology.

Text Books:

TB1. Environmental Geology: Geology and the Human Environment by Bennett and Doyle by Wiley Publications

TB2. Environmental Geology by Jim Reichard by McGraw Hill

TB3. Environmental Science by Botkin and Keller by Wiley Publications

Reference Books:

RB1. Environmental Geology: Geology and the Human Environment by Bennett and Doyle by Wiley Publications

RB2. Environmental Geology by Jim Reichard by McGraw Hill

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	To gain the knowledge and recognition of natural hazards and mitigation of their human impacts to understand and learn the concepts of environmental geology,
CO2	To understand and learn the managing geological resources,
CO3	To understand and learn the appropriate use of the geological environment for waste disposal
CO4	To classify the natural hazards and mitigation, their human impacts.
CO5	Write about the water and pollution waste managements.
CO6	Develop an urban concept: Urban Environments; Urban planning and geology

Semester V

Course code	**: GELGE 503**				
Course Name	**: Fuel Geology**				
Semester /Year	**: V**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To understand the concept of Fuel Formation.
2. To learn about the Use of Fuel in industry and economy.

Course Content

Unit I: Introduction: Sources of energy, Indian scenario, elementary idea of solar and wind energy and hydrogen sources of energy.

Unit II: Coal Geology: Introduction and basic idea of origin of coal, Biochemical and dynamo-chemical changes in coal formation, Macroscopic constituents. Lignite, coal bed methane distribution of coal and lignite in India.,

Unit III: Petroleum Geology: physical properties of petroleum, Origin of Petroleum; Kerogen and their types. Petroleum traps, Basic idea of source rock, reservoir rock and cap rocks. Distribution of petroleum and natural gas in India.

Text Books:

TB1: Barker, C. (1996): Thermal Modeling of Petroleum Generation, Elsevier Science.

TB2: Jahn, F., Cook, M. and Graham, M. (1998): Hydrocarbon Exploration and Production, Elsevier Science.

TB3: Makhous, M. (2000): The Formation of Hydrocarbon Deposits in North African Basins, Geological and Geochemical Conditions, Springer-Verlag.
TB4: North, F.K. (1985): Petroleum Geology, Allen Unwin. Selley, R.C. (1998): Elements of petroleum geology, Academic Press.

Course outcome (CO'S):

Upon successful completion of the course a student will be able to

CO 1	To gain the knowledge in different aspect of the field of fuel formation.
CO 2	To gain knowledge and understand the various fossil fuels including coal petroleum and gas regarding their formation and mode of occurrence.
CO 3	To apply the knowledge in the field of oil prospecting and exploration techniques.
CO 4	To understand the concept of exploration techniques of radioactive minerals and distinguished from the oil exploration.
CO 5	To understand the process will also help students to enhance their knowledge about nuclear energy.
CO 6	To compare and write the sources form base for a country's development so it will be beneficial for the students as they can contribute for its development by choosing a carrier related to fuel energy

Semester VI

Course code	**: GELGE 603**			
Course Name	**: Quaternary Geology**			
Semester /Year	**: VI**			
L	**T**	**P**	**C**	
4	**0**	**0**	**4**	

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives :The objectives of this course are

1. To understand the Quaternary deformation.

2.To learn about the deposition and its relation with climate and tectonics.

Course Contents

Unit-1 Importance of Quaternary period and location of Quaternary basin. Responses of geomorphic systems to climate, sea level and tectonics on variable time scales in the Quaternary.

Unit-2 Proxy indicators of paleoenvironmental/' paleoclimatic changes, Basic concept of biostratigraphy and magneto stratigraphy. Quaternary climates glacial interglacial cycles.

Unit 3 Introduction to Quaternary dating methods, Quaternary stratigraphy of India); continental-marine correlation of Quaternary record.

Unit 4 Indo-Gangetic Plain, Himalayan glaciations. Climate change and global warming; neotectonics.

Text Books:

TB 1: D. Q. Bowen, 1978: Quaternary Geology, Pergamon

TB 2 • R. F. Flint, 1971: Glacial and Quaternary geology

TB 3 • A.G. Dawson, 1992, Ice age earth. Late quaternary geology and climate. Routledge, London

TB 4 • Griffith Taylo, 2008: History of Geomorphology and Quaternary Geology

Course outcome (CO'S):
Upon successful completion of the course a student will be able to

CO 1	To gain the knowledge in different aspect of Quaternary.
CO 2	To learn and understand the processes involve in the quaternary tectonics.
CO 3	To apply the knowledge in the field of tectonics and climate interplay
CO 4	To understand the concept of quaternary deformation.
CO 5	To understand the process of sedimentation and climatic factors.
CO 6	To compare and write the Quaternary geology with climate and tectonics.

Skill Enhancement Courses

Semester I

Course code	:	**GEL SC105**			
Course Name	:	**Field Geology**			
Semester /Year	:	**I**			
		L	**T**	**P**	**C**
		2	**0**	**0**	**2**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To Provide basic knowledge of surveying techniques.
2. To upgrade and relate the theoretical knowledge of Geological aspects to field observations.
3. Learn to plan for a geology field trip.

Course Contents

Unit 1 Definition and scope of Field Geology – Prior planning – Basic equipment required for field work – Types of field investigations. Field work objectives.

Unit II: Studying the geologic maps, understanding the interaction between topography and geologic structures.

Unit III: Basics and types of field data collection, analyses, interpretation, and geological report writing.

Text Books:

TB1: Lahee, F (1987). Field Geology, CBS Publishers, New Delhi.

TB2: Gokhale, N.W. (2001). A Guide to Field Geology. CBS Publishers, New Delhi

Reference Books:

RB1: McClay, K.R. (2003) The Mapping of Geological Structures, 2nd ed., John Wiley & Sons Ltd, New Delhi.

RB2: Barnes, J.W. (2004). Basic Geological Mapping. John Wiley & Sons Inc., New Delhi.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Learn and Gains knowledge into the methods of geological mapping and can gain expertise by proper practice.
CO2	Understand Rock outcrop.
CO3	Use of field note book and information on personal safety and camping.

CO4	Analyze the rock samples in field.
CO5	Measure the dip direction and dip strike from the clinometer compass.
CO6	Prepare field geological reports.

Semester II

Course code	:	**GEL SC205**			
Course Name	:	**Remote Sensing and GIS**			
Semester /Year	:	**II**			
		L	**T**	**P**	**C**
		2	**0**	**0**	**2**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1.To learnremote sensing principles, purposes, advantages and limitations.
2. The basic concepts of image production, processing and interpretations are covered.
3. To learn about GIS component.

Course Contents

Unit 1 Elementary idea about photogeology: electro-magnetic spectrum, types & geometry of aerial photo graphs; factors affecting aerial photography.

Unit 2 Fundamentals of remote sensing; remote sensing systems; remote sensing sensors; Application of remote sensing in geosciences and geomorphological studies.

.**Unit 3** Introduction to Geographic Information System (GIS); components of GIS; product generation in GIS; tools for map analysis; integration of GIS with remote sensing.

Text Books:

TB1: Bhatta, B.,2008. Remote Sensing and GIS. Oxford, New Delhi.

TB2: Pandey, S.N.,1987. Principles and Application of Photo geology. Wiley Eastern, New Delhi.

Reference Books:

RB1: Siegel, B.S. and Gillespie, A.R.,1980. Remote Sensing in Geology. John Wiley.

RB2: Gupta, R.P.,1990. Remote Sensing Geology. Springer Verlag.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Learn and Gain Knowledge of Remote sensing and GIS.
CO2	To understand the interpretation of photography, component of GIS, Digital Image processing.
CO3	Use of Remote Sensing in various field, Explain the concept of aerial photography, tools used in GIS.
CO4	Analyze various physiographical features through GIS, explain factors affecting aerial photography; types of camera.
CO5	Evaluate the data with the help of satellites Images, Application of remote sensing.
CO6	Write the GIS concept, remote sensing sensor.

Semester III

Course code	:	**GELSC305**			
Course Name	:	**Geological Field**			
Semester /Year	:	**III**			
		L	**T**	**P**	**C**
		2	**0**	**0**	**2**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To Provide basic knowledge of surveying techniques.

2. To upgrade and relate the theoretical knowledge of Geological aspects to field observations.

3. Learn to plan for a geology field trip.

Course Contents

The paper will be based on training on geological field, and various instruments used in geological analysis. During fieldwork the students will be exposed to terrains of different geological characteristics, different types of mines, natural resource exploration sites, various types of geohazard sites. Students will prepare geological reports based on their training, which will be evaluated for the marking.

Text Books:

TB1: Lahee, F (1987). Field Geology, CBS Publishers, New Delhi.

TB2: Gokhale, N.W. (2001). A Guide to Field Geology. CBS Publishers, New Delhi

Reference Books:

RB1: McClay, K.R. (2003) The Mapping of Geological Structures, 2nd ed., John Wiley & Sons Ltd, New Delhi.

RB2: Barnes, J.W. (2004). Basic Geological Mapping. John Wiley & Sons Inc., New Delhi.

Course

Upon successful completion of the course a student will be able to

CO1	Learn and Gains knowledge into the methods of geological mapping and can gain expertise by proper practice.
CO2	Understand Rock outcrop.
CO3	Use of field note book and information on personal safety and camping.
CO4	Analyze the rock samples in field.
CO5	Measure the dip direction and dip strike from the clinometer compass.
CO6	Prepare field geological reports

Semester IV

Course code : GELSC405				
Course Name : Laboratory techniques in Geology				
Semester /Year : IV				
	L	**T**	**P**	**C**
	2	**0**	**0**	**2**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To Provide basic knowledge of surveying techniques.
2. To upgrade and relate the theoretical knowledge of Geological aspects to field observations.
3. Learn to plan for a geology field trip.

Course Contents

Unit 1: Definition and scope of Field Geology, Basic equipment required for field work, Types of field investigations, Preparation of topographic maps: parts, symbols, and other information, relief, contours, slope, gradients, profiles and sections.

Unit 2: Field geological report: parts and preparation. Geological and topographic map symbols. Brief introduction of field indicators used in geological mapping: geomorphological, weathering,

mineral composition and petrography. Geological materials: types of samples – mineral, ore, fossil, rock. Methods of sampling -care and packing of samples in the field. outline of preparation of thin sections of geological samples, draw stereographic projection.

Text Books:

TB1: Lahee, F (1987). Field Geology, CBS Publishers, New Delhi.

TB2: Gokhale, N.W. (2001). A Guide to Field Geology. CBS Publishers, New Delhi

Reference Books:

RB1: McClay, K.R. (2003) The Mapping of Geological Structures, 2nd ed., John Wiley & Sons Ltd, New Delhi.

RB2: Barnes, J.W. (2004). Basic Geological Mapping. John Wiley & Sons Inc., New Delhi.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Learn and Gains knowledge into the methods of geological mapping and can gain expertise by proper practice.
CO2	Understand Rock outcrop.
CO3	Use of field note book and information on personal safety and camping.
CO4	Analyze the rock samples in field.
CO5	Measure the dip direction and dip strike from the clinometer compass.
CO6	Prepare field geological reports

Discipline Specific Elective Courses
Semester V

Course code	:	**GELDE 504**			
Course Name	:	**Geochemistry**			
Semester /Year	:	**V**			
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1.This course is designed to understand high-T and low-T geochemical processes that operate in the earth's deeper and near-surface environments

2. The major task of geochemists is to know the physical and chemical laws governing the abundance, distribution and migration of chemical elements from one sphere to another sphere of the Earth i.e. chemical differentiation of the Earth

Content

Unit 1: Composition of Earth and its constituents (Crust, mantle and core); Ionic and co-ordination number; Rules of ionic substitution, coupled substitution; Distribution coefficient: Capture admission and camouflage, Geochemical classification of elements; Behavior of major and trace including rare earth elements during magmatic crystallization.

Unit 2: Near-Earth surface geochemical environment: Eh pH diagram; Principle of chemical mass balance and rock-cycle; Chemical weathering of minerals and rocks.

Unit 3: Introduction of Stable isotopes geochemistry, Fission Track (FT) and OSL dating techniques.

Text Books:

TB1: Allegre, C.J. and Michard, G. (1974). Introduction to Geochemistry, Reidel, Holland.

TB2: Evans, R. C. (1964). Introduction to Crystal Chemistry, Cambridge Univ. Press.

Reference Books:

RB1: Faure, G. (1986). Principles of Isotope Geology,2nd Edn., John Wiley.

RB2: Misra, K. C. (2012). Introduction to Geochemistry: Principles and Applications, Wiley-Blackwell.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Learn and Gain Knowledge of the basic concept of the Geochemistry and Geochronology, Structure of earth, geochemistry of earth, geochemical behavior of different elements, Stable isotopes geochemistry.
CO2	Discuss the geochemical classification of elements, Major, minor and trace and elements.
CO3	Explain element partitioning in minerals and rocks. and Radiactive isotopes.
CO4	Idea about Fission Track (FT) and OSL dating techniques; Dendrochronology and Lichenometry
CO5	Distinguish between the different Layer of Earth, chemical weathering of mineral and rocks.
CO6	Write the chemical composition characteristics of the Earth,

Semester VI

Course code : GELDE 604				
Course Name : Sedimentology				
Semester /Year : VI				
	L	**T**	**P**	**C**
	3	**1**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are:

The course in-depth knowledge about the types and origin of sedimentary rocks, and source-to-sink sedimentary processes. It emphasizes upon the modern concepts of paleoenvironmental analysis, as well as provenance determination of sedimentary rocks. The course content deals with all the essential aspects required in exploring oil and natural gas, underground water, mechanically concentrated mineral deposits (placer deposits), and building stones

Course Contents

Unit 1: Introduction of Sedimentology and its uses, Sedimentary texture, and textural parameters and their significance, sediment transport, bedforms and sedimentary structures. Allogenic and autogenic controls on sedimentation. Paleocurrent analysis and its significance

Unit 2: Basic Concept of sedimentary facies, Classification of Sedimentary rock.

Unit 3: Types, classification and petrogenesis of common sedimentary rocks, Evaporites: Gypsum and anhydrite, Diagenesis- physical and chemical processes, Provenance of sedimentary rocks.

Text Books:

TB1: Blatt, H., Middleton, G.V. and Murray, R.C. (1980). Origin of sedimentary rocks. Prentice Hall Inc.
TB2: Collins, J.D. and Thompson, D.B. (1982). Sedimentary structures. George Allen and Unwin, London

Reference Books:

RB1: Pettijohn, F.J. (1975). Sedimentary rocks (3rd Ed), Harper and Row Publ., New Delhi.

RB2: Lindholm, R.C. (1987). A practical approach to sedimentology. Allen and Unwin, London

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Gain knowledge about the types and origin of sedimentary rocks, and source-to-sink sedimentary processes, facies, petrography.
CO2	Understand the modern concepts of Palaeoenvironmental analysis, as well as provenance determination of sedimentary rocks, sedimentary texture.
CO3	Apply the petrography detail on the identification of sandstone, sedimentary facies concept identification of environment.
CO4	Differentiate among limestones and dolomites. Evaporites: Gypsum and anhydrite, Allogenic and autogenic controls on sedimentation.
CO5	On the bases of environment measures different facies, structures, and texture.
CO6	Write the concept of Palaeocurrent analysis and its significance, Digenesis process.

Semester VII

Course code	**: GELDE 703**				
Course Name	**: Advanced Mineralogy**				
Semester /Year	**: VII**				
	L	**T**	**P**	**C**	
	3	**1**	**0**	**4**	

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. The present course will teach the characteristics of major rock forming mineral groups, crystal symmetry, and crystallography axis.
2. The present course will teach the atomic structure, formation environments and associations of rock-forming minerals.

3. The present course will teach the techniques of mineral characterization.

Course Content:

Unit1: structures and types of atoms, types of chemical bonding, chemical properties of minerals.

Unit2: Structures and classification of Silicates, Physical properties of minerals.

Unit3:-A detail study of important silicates with reference to general and structure formulae, classification, atomic structures, chemistry including substitution of element and mode of occurrence of Neosilicates/orthosilicates, Sorosilicate, Cyclosilicate, Inosilicate, Phyllosilicate, Tectosilicate.

Unit 4:- Properties of uniaxial and biaxial minerals.

Text Books:

TB1. Moorhouse, W. W.: Optical Mineralogy.
TB2. Dana, E. S. &Ford, W. E.: A Textbook of Mineralogy, Wiley Eastern Ltd.
TB3. Phillips, W. R & Guffen, D. T- Optical mineralogy.
TB4. Barry & Mason- Mineralogy.

Reference Books:

RB1. Dexter Perkin, optical mineralogy
RB2. Alexander N. Winchill, Element of optical mineralogy, ulan press pub.
RB3. Babu. S. K and Snha. D.K ,Mineralogy, CBS pub

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Learn and Gain knowledge of chemical bonding, types of atom, and properties of minerals, different silicate structure, uniaxial and biaxial crystal.
CO2	Understand Properties of uniaxial and biaxial crystal
CO3	Explain structure of silicates.
CO4	Classify Silicate, and Explain the different properties of minerals.
CO5	Distinguish among different properties of minerals.
CO6	Compose structure of various silicates.

Course code	**:**	**GELDE 704**			
Course Name	**:**	**Engineering and Disaster Management**			
Semester /Year	**:**	**VII**			
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To learn about the basic principles of Engineering geology and disaster.

2.To understand the site selection of Dams, Tunnels and bridge:

3. To learn about the process and prevention measures of disaster concept.

Course Contents

Unit 1 Engineering properties of rocks and Soils, Dam, Types, geological and environmental considerations.

Unit 2 Tunnel and Bridge definition, terminology, types, geological investigation and problems.

Unit 3 Introduction to disaster and its management, classification of disasters- natural, manmade; difference between disaster and hazard- atmospheric and geo- hazards, Disaster risk, Vulnerability.

Unit 4 Landslides: definition – terminology – classification. Causes of landslides, and precautionary measures.

Text Books:

TB1: Krynine D.P. and Judd W.R., 1957. Principles of Engineering Geology & Geotechnics. McGraw-Hill Book.

TB2: Radhakrishnan,V. (1996). General Geology, V.V.P. Publishers, Tuticorin.

TB3: Kesavulu, N.C., 2009. A text book of engineering geology. Macmillan P publishing India Ltd.

Reference Books:

RB1 :. Mahapatra, G.P. (1994). Physical Geology, CBS Publishers, New Delhi.
RB2: Crozier. M.J., 1989.Landslides: causes, consequences and environment. Academic Press.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Gain Knowledge of the basic principles of Engineering geology and disaster.
CO2	Understand Engineering properties of rocks, selection of Dam, tunnel and bridge.
CO3	Explain the concept of Earthquake, landslide.
CO4	Analyze influence of geological conditions on various engineering structures
CO5	Awareness of natural disasters for future safety measures and preparedness
CO6	Solve the problems based on dam and tunnel.

Course code : GELDE705				
Course Name : Research Methodology				
Semester : VII				
L	**T**	**P**	**C**	
3	**1**	**0**	**4**	

Course Objectives: The objectives of this course are

1. To introduce with meaning, functions of research and research process.
2. To highlights the various postulates of research problems, research Design, interpretation and report writing.
3. To expose the student to concepts of measure of central tendency and variation and their application to analyze the statistical data.
4. To acquire the knowledge of correlation, regression, data analysis and hypothesis testing using suitable test of statistical significance.

Unit-I: Meaning &Functions of Research

Meaning of Research, Characteristics of Research, Steps involved in Research, Research in Pure and Applied Sciences, Inter Disciplinary Research, Trans disciplinary research, Significance of Research, Research and scientific methods, Research Process, Criteria of good Research, Problems encountered by Researchers, Literature review.

Unit –II: Research Problem and Research Design

Selecting the Research problem, Necessity of defining the problem, Goals and Criteria for identifying problems for research, Perception of Research problem, Formulation of Research design, Need for Research design, Features of good design, Basic principles of experimental designs, Computer and internet in designs.

Unit- III: Interpretation and Report Writing

Meaning and Technique of interpretation, Precautions in interpretation, Significance of report writing, Different steps in writing a report, Layout of a Research report, Types of report, Mechanics of writing a research report, Precautions for writing a research report

Unit-iv: Statistical Techniques and Tools -I

Introduction of statistics, frequency distribution, Graphical representation of data, Measures of central tendency, Mean, Median, Mode, Standard deviation, Co-efficient of variation, Probability & distribution

Unit-v: Statistical Techniques and Tools –II

Correlation, coefficient of correlation, Scatter diagram, Regression, Sampling distribution, Standard error, Hypothesis testing, Level of significance, Degree of freedom, Chi Square, T-test, Analysis of variance (ANOVA)

Suggested readings:

1. Kothari C. R, Research Methodology Methods & Techniques, New Age international Publishers.
2. Gupta G. and Gupta M., Research Methodology, PHI Learning Private Ltd.
3. Gupta S.C. and Kapoor V.K., Fundamentals of Mathematical statistics, , Sultan Chand & Sons, New Delhi.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1.	Define various kind of research, objectives of doing research, research process and research design.
CO2.	Discuss the ability to choose methods appropriate to research aims and objectives.
CO3.	Explain analyse data and draw reasonable interpretations as well as communicate research findings in a clear and well-organized way.
CO4.	Explain Statistical tools and techniques to carry out data analysis and hypothesis testing using suitable test of statistical significance.
CO5.	Summarize the properties of mechanism of research methodology
CO6.	Create a research methodology

Course code	**: GELDE 706**				
Course Name	**: Geological Field**				
Semester /Year	**: VII**				
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To Provide basic knowledge of surveying techniques.
2. To upgrade and relate the theoretical knowledge of Geological aspects to field observations.
3. Learn to plan for a geological field trip.

Course Content:

Students will be required to visit geologically important areas including mines, dams, oilfields, fossiliferous sequences and laboratories/institutes of repute and submit a report thereon, under the supervision of a faculty member.

Text Books:

TB1: Mathur S.M., Guide To Field Geology

TB2: Gokhale N.W., A Guide to Field Geology

Reference Books:

RB1: Mathur S.M., Guide To Field Geology

RB2: Gokhale N.W., A Guide to Field Geology

Course outcomes (COs):

Upon successful completion of the course a student will be able:

CO1	The course is intended to expose students to any economic deposit, familiarize them about host rock and economic mineral relationship, variable geometry of ore bodies.
CO2	To understand the planning of exploration and exploitation, Open and/or underground mine- section.
CO3	To apply the knowledge of geology to identify the structures and microstructures in the field
CO4	To analyze the fundamentals, work on the field.
CO5	To estimate the collected data from the field.
CO6	To develop skills for the writing of the tour report.

Semester VIII

Course code	**: GELDE803**				
Course Name	**: Igneous Petrology**				
Semester /Year	**: VIII**				
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. This is an introductory course to provide a basic understanding of the different groups of igneous rocks and the processes involved in their formation.

2. This course starts with the chemistry and physics of melts and their behavior under varying temperature and pressure conditions, and goes on to discuss the different kinds of igneous rocks and rock suites that form under different tectonic conditions.

3. The focus broadens to the formation of the solar system, the Earth, and the elements themselves. Then the composition of the Earth itself becomes the topic, examining the composition of the core, the mantle, and the crust and exploring how this structure originated.

Course content:

Unit1: Magmatic processes: fractional crystallization, magma mixing, crystal setting, liquid immiscibility, assimilation, differentiation, and effects, magmatic crystallization – Bowens reaction principle.

Unit2: Gibbs phase rule–definition of phase, component and degree of freedom, application of Phase rule in bi-component and tricomponent magma. The Phase equilibrium of binary (Ab-An, Ab-Or, Di-An), ternary magma (An-Al-Di system and An- Di – Fo, system).

Unit3: Texture and structures, IUGS classification of the volcanic and plutonic Igneous rocks, and ophiolite

Unit4: Petrogenesis and petrography of the following rocks: -Aplite, Anorthosite, Andesite, Basalt, Carbonatite, Charnockite, Diorite, Dunite, Dolerite, Gabbro, Granite, Granodiorite, Kimberlite, Komatiite, Lamprophyre, Pegmatite, Peridotite, Syenite, Trachyte.

Text Books:

TB1. Gupta , A.K.(1998): Igneous Rocks Allied Publishers Ltd. New Delhi.

TB2. Jackson: Textbook of lithology.

TB3. McBirney, A. R. (1984): Igneous Petrology, Freeman Cooper & Co. California.

Reference Books:

RB1. Bose, M. K. (1997): Igneous Petrology, World Press, Kolkata.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Learn and Gain Knowledge of characterize, identify and name different types of rocks in the field and in hand-specimens, and rock-thin sections, and finally they will propose the rock-forming processes.
CO2	Understand the formation, texture, structure of Igneous rocks.
CO3	Explain the use of Petrography of Igneous rocks
CO4	Classify the Igneous rock, Crystallization of uni-component and bi-component (mix-crystals); Bowen's reaction principle
CO5	Distinguish between different types of igneous rocks and application of Gibbs phase rule in Uni component, Bi component, and Tri component system.
CO6	Write the process of magmatism, petrography of igneous rock.

Course code	**: GELDE804**				
Course Name	**: Metamorphic Petrology**				
Semester /Year	**: VIII**				
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

The study of metamorphic rocks encompasses the chemical and physical transformations that take place in response to changing pressure, temperature, and chemical environments in the Earth's interior. In this course, different petro genetic processes involving mineral reactions will be

explored using equilibrium thermodynamics.

Course content:

Unit 1: Introduction of Metamorphic rock, Agents of metamorphic rock, Textures of metamorphic rocks; Deformation and metamorphism.

Unit 2: Types of metamorphism, Law of thermodynamics and Gibbs Equation.

Unit 3 Isograds and Reaction Isograds, Metamorphic differentiation, origin of migmatites, Paired metamorphic belts, Concept of metamorphic facies, Introduction to ACF,AKF and AFM diagrams.

Text Books

TB1. Winter, J. D. (2001): An Introduction to Igneous and Metamorphic Petrology New York.

TB2. Bucher, K. and Martin, F. 2002: Petrogenesis of Metamorphic Rocks, Springer-Verlag,7th Revised Edition.

Reference Books:

RB1. Yardley, B. W. D. 1989: An Introduction to Metamorphic Petrology, Longman scientific &Technical, New York.

RB2. Spry, A.1976: Metamorphic Texture, Pergamon Press.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	Learn and Gain Knowledge of characterize, identify and name different types of rocks in the field and in hand-specimens, and rock-thin sections, and finally they will propose the rock-forming processes.
CO2	Understand types of metamorphism, texture of Metamorphic rock.
CO3	Explain the thermal equilibrium, Facies.
CO4	Classify the Metamorphic rock.
CO5	Distinguish between different types of metamorphic rocks.
CO6	Write the process of metamorphism, agents of metamorphism, petrography of metamorphic rock.

Course code	: GELDE805			
Course Name	: Mineral Exploration and Mining Geology			
Semester /Year	: VIII			
	L	T	P	C
	3	1	0	4

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

Exploration is a range of activities to help determine if there are minerals under the ground. If the exploration process identifies minerals can be commercially extracted, then mining in the future may be possible. Less than one per cent of exploration projects typically progress to establishing a mine. Geology is the first step in mining and involves identifying prospective mineral deposits that might become mines. Geology also helps mine managers know where to develop once the mine is up and running.

Course Content:

Unit1: Prospecting for economic minerals, sampling gas saying and evaluation of mineral deposits, geological and geo-botanical techniques of prospecting.

Unit 2: Gravity method: principle of gravimeters, gravity field surveys, various types of corrections applied to gravity data, Resistivity method: basic principles, various types of electrode configuration, field procedure: profiling and sounding and magnetic, seismic and radioactive methods.

Unit3: Brief outline of well-logging techniques and their methods, Planning, exploration and exploratory mining of surface and underground mineral deposits

Text Books:

TB1. Sinha, R.K. & Sharma, N. L. (1976): Mineral Economics.

TB2. Arogyaswami, R. N. P. (1996): Courses in Mining Geology

Reference Books:

RB1. P.K. Banerjee and S. Ghosh (1997): Elements of prospecting for non-fuel mineral deposits.

RB2. Bagchi, T.C., Sengupta, D.K. & Rao, S. L. V. N. (1979): Elements of Prospecting and Exploration.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO1	To understand the knowledge of selected ore deposit types, including genesis and exploration requirements.
CO2	To understand the prospecting methods and sampling methods and assaying
CO3	To classify the exploration methods and Geochemical & Geobotanical exploration methods
CO4	To differentiate the geophysical methods eg:- gravity, magnetic and seismic methods etc.
CO5	To distinguished between the surface mining methods and underground mining methods
CO6	Write about the mining processes and mining hazards and their impact

Course code : GELDE 806				
Course Name : Research-IPR				
Semester : VIII				
	L	T	P	C
	3	1	0	4

Course Objectives: The objectives of this course are

1. To explain about Intellectual Property and Copyrights
2. To explain about software patents and their importance.
3. To gain knowledge about trade marks
4. To layout design of integrated circuits and Industrial Designs
5. To Illustrate layout design and Different International Agreements.

Course Content:

Unit 1: Introduction to Intellectual Property: Historical Perspective, Different Types of IP, Importance of protecting IP.
Copyrights: Introduction, how to obtain, Differences from Patents.
Unit 2: Trade Marks: Introduction, how to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs.
Patents: Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.
Unit 3: Geographical Indications: Definition, rules for registration, prevention of illegal exploitation, importance to India.

Industrial Designs: Definition, how to obtain, features, international design registration.
Layout design of integrated circuits: Circuit Boards, Integrated Chips, Importance for electronic industry.
Unit 4: Trade Secrets: Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection. World Trade Organization (WTO): (i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement (ii) General Agreement on Trade related Services (GATS), (iii) Madrid Protocol (iv) Berne Convention, (v) Budapest Treaty (b) Paris Convention WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity IP Infringement issue and enforcement-Role of Judiciary, Role of law enforcement Agencies-Police, Customs etc. Economic Value of Intellectual Property – Intangible assets and their valuation, Intellectual Property in the Indian Context – Various laws in India Licensing and technology transfer.

Suggested Readings:

Acharya, N.K.: Textbook on intellectual property rights, Asia Law House.
Guru, M, & Rao, M.B., Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications.
Ganguli, P., Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill.
Miller, A, R, Micheal H. Davis; Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers.
Watal, J., Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford

Course Outcome:

CO1.	Acquire knowledge about Intellectual property rights, copyrights, trademarks, and patents.
CO2.	Appraise about geographical indications, industrial designs, trade secrets and different international agreements including Paris convention, Budapest treaty etc
CO3.	Analyse layout designs of integrated circuits, risks involved in trade secret protection, international design registration, rules for registration of geographical indications etc.
CO4.	Anaylze to Research-IPR. Assess introduction and historical perspectives of trade secrets, working of WTO, Madrid protocol, different type of IPs, trademarks, copyrights etc.
CO5.	Summarize the properties of mechanism of Research-IPR.
CO6.	Create the Research-IPR.