Kurukshetra University, Kurukshetra

(Established by the State Legislature Act XII of 1956)

('A+' Grade, NAAC Accredited)

Scheme of Examinations & Syllabus
of
M.Tech. Applied Geology (5 Year Integrated Course)
I to X semester

Under

Choice Based Credit System (CBCS)
Learning Outcomes-based Curriculum Framework (LOCF)
w.e.f. Session 2020-21 in phased manner

OUTCOME BASED SYLLABUS

M.Tech. APPLIED GEOLOGY COURSE
DURATION OF COURSE - 5 YEARS

VISION

To be globally acknowledged as a distinguished center of academic excellence.

MISSION

To prepare a class of proficient scholars and professionals with ingrained human values and commitment to expand the frontiers of knowledge for the advancement of society.

DEPARTMENT VISION AND MISSION

VISION

To be acknowledged as a distinguished centre for Geoscience education.

MISSION

M1: To provide quality education to aspiring young minds for improving their skills, inculcating values, creating leadership qualities and enhancing research with innovative methods.
M2: To produce young geoscientists capable of being utilized in the areas of new technological design, environment, ethics, and sustainable technologies.
M3: To develop Teaching-Learning methods which can produce socially committed professional human beings who can contribute effectively in Nation building and represent the Country Internationally.

Mapping of University Vision and Mission to Department Vision and Mission

University Vision and Mission	Department Vision and Mission
To be globally acknowledged as a distinguished center of academic excellence.	Yes
To prepare a class of proficient scholars and professionals with ingrained human values and commitment to expand the frontiers of knowledge for the advancement of society.	Yes

Programme Outcomes (POs) with Post Graduate Attributes
Programme outcomes are attributes of the post graduates from the programme that are indicative of the post graduates' ability and competence to work after being a qualified Geologist upon completion of post graduation. Programme outcomes are statements that describe what students are expected to know or do by the time of post graduation, they must relate to knowledge and skills that the students acquire from the programme. The achievement of all outcomes indicates that the student is well prepared to achieve the programme educational

objectives down the road. The department of geology has the following eleven PO's. The course syllabi and the overall curriculum have been designed to achieve these outcomes:

Programme OUTCOMES (POs):

Programme Outcomes (POs) for Post Graduate programmes (CBCS) in the Faculty of Sciences, Kurukshetra University, Kurukshetra

PO1	Knowledge	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study
PO2	Research Aptitude	Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis
PO3	Communication	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large
PO4	Problem Solving	Capability of applying knowledge to solve scientific and other problems
PO5	Individual and Team Work	Capable to learn and work effectively as an individual, and as a member Or leader in diverse teams, in multidisciplinary settings.
PO6	Investigation of Problems	Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
PO7	Modern Tool usage	Ability to use and learn techniques, skills and modern tools for scientific practices
PO8	Science and Society	Ability to apply reasoning to assess the different issues related to Society and the consequent responsibilities relevant to the professional scientific practices
PO9	Life-Long Learning	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
PO10	Ethics	Capability to identity and apply ethical issues related to one's work, avoid unethical behavior such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work
PO11	Project Management	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects

Programme Specific Outcomes (PSO's):

PSO1: Basic understanding of fundamental concepts of geology and applying it on the various natural processes occurring on and inside the earth as a whole system.
PSO2: Clearly formulate and solve real life challenges with respect to human environment interactions.
PSO3: Applications of fundamental principles of geology in finding out various minerals and other natural resources for the betterment of human society.
PSO4: Acquisition of skills to effectively communicate the knowledge of geology to the society for safeguarding the physical environment.

Scheme of examinations & Syllabus

of

M.Tech Applied Geology (5 Year integrated course)

Under CBCS-LOCF Pattern

Semester - I to II

w.e.f 2020-21 in phased manner

Course Code and Definition

for

First Year Scheme

Course Code	Definitions
BS	Basic Science
ES	Engineering Science
HM	Humanities and Social Sciences including Management

Scheme of Examinations of M.Tech. Applied Geology under CBCS-LOCF (I to X Sem.) w.e.f. 2020-21 in phased manner

(Semester - I)

S.No	Course No./ Code	Subject	L:T:P	Hours/ Week	Credits	Examination Schedule (Marks)				Duration of exam (Hours)
						Major Test	Minor Test	Practical	Total	
1A	BS-111	Applied Physics	3:1:0	4	4	75	25	0	100	3
1B	BS-101	Chemistry	3:1:0	4	4	75	25	0	100	3
2A	ES-105	Programming for Problem Solving	3:0:0	3	3	75	25	0	100	3
2B	HM-101	English	2:0:0	2	2	75	25	0	100	3
3	BS-131	Applied Mathematics-I	3:1:0	4	4	75	25	0	100	3
4A	ES-109	Engineering Graphics & Design	1:2:0	3	3	75	25	0	100	3
4B	ES-111L	Manufacturing Processes Workshop	0:0:3	3	1.5	-	40	60	100	3
5A	BS-141	Biology	2:1:0	3	3	75	25	0	100	3
5B	ES-101	Basic Electrical Engineering	4:1:0	5	5	75	25	0	100	3
6A	BS-113L	Applied Physics Lab	0:0:3	3	1.5	--	20	30	50	3
6B	BS-103L	Chemistry Lab	0:0:3	3	1.5	--	20	30	50	3
7A	ES-107L	Programming for Problem Solving Lab	0:0:2	2	1	--	20	30	50	3
7B	ES-103L	Basic Electrical Engineering Lab	0:0:2	2	1	--	20	30	50	3
8A	ES-113L	Engineering Graphics & Design Practice	0:0:3	3	1.5	--	20	30	50	3
8B	HM-103L	Language Lab	0:0:2	2	1	--	20	30	50	3
		Total	12:5:8/ 12:3:10	25/25	21.0/ 20.0	375/ 300	185/ 200	90/ 150	650A/ 650B	

Note: A branch will study either the subjects corresponding to Sr. No. Marked A or corresponding to Sr. No. Marked B in one particular semester. The Induction Program (Three weeks duration) is a part of scheme of first year in Ist semester for all branches.

*SCHEME OF STUDIES/EXAMINATIONS (***Semester -II***)*

S. No.	Course No./ Code	Subject	L:T:P	Hours/ Week	Credits	Examination Schedule (Marks)				Duration of exam (Hours)
						Major Test	Minor Test	Practical	Total	
1A	BS-111	Applied Physics	3:1:0	4	4	75	25	0	100	3
1B	BS-101	Chemistry	3:1:0	4	4	75	25	0	100	3
2A	ES-105	Programming for Problem Solving	3:0:0	3	3	75	25	0	100	3
2B	HM-101	English	2:0:0	2	2	75	25	0	100	3
3	BS-132	Applied Mathematics-II	3:1:0	4	4	75	25	0	100	3
4A	ES-109	Engineering Graphics & Design	1:2:0	3	3	75	25	0	100	3
4B	ES-111L	Manufacturing Processes Workshop	0:0:3	3	1.5	-	40	60	100	3
5A	BS-141	Biology	2:1:0	3	3	75	25	0	100	3
5B	ES-101	Basic Electrical Engineering	4:1:0	5	5	75	25	0	100	3
6A	BS-113L	Applied Physics Lab	0:0:3	3	1.5	--	20	30	50	3
6B	BS-103L	Chemistry Lab	0:0:3	3	1.5	--	20	30	50	3
7A	ES-107L	Programming for Problem Solving Lab	0:0:2	2	1	--	20	30	50	3
7B	ES-103L	Basic Electrical Engineering Lab	0:0:2	2	1	--	20	30	50	3
8A	ES-113L	Engineering Graphics & Design Practice	0:0:3	3	1.5	--	20	30	50	3
8B	HM-103L	Language Lab	0:0:2	2	1	--	20	30	50	3
		Total	12:5:8/ 12:3:10	25/ 25	21.0/ 20.0	375/ 300	185/200	90/150	650A/ 650B	

Note: (1) A branch will study either the subjects corresponding to Sr. No. Marked A or corresponding to Sr. No. Marked B in one particular semester.

(2) All students have to undertake the industrial training for 4 to 6 weeks after 2nd semester which will be evaluated in 3rd semester.

BS-111	Applied Physics						
L	T	P	Credit	Major Test	Minor Test	Total	Time
3	1	-	4	75	25	100	3h

Purpose	To introduce the basics of physics to the students for applications in the Engineering field.
Course Outcomes	
CO 1	Introduce the fundamentals of interference and diffraction and their applications.
CO 2	To make the students aware of the importance of polarization and Laser in technology.
CO 3	Applications of optical fiber and ultrasonics in various fields.
CO 4	Introduce the nuclear radiations and its biological effects.

Unit - I

Interference: Principle of Superposition, Conditions for interference, Division of wave-front: Fresnel's Biprism and Applications, Division of amplitude: Wedge-shaped film, Newton's rings, Michelson Interferometer and Applications.

Diffraction: Types of diffraction, Fraunhofer diffraction at a single slit, Plane transmission diffraction grating: theory, secondary maxima and minima, width of principal maxima, absent spectra, overlapping of spectral lines, determination of wavelength; Dispersive power and resolving power of diffraction grating.

Unit – II

Polarization: Polarization of transverse waves, Plane of polarization, Polarization by reflection, Double refraction, Nicol Prism, Quarter and half wave plate, Specific Rotation, Laurent 's half shade polarimeter, Biquartzpolarimeter.

Laser: Introduction, Stimulated Absorption, Spontaneous and Stimulated Emission; Einstein's Coefficients and its derivation, Population Inversion, Direct and Indirect pumping, Pumping schemes, Main components of Laser, He-Ne Laser, Semiconductor Laser, Characteristics of Laser, Applications of Laser.

Unit – III

Optical Fiber: Introduction, Principle of propagation of light waves in optical fibers: total internal reflection, acceptance angle, numerical aperture, V- number; Modes of propagation, Types of optical fibers: single mode fiber, multimode fibers; Fiber optics communication system, Advantages of optical fiber communication, Applications of optical fibers.

Ultrasonics: Ultrasonic waves, Properties of ultrasonic waves, Production of ultrasonic waves: Magnetostriction and Piezoelectric methods, Detection of ultrasonic waves, Measurement of velocity of ultrasonic waves, Applications of ultrasonic waves.

Unit – IV

Nuclear radiations and its Biological Effects: Classification of nuclear radiations, Interaction of charged particle (light and heavy) and gamma radiations with matter (basic concepts), Dosimetric units, Relative Biological Effectiveness (RBE), Typical doses from commons sources in the environment, Biological Effects, Maximum Permissible Dose, (MPD), Shielding, Radiation safety in the nuclear radiation laboratory.

Biomaterials: Introduction, Classification of biomaterials, Applications.

Suggested Books:

1. Applied Physics for Engineers, Wiley India Pvt. Ltd.
2. Concepts of Modern Physics (5th edition), Tata McGraw-Hill Publishing Company Limited.
3. A Textbook of Optics, S. Chand & Company Ltd.
4. Techniques for Nuclear and Particle Physics Experiments: A How-to Approach, Springer-Verlag.
5. Introduction to Nuclear and Particle Physics, PHI Learning Private Limited.
6. Biomaterials: The intersection of Biology and Materials Science, Pearson, New Delhi.

Note: The paper setter will set the paper as per the question paper templates provide.

BS-113L	Applied Physics Lab						
L	T	P	Credit	Practical	Minor Test	Total	Time
-	-	3	1.5	30	20	50	3h
Purpose	Give the knowledge of basic practicals of Physics in Engineering.						
Course Outcomes							
CO1	To make the students familiar with the experiments related with optics.						
CO2	To give the knowledge of handling of the experiments related with resistance using different methods.						

Note: Students will be required to perform at least 10 experiments out of the following list.

1. To verify Newton's formula and hence to find the focal length of the given convex lens.
2. To find the frequency of A.C. mains by using a Sonometer and horseshoe magnet.
3. To find the resistance of a galvanometer by post office box.
4. To find low resistance by Carrey-Foster bridge.
5. To find the value of high resistance by substitution method.
6. To compare the capacitances of two capacitors by De-Sauty's bridge and hence to find the dielectric constant of a medium.
7. To convert a galvanometer into an ammeter of desired range and verify the same.
8. To find the wavelength of monochromatic light by Newton's ring experiment.
9. To find the wavelength of sodium light by Michelson's interferometer.
10. To find the resolving power of a telescope.
11. To find the wavelength of sodium light using Fresnel bi-prism.
12. To find the wavelength of various colours of white light with the help of plane transmission diffraction grating.
13. To find the specific rotation of sugar solution by using a Polarimeter.

Suggested Books:

1. C.L.Arora, B. Sc. Practical Physics, S. Chand.
2. B.L. Worshnop and H, T, Flint, Advanced Practical Physics, KPH.
3. S.L. Gupta & V. Kumar, Practical Physics, Pragati Prakashan.

1. C.L.Arora, B. Sc. Practical Physics, S. Chand.
2. B.L. Worshnop and H, T, Flint, Advanced Practical Physics, KPH.
3. S.L. Gupta & V. Kumar, Practical Physics, PragatiPrakashan.

BS-101	Chemistry						
L	T	P	Credit	Major Test	Minor Test	Total	Time
3	1	-	4	75	25	100	3h

Purpose	To familiarize the students with basic and applied concept in chemistry
CO1	An insight into the atomic and molecular structure
CO2	Analytical techniques used in identification of molecules
CO3	To understand Periodic properties
CO4	To understand the spatial arrangement of molecules

UNIT - I

Atomic and molecular structure (10 lectures)

Molecular orbitals of diatomic molecules (N2, O2, CO) Equations for atomic and molecular orbitals. Energy level diagrams of diatomics. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and energy level diagrams of [Co(NH3)6], [Ni(CO)4], [PtCl2(NH3)2] and magnetic properties of metal complexes. Band structure of solids and the role of doping on band structures.

UNIT - II

Spectroscopic techniques and applications (8 lectures)

Principles of spectroscopy and selection rules. Electronic spectroscopy (basic concept). Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Basic concepts of Nuclear magnetic resonance and magnetic resonance imaging, Diffraction and scattering.

UNIT - III

Use of free energy in chemical equilibria (4 lectures)

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications.

Periodic properties (4 Lectures)

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries (H2O, NH3, PCl5, SF6, CCl4, Pt(NH3)2Cl2

UNIT - IV

Stereochemistry (6 lectures)

Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis.

Organic reactions and synthesis of a drug molecule (4 lectures)

Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule(paracetamol and Aspirin)

Suggested Books:

1) University chemistry, by B. M. Mahan, Pearson Education
2) Chemistry: Principles and Applications, byM. J. SienkoandR. A. Plane
3) Fundamentals of Molecular Spectroscopy, by C. N. Banwell
4) Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S.Krishnan
5) Physical Chemistry, by P. W. Atkins

Note: The paper setter will set the paper as per the question paper templates provided

BS-103L	Chemistry Lab						
L	T	P	Credit	Practical	Minor Test	Total	Time
-	-	3	1.5	30	20	50	3h

LIST OF EXPERIMENTS

1. To Determine the surface tension of a given liquid
2. To determine the relative viscosity of a given liquid using Ostwald's viscometer
3. To identify the number of components present in a given organic mixture by thin layer chromatography
4. To determine the alkalinity of a given water sample
5. Determination of the strength of a given HCl solution by titrating it with standard NaOH solution using conductometer
6. Synthesis of a drug (paracetamol/Aspirin)
7. Determination of chloride content of a given water sample
8. To determine the calcium & magnesium or temporary & permanent hardness of a given water sample by EDTA method
9. To determine the total iron content present in a given iron ore solution by redox titration
10. Determination of the partition coefficient of a substance between two immiscible liquids
11. To find out the content of sodium, potassium in a given salt solution by Flame Photometer
12. To find out the λmax and concentration of unknown solution by a spectrophotometer
13. To find out the flash point and fire point of the given oil sample by Pensky Martin apparatus
14. To determine the amount of dissolved oxygen present in a given water sample
15. To find out the pour point and cloud point of a lubricating oil
16. Determination of the strength of a given HCl solution by titrating it with standard NaOH solution using pH meter
17. Using Redwood Viscometer find out the viscosity of an oil sample

Note: At Least 9 experiments to be performed from the list .

ES-105	Programming for Problem Solving						
L	T	P	Credit	Major Test	Minor Test	Total	Time
3	-	-	3	75	25	100	3h
Purpose	To familiarize the students with the basics of Computer System and C Programming						
Course Outcomes							
CO 1	Describe the overview of Computer System and Levels of Programming Languages .						
CO 2	Learn to translate the algorithms to programs (in C language).						
CO 3	Learn description and applications of conditional branching, iteration and recursion.						
CO 4	To use arrays, pointers and structures to formulate algorithms and programs.						

UNIT – I

Overview of Computers: Block diagram and its description, Number systems, Arithmetic of number systems, Computer Hardware: Printers, Keyboard and Mouse, Storage Devices.
Introduction to programming language: Different levels of PL: High Level language, Assembly language, Machine language; Introduction to Compiler, Interpreter, Debugger, Linker, Loader, Assembler.
Problem Analysis: Problem solving techniques, Algorithms and Flowchart representation.

UNIT – II

Overview of C: Elements of C, Data types; Storage classes in C; Operators: Arithmetic, relational, logical, bitwise, unary, assignment and conditional operators, precedence & associativity of operators.
Input/output: Unformatted & formatted I/O function in C.
Control statements: if statement, switch statement; Repetition: for, while, and do-while loop; break, continue, goto statements.

UNIT – III

Arrays: Definition, types, initialization, processing an array, String handling.
Functions: Definition, prototype, parameters passing techniques, recursion, built-in functions, passing arrays to functions, returning arrays from functions.

UNIT – IV

Pointers: Declaration, operations on pointers, pointers and arrays, dynamic memory allocation, pointers and functions, pointers and strings.
Structure & Union: Definition, processing, passing structures to functions, use of union. Data files: Opening and closing a file, I/O operations on files.

Suggested Books:

1. Brian W. Kernighan Dennis Ritchie, “C Programming Language” Pearson Education India.
2. Subrata Saha,Subhodip Mukherjee:Basic Computation & Programming with ‘C’-Cambridge University Press. 3.Ajay Mittal, “Programming in C - A Practical Approach”, Pearson.
4.E Balagurusamy :Programming in ANSI C,TMH Education.
5.Pradip Dey and Manas Ghose, “Computer Fundamental and Programming in C”, Oxford Pub.
6.ForouzanBehrouz, “Computer Science: A Structured Programming Approach Using C”, Cengage Learning.
7.Ashok Kamthane, “Programming in C, 3e”, Pearson Education India..
8.Yashwant Kanetker, “Let us C”, BPB Publications.
9.A K Sharma, “ Fundamentals of Computers & Programming” DhanpatRai Publications
10. Rajaraman V., “Computer Basic and C Programming”, Prentice Hall of India Learning.

Note: The paper setter will set the paper as per the question paper templates provided.

ES-107L	Programming for Problem Solving Lab						
L	T	P	Credit	Practical	Minor Test	Total	Time
-	-	2	1	30	20	50	3h
Purpose	To Introduce students with problem solving using C Programming language						
Course Outcomes							
CO 1	To formulate the algorithms for simple problems						
CO 2	Implementation of arrays and functions.						
CO 3	Implementation of pointers and user defined data types.						
CO 4	Write individual and group reports: present objectives, describe test procedures and results.						

LIST OF PROGRAMS

1. Write a program to find the sum of individual digits of a positive integer.
2. Write a program to generate the first n terms of the Fibonacci sequence.
3. Write a program to generate all the prime numbers between 1 and n, where n is the input value given by the user.
4. Write a program to find the roots of a quadratic equation.
5. Write a function to generate Pascal's triangle.
6. Write a program for addition of Two Matrices
7. Write a program for calculating transpose of a matrix.
8. Write a program for Matrix multiplication by checking compatibility
9. Write programs to find the factorial of a given integer by using both recursive and non-recursive functions.
10. Write a function that uses functions to perform the count of lines, words and characters in a given text.
11. Write a program to explores the use of structures, union and other user defined variables
12. Write a program to print the element of array using pointers
13. Write a program to implement call by reference
14. Write a program to print the elements of a structure using pointers
15. Write a program to read a string and write it in reverse order
16. Write a program to concatenate two strings
17. Write a program to check that the input string is a palindrome or not.
18. Write a program which copies one file to another.
19. Write a program to reverse the first n characters in a file.

Note: At least 10 programs are to be performed & executed from the above list.

HM-101	English						
L	T	P	Credit	Major Test	Minor Test	Total	Time
2	-	-	2	75	25	100	3h

Course Outcomes	
CO 1	Building up the vocabulary
CO 2	Students will acquire basic proficiency in English including writing skills

UNIT- 1

Vocabulary Building

1.1 The concept of Word Formation
1.2 Root words from foreign languages and their use in English
1.3 Acquaintance with prefixes and suffixes from foreign languages in English to farm derivatives.
1.4 Synonyms, antonyms, and standard abbreviations.

Basic Writing Skills

2.1 Sentence Structures
2.2 Use of phrases and clauses in sentences
2.3 Importance of proper punctuation
2.4 Creating coherence
2.5 Organizing principles of paragraphs in documents
2.6 Techniques for writing precisely

UNIT- 3

Identifying Common Errors in Writing

3.1 Subject-verb agreement
3.2 Noun-pronoun agreement
3.3 Misplaced modifiers
3.4 Articles
3.5 Prepositions
3.6 Redundancies
3.7 Clichés

UNIT- 4

Nature and Style of sensible Writing

4.1 Describing
4.2 Defining
4.3 Classifying
4.4 Providing examples or evidence
4.5 Writing introduction and conclusion
4.6 Comprehension
4.7 Précis Writing
4.8 Essay Writing

Suggested Books:

(i) Practical English Usage. Michael Swan. OUP. 1995 .

UNIT- 2

(ii) Remedial English Grammar. F.T. Wood.
Macmillan.2007 (iii)On Writing Well. William Zinsser.
(iii) Harper Resource Book. 2001
(iv) Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
(v) Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
(vi) Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

Note: The paper setter will set the paper as per the question paper templates provided.

HM-103L	Language Lab						
L	T	P	Credit	Practical	Minor Test	Total	Time
-	-	2	1	30	20	50	3h

OBJECTIVES

1. Listening Comprehension
2. Pronunciation, Intonation, Stress and Rhythm
3. Common Everyday Situations: Conversations and Dialogues
4. Communication at Workplace
5. Interviews
6. Formal Presentations

BS-131	APPLIED MATHEMATICS-I						
L	T	P	Credit	Major Test	Minor Test	Total	Time
3	1	-	4	75	25	100	3 h
Purpose	The objective of this course is to familiarize the prospective Biotechnology Engineers with techniques in Limit, Continuity, Differential & Integral Calculus and Complex Numbers. It aims to equip the students with standard concepts and tools at a beginner to intermediate and then at advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines. More precisely, the objectives are as under:						
Course Outcomes							
CO1	To introduce the idea of sets, relations, functions, trigonometric functions, inverse trigonometric functions, these concepts are prerequisite to learn the concepts of differentiation and integration.						
CO 2	To introduce the Complex numbers which is fundamental to solve any kind of quadratic equations, Limit is precondition to understand the concept of rate of change and derivative.						
CO 3	To develop the essential tool of Continuity and Differentiability needed in evaluating higher order derivatives of functions.						
CO 4	To introduce the tools of Indefinite and Definite integrals of functions in a comprehensive manner that are used in various techniques dealing engineering problems.						

UNIT-I (12 hrs)

Sets, Relations, Functions

Sets and its types: Operations on sets, complement of a set, Cartesian Product of sets, relations , functions, types of functions, **Trigonometric functions:** Introduction, Angles, Trigonometric functions, Trigonometric functions of sum and difference of two angles, Trigonometric equations, **Inverse Trigonometric functions:** Introduction, basic concepts and its properties.

UNIT-II (12 hrs)

Pre-Calculus

Complex Numbers: Introduction, Algebra of Complex Numbers, Modulus and the conjugate of a complex number, quadratic equations, **Limits and Derivatives:** Introduction, Limits, Limits of Trigonometric Functions, Derivatives (single variable).

UNIT-III (12 hrs)

Differential Calculus

Continuity and Differentiability: Introduction, Continuity, Differentiability, Exponential and Logarithmic functions, Logarithmic differentiation, Derivatives of functions in parametric forms, second order derivatives, **Application of Derivatives (single variable)**: Increasing and decreasing functions, Maxima and Minima.

UNIT-IV

(12 hrs)Integral Calculus

Integrals: Introduction, Integration as an Inverse process of Differentiation, Method of Integration, Integration by Partial Fractions, Integration by Parts, **Definite Integrals**: Fundamental theorem of Calculus, Evaluation of Definite Integrals by Substitution, properties of

Definite Integrals.

Suggested Books:

1. G. B. Thomas, R. L. Finney: Calculus and Analytic Geometry, Pearson Education.
2. Mathematics Textbook for Class 11^{th} & 12^{th} by NCERT.
3. Howard Anton: Calculus, Wiley Publication.
4. E. Kreyszig: Advanced Engineering Mathematics, Wiley India.

Note: The paper setter will set the paper as per the question paper templates provided.

Course code	ES-109							
Coursetitle	Engineering Graphics & Design							
Scheme and Credits	L	T	P	Credits	Major Test	Minor Test	Total	Time
	1	2	0	3	75	25	100	3h

Course Outcomes

Objective- To expose students to the basics of Engineering Drawing , graphics and Projections.	
CO-1	To learn about construction of various types of curves and scales.
CO-2	To learn about orthographic projections of points, lines and planes.
CO-3	To Learn about the sectional views and development of Right regular solids
CO-4	To Learn about the construction of Isometric Projections and conversion of Isometric views to Orthographic views and vice-versa.

UNIT - I

IntroductiontoEngineeringDrawing:
Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales;

UNIT - II

Orthographic Projections:
Principles of Orthographic Projections-Conventions-Projections of Points and lines inclined to both planes; Projections of planes inclined to one principalPlane.

Projections of Regular Solids:

Solid with axis inclinedtobothThePlanes;

UNIT - III

Sections andSectionalViewsofRightRegular Solids:
Sectional views of simple right regular solids like prism, pyramid, Cylinder and Cone. Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone;

UNIT - IV

Isometric Projections:
Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of IsometricViews to Orthographic Views and Vice-versa, Conventions:

Suggested Books:

1. Engineering Graphics using AUTOCAD 2000: T. Jeyapoovan, Vikas Publishing House.
2. Engineering Drawing: Plane and Solid Geometry: N.D. Bhatt and V.M.Panchal, Charotar Publishing House.
3. Engineering Drawing: Amar Pathak, Dreamtech Press, New Delhi.
4. Thomas E.French, Charles J.Vierck, Robert J.Foster, “Engineering drawing and graphic technology”,

McGraw Hill International Editions.
5. Engineering Graphics and Drafting: P.S. Gill, Millennium Edition, S.K. Katariaand Sons.
6. A Primer on Computer aided Engineering Drawing-2006, published by VTU, Belgaum.
7. A.Yarwood, Introduction to AutoCAD 2017, Published by CRC Press.
8. O. Ostrowsky, Engineering Drawing with CAD applications, Butterworth Heinemann,1999.
9. BSI, Technical production documentation (TPD) – specification for defining, specifying and graphically reporting products, BS8888, 2002.
10. CorrespondingsetofCADSoftwareTheoryandUserManuals.

Note: The paper setter will set the paper as per the question paper templates provided.

Course code	ES-113L							
Course title	Engineering Graphics & Design Practice							
Scheme and Credits	L	T	P	Credits	Practical	Minor Test	Total	Time
	-	-	3	1.5	30	20	50	3h
Pre-requisites(if any)	-							

Aim: To make student practice on graphics and design softwares and provide engineering exposure to the visual aspects of engineering design.	
CO-1	To give an overview of the user interface and toolboxes in a CAD software.
CO-2	To understand how to customize settings of CAD software and produce CAD drawing.
CO-3	To practice performing various functions in CAD softwares.
CO-4	To Learn about solid modelling and demonstration of a simple team design project.

Module 1: Overview of Computer Graphics:

Listing the computer technologies that impact on graphical communication, Demonstrating Knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus(Button Bars),The Command Line(where applicable),The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids];

Module2: Customization & CAD Drawing:

Setup of the drawing page and the printer ,including scale settings, Setting up of units and drawing limits ;ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

Module3: Annotations, layering & other functions:

Applying dimensions to objects ,applying annotations to drawings ;Setting up and use of Layers ,layers to create drawings ,Create ,edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen);Printing documents to paper using the print command ;orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation ,Computer-aided design(CAD) software modeling of parts and assemblies .Parametric and non-parametric solid, surface, and wire frame models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises .Dimensioning guidelines ,tolerancing techniques; dimensioning and scale multi views of dwelling;

Module4: Demonstration of a simple team design project:

Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid-modeling software for creating associative models at the component and assembly levels; floor plans that include: windows ,doors ,and fixtures such as WC, bath ,sink ,shower ,etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modeling (BIM).

Suggested Books(ES-113L):

1. Chris McMahon and Jimmie Browne, CAD/CAM – Principle Practice and Manufacturing Management, Addison Wesley England, Second Edition, 2000.
2. Chougule N.K.; CAD/CAM /CAE, Scitech Publications India Pvt. Ltd.
3. Vikram Sharma; Computer Aided Design and Manufacturing, S.K. Kataria and Sons.
4. Rogers, D.F. and Adams, A., Mathematical Elements for Computer Graphics, McGraw Hill Inc, NY, 1989
5. Ibrahim Zeid, CAD/CAM theory and Practice, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1992.
6. M.P. Groover, Automation, Productions systems and Computer-Integrated Manufacturing by Prentice – Hall.
7. A Primer on Computer aided Engineering Drawing-2006, published by VTU, Belgaum.
8. A.Yarwood, Introduction to AutoCAD 2017, Published by CRC Press.
9. O. Ostrowsky, Engineering Drawing with CAD applications, Butterworth Heinemann,1999.
10. BSI, Technical production documentation (TPD) – specification for defining, specifying and graphically reporting products, BS8888, 2002.
11. (Corresponding set of)CAD Software Theory and User Manuals
12. Ibrahim Zeid, Mastering CAD/CAM, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
13. P. Radhakrishnan, S. Subramanayan and V.Raju, CAD/CAM/CIM, New Age International (P) Ltd., New Delhi.
14. Groover M.P. and Zimmers E. W., CAD/CAM: Computer Aided Design and Manufacturing, Prentice Hall International, New Delhi, 1992.
15. Dr. Sadhu Singh, Computer Aided Design and Manufacturing, Khanna Publishers, New Delhi, Second Edition, 2000.
16. Thomas E.French, Charles J.Vierck, Robert J.Foster, “Engineering drawing and graphic technology”, McGraw Hill International Editions.

Course code	ES-111L							
Course title	Manufacturing Processes Workshop							
Scheme and Credits	L	T	P	Credits	Practical	Minor Test	Total	Time
	0	0	3	1.5	60	40	100	3h
Pre-requisites (if any)								

Aim: To make students gain a hands on work experience in a typical manufacturing industry environment.	
CO-1	To familiarize with different manufacturing methods in industries and work on CNC machines.
CO-2	To learn working in Fitting shop and Electrical and Electronics shops,
CO-3	To practice working on Carpentry and Plastic moulding/glass cutting jobs.
CO-4	To gain hands on practice experience on Metal casting and Welding jobs.

Manufacturing Processes Workshop Contents

1. Manufacturing Methods-casting, forming, machining ,joining, advanced manufacturing methods
2. CNC machining, Additive manufacturing
3. Fitting operations & power tools
4. Electrical & Electronics
5. Carpentry
6. Plastic moulding ,glass cutting
7. Metalcasting
8. Welding(arc welding & gas welding), brazing

Suggested Books:

1. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology" , 7th edition, Pearson Education India Edition.
2. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., " Elements of Workshop Technology" , Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
3. Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" , Pearson Education, 2008.
4. Roy A. Lindberg, " Processes and Materials of Manufacture" , 4th edition, Prentice Hall India, 1998
5. Rao P.N., " Manufacturing Technology" , Vol. I and Vol. II, Tata McGraw-Hill House, 2017.

BS-141	Biology						
L	T	P	Credit	Major Test	Minor Test	Total	Time
2	1	-	3	75	25	100	3h
Purpose	To familiarize the students with the basics of Biotechnology						
Course Outcomes							
CO1	Introduction to essentials of life and macromolecules essential for growth and Development						
CO2	Defining the basic concepts of cell division, genes and Immune system						
CO3	Introduction of basic Concept of Thermo Genetic Engg. & Biochemistry						
CO4	Introduction of basic Concept of Microbiology & Role of Biology in Different Fields						

Unit – I

Introduction to living world: Concept and definition of Biology; Importance of biology in major discoveries of life Characteristic features of living organisms; Cell ultra -structure and functions of cell organelles like nucleus, mitochondria,chloroplast, ribosomes and endoplasmic reticulum; Difference between prokaryotic and eukaryotic cell; Difference between animal and plant cell.

Classification of organisms: Classify the organisms on the basis of (a) Cellularity;- Unicellular and Multicellular organisms. (b) Energy and Carbon Utilization:- Autotrophs, Heterotrophs and Lithotrophs (c) Habitat (d) Ammonia excretion: - ammonotelic, 23ricotelic and ureotelic. (e) Habitat- aquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life

Unit-II

Introduction to Biomolecules: Definition, general classification and important functions of carbohydrates, lipids, proteins, nucleic acids (DNA & RNA: Structure and forms). Hierarchy in protein structure : Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.

Enzymes as biocatalysts: General characteristics, nomenclature and classification of Enzymes. Effect of temperature, Ph, enzyme and substrate concentrations on the activity of enzymes. Elementary concept of and coenzymes. Mechanism of enzyme action. Enzyme kinetics and kinetic parameters (Km and Vmax)

Unit-III

Genetics:-Mendel's laws of inheritance. Variation and speciation. Concepts of recessiveness and dominance.

Geneti

c Disorders: Single gene disorders in humans. **Human traits**: Genetics of blood groups, diabetes type I & II.

Cell Division:- Mitosis and its utility to living systems. Meiosis and its genetic significance. Evidence of nucleic acids as a genetic material. Central Dogma of molecular biology

4. Role of immune system in health and disease : Brief introduction to morphology and pathogenicity o f bacteria, fungi, virus, protozoa beneficial and harmful for human beings.

Unit-IV

Metabolism:-Concept of Exothermic and endothermic reactions. Concept of standard free energy and Spontaneity in biological reactions. Catabolism (Glycolysis and Krebs cycle) and synthesis of glucose (Photosynthesis: - Light and Dark Reaction) of glucose. ATP as Energy Currency of the cell

Microbiology: Concept of species and strains, sterilization and media compositions, growth kinetics.

Role of Biology : Role of Biology in Agriculture, Medicine, Forensic science, Bioinformatics, Nanotechnology, Micro - electromechanical systems (Bio -MEMS) and Sensors (Biosensors).

Text Book:

1. Introduction to Biotechnology, By Deswal & Deswal, Dhanpat Rai Publications N.A
2. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, "Biology: A global approach ", Pearson Education Ltd, 2014.
3. E. E. Conn, P. K. Stumpf, G. Bruening and R. H. Doi, "Outlines of Biochemistry", John Wiley and Sons, 2009.

D. L. Nelson and M. M. Cox, "Principles of Biochemistry", W.H. Freeman and Company, 2012.

4.G. S. Stent and R. Calendar, "Molecular Genetics", Freeman and company, 1978.

Note: The paper setter will set the paper as per the question paper templates provided

Suggested Books:

1. Molecular Biology of Cell, 4th ed. Alberts, Bruce et al. Garland Science Publishing, New York.
2. Microbiology. Pelczar Jr., M.J.; Chan, E.C.S. and Krieg, N.R. Tata McGraw Hill, New Delhi.
3. Lehninger: Principles of Biochemistry, 3rd edition, by David L. Nelson and M.M. Cox. Maxmillan/ Worth publishers.
4. Genetics by Snusted & Simmons.
5. Molecular Biotechnology: Principles Application of Recombinant DNA. Glick, B. R. and Pasternak, J. J. ASM press Washington DC.
6. Kuby's Immunology, Goldsby, R A,.Kindt, T.J, Osborne, B.A.(2003) W. H. Freeman and company, New York.
7. Recombinant DNA 2nd Edition. Watson, James D. and Gilman, M. (2001) W.H Freeman and Company, NewYork.
8. Essentials of Molecular Biology 4 thed, Malacinski, G. M. (2003) Jones &Bartlet Publishers, Boston.

ES-101	BASIC ELECTRICAL ENGINEERING						
L	T	P	Credit	Major Test	Minor Test	Total	Time(Hrs)
4	1	-	5	75	25	100	3
Purpose	To familiarize the students with the basics of Electrical Engineering						
Course Outcomes							
CO1	Deals with steady state circuit analysis subject to DC.						
CO 2	Deals with AC fundamentals & steady state circuit response subject to AC.						
CO 3	Deals with introductory Balanced Three Phas e System analysis and Single Phase Transformer.						
CO 4	Explains the Basics of Electrical Machines & Electrical installations						

Unit-I

D.C. circuits: Ohm's Law, junction, node, circuit elements classification: Linear & nonlinear, active & passive, lumped & distributed, unilateral & bilateral with examples. KVL, KCL, Loop and node-voltage analysis of resistive circuits. Star- Delta transformation for resistors. **Network Theorems:** Superposition, Thevenin's, Norton's and Maximum power transfer theorems in a resistive network.

Unit-II

AC Fundamentals: Mathematical representation of various wave functions. Sinusoidal periodic signal, instantaneous and peak values, polar & rectangular form of representation of impedances and phasor quantities. Addition & subtraction of two or more phasor sinusoidal quantities using component resolution method.RMS and average values of various waveforms.

A.C. Circuits: Behavior of various components fed by A.C. source (steady state response of pureR, pure L, pure C, RL, RC, RLC series with waveforms of instantaneous voltage, current & power on simultaneous time axis scale and corresponding phasor diagrams), power factor, active, reactive & apparent power. Frequency response of Series & Parallel RLC ckts. including resonance, Q factor, cut-off frequency & bandwidth. Generation of alternating emf.

Unit-III

Balanced Three Phase Systems: Generation of alternating 3- phase emf). 3-phase balanced circuits, voltage and current relations in star and delta connections. Measurement of 3-phase power by two wattmeter methods for various types of star & delta connected balanced loads.

Single Phase Transformer (qualitative analysis only): Concept of magnetic circuits.Relation between MMF & Reluctance.Hysteresis & Eddy current phenomenon. Principle, construction & emf equationPhasor diagram at ideal, no load and on load conditions. Losses & Efficiency, regulation. OC & SC test, equivalent circuit, concept of auto transformer.

Unit-IV

Electrical Machines (qualitative analysis only)**:** Construction and working of a dc machine with commutator action, speed control of dc shunt motor. Generation of rotating magnetic fields, Construction and working of a three -phase induction motor, Significance of torque-slip characteristic. Basics of Single-phase induction motor, capacitor start capacitor run Single-phase induction motor working. Basic construction and working of synchronous generator and motor.

Electrical Installations (LT Switchgear): Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing.

Suggested Books:

1. Basic Electrical Engg: A complete Solution by Vijay Kumar Garg, Wiley India Ltd.
2. Electrical Engg. Fundamentals by Rajendra Prasad, PHI Pub.
3. Basic Electrical Engg. by S.K. Sahdev, Pearson Education
4. Electrical Engg. Fundamentals: by Bobrow, Oxford Univ. Press
5. Basic Electrical Engg. By Del Toro.
6. Saxena & Dasgupta: Fundamentals of Electrical Engg (Cambridge University Press).

Note: The paper setter will set the paper as per the question paper templates provided.

ES-103L	BASIC ELECTRICAL ENGINEERING LAB						
L	T	Practical	Credit 1	Minor Test	(Practical)	Total	Time (Hrs)
-	-	2		20	30	50	3

Purpose	To familiarize the students with the Electrical Technology Practicals
Course Outcomes	
CO1	Understand basic concepts of Network theorems
CO 2	Deals with steady state frequency response of RLC circuit parameters solution techniques
CO 3	Deals with introductory Single Phase Transformer practicals
CO 4	Explains the constructional features and practicals of various types of Electrical Machines

LIST OF EXPERIMENTS

1. To verify KVL and KCL.
2. To verify Superposition theorem on a linear circuit with at least one voltage & one current source.
3. To verify Thevenin's Theorem on a linear circuit with at least one voltage & one current source.
4. To verify Norton's Theorem on a linear circuit with at least one voltage & one current source.
5. To study frequency response of a series R-L-C circuit on CRO and determine resonant frequency & Q- factor for various Values of R, L, and C.
6. To study frequency response of a parallel R-L-C circuit on CRO and determine resonant frequency & Q - Factor for various values of R, L, and C.
7. To perform O.C. and S.C. tests on a single phase transformer.
8. To perform direct load test on a single phase transformer and plot efficiency v/s load characteristic.
9. To perform speed control of the DC shunt motor.
10. To perform starting & reversal of direction of a three phase induction motor.
11. Measurement of power in a 3 phase balanced system by two wattmeter methods.
12. Study of Cut sections of DC Machines, Induction Motor
13. To study components of various LT Switchgears

Note: At least 9 out of the listed experiments to be performed during the semester.

M.Tech. Applied Geology (5-Year Integrated Course) 3rd semester

Course No.	Course Title	Hours / Week	External Assessment	Internal Assessment	Total	Credits	Duration of exam
GT-301	Introduction to Geosciences	4	100	50	150	4	3 Hrs
GT-302	Physical Geology	4	100	50	150	4	3 Hrs
GT-303	Structural Geology	4	100	50	150	4	3 Hrs
GT-304	Crystallography and Mineralogy	4	100	50	150	4	3 Hrs
GT-305	Surveying	4	100	50	150	4	3 Hrs
GT-306	Practical based on GT-301, GT-302 and GT-304	12	75	25	100	6	3 Hrs
GT-307	Practical based on GT-303 and GT-305	12	75	25	100	6	3 Hrs
	Total		650	300	**950**	**32**	

M.Tech. Applied Geology (5-Year Integrated Course) 4th semester

Course No.	Course Title	Hours/Week	External Assessment	Internal Assessment	Total	Credits	Duration of exam
GT-401	Geomorphology	4	100	50	150	4	3 Hrs
GT-402	Geochemistry-I	4	100	50	150	4	3 Hrs
GT-403	Basic Petrology	4	100	50	150	4	3 Hrs
GT-404	Energy Mineral Resources of India	4	100	50	150	4	3 Hrs
GT-405	Computational and Statistical Methods in Geology	4	100	50	150	4	3 Hrs
GT-406	Practical based on GT-402 and GT-403	12	75	25	100	6	3 Hrs
GT-407	Practical based on GT-401, GT-404 and GT-405	12	75	25	100	6	3 Hrs
	Total		650	300	**950**	**32**	

M.Tech. Applied Geology (5-Year Integrated Course) 5th semester

Course No.	Course Title	Hours/Week	External Assessment	Internal Assessment	Total	Credits	Duration of exam
GT-501	Palaeontology -I	4	100	50	150	4	3 Hrs
GT-502	Plate Tectonics	4	100	50	150	4	3 Hrs
GT-503	Igneous Petrology	4	100	50	150	4	3 Hrs
GT-504	Sedimentology	4	100	50	150	4	3 Hrs
GT-505	Geophysical Prospecting	4	100	50	150	4	3 Hrs
GT-506	Practical: Based on GT-501; GT-503	12	75	25	100	6	3 Hrs
GT-507	Practical: Based on GT-502, GT-504, GT-505	12	75	25	100	6	3 Hrs
GT-508	Field Training-I	5 to 7 days	100	50	150	4	-
	Total		**750**	**350**	**1100**	**36**	

M.Tech. Applied Geology (5-Year Integrated Course) 6th semester

Course No.	Course Title	Hours/Week	External Assessment	Internal Assessment	Total	Credits	Duration of exam
GT-601	Stratigraphy	4	100	50	150	4	3 Hrs
GT-602	Structural Geology-II	4	100	50	150	4	3 Hrs
GT-603	Metamorphic Petrology	4	100	50	150	4	3 Hrs
GT-604	Applied Geochemistry	4	100	50	150	4	3 Hrs
GT-605	Economic and Ore Geology	4	100	50	150	4	3 Hrs
GT-606	Practical : Based on GT-601, GT-602	12	75	25	100	6	3 Hrs
GT-607	Practical : Based on GT-603, GT-604, GT-605	12	75	25	100	6	3 Hrs
	Total		650	300	**950**	**32**	

M.Tech. Applied Geology (5-Year Integrated Course) 7th semester

Course No.	Course Title	Hours/Week	External Assessment	Internal Assessment	Total	Credits	Duration of exam
GT-701	Remote Sensing Technology	4	100	50	150	4	3 Hrs
GT-702	Mineral Exploration	4	100	50	150	4	3 Hrs
GT-703	Micropalaeontology and Palynology	4	100	50	150	4	3 Hrs
GT-704	Hydrogeology	4	100	50	150	4	3 Hrs
GT-705	Petroleum Geology	4	100	50	150	4	3 Hrs
GT-706	Practical: Based on GT-701 and GT – 702	12	75	25	100	6	3 Hrs
GT-707	Practical: Based on GT-703, GT-704 and GT- 705	12	75	25	100	6	3 Hrs
GT-708	Field Training – II	5 to 7 days	100	50	150	4	-
	Total		**750**	**350**	**1100**	**36**	

M.Tech. Applied Geology (5-Year Integrated Course) 8th semester

Course No.	Course Title	Hours/Week	External Assessment	Internal Assessment	Total	Credits	Duration of exam
GT-801	Environmental Geoscience	4	100	50	150	4	3 Hrs
GT-802	Coal Geology and Technology	4	100	50	150	4	3 Hrs
GT-803	Mining Geology	4	100	50	150	4	3 Hrs
GT-804	GIS Technology	4	100	50	150	4	3 Hrs
GT-805	Engineering Geology	4	100	50	150	4	3 Hrs
GT-806	Practical: Based on GT-801 and GT - 804	12	75	25	100	6	3 Hrs
GT-807	Practical: Based on GT-802, GT-803 and GT- 805	12	75	25	100	6	3 Hrs
GT-808 (OE-205)	Geoscience and Society*	2	35	15	50	2	3 Hrs
	Total		**685**	**315**	**1000**	**34**	

* **To be opted by the students of other Departments in the science faculty.**

M.Tech. Applied Geology (5-Year Integrated Course) 9th semester

Course No.	Course Title	Hours/ Week	External Assessment	Internal Assessment	Total	Credits	Duration of exam
GT-901	Well Logging	4	100	50	150	4	3 Hrs
GT-902	Advanced Stratigraphy, Palaeogeography and Paleoecology	4	100	50	150	4	3 Hrs
GT-903	Organizational Behavior and Business Management	4	100	50	150	4	3 Hrs
Electives: Any two of following four theory subjects							
GT-904	Geohazards and Disaster Management	4	100	50	150	4	3 Hrs
GT-905	Geoscientific Instrumentation and Analytical Techniques	4	100	50	150	4	3 Hrs
GT-906	Oceanography and Marine Geology	4	100	50	150	4	3 Hrs
GT-907	Meteorology	4	100	50	150	4	3 Hrs
GT-908	Practical: Based on GT-901, GT-902 and GT-903	12	75	25	100	6	3 Hrs
GT-909	Practical: Based on two elective subjects opted	12	75	25	100	6	3 Hrs
GT-910 (OE-305)	Natural Hazards*	2	35	15	50	2	3 Hrs
	Total		**685**	**315**	**1000**	**34**	

To be opted by the students of other Departments in the science faculty.

M.Tech. Applied Geology (5-Year Integrated Course) 10th semester

Course No.	Course Title	Total	Credits	Duration of Exam
GT-1001	Project work	150	4	-
GT-1002	Dissertation	150	4	-
GT-1003	Viva voce	150	4	-
	Total	**450**	**12**	

INTRODUCTION TO GEOSCIENCES (GT-301)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To provide an overview of Earth Sciences including earth processes, resources and geo-hazards.						
COURSE OUTCOMES						
1. Students will get knowledge about Geology as a discipline and its branches. Earth and solar system and development of geology as a subject.						
2. Students will learn about minerals, rocks, groundwater and fossil fuels along with tectonics and morphological context of major catastrophic events of geological significance.						
3. Students will learn about the history of life on earth, study of ecological spheres and their relationship with earth's surface.						
4. Students will get knowledge about various tools and technologies and their application in earth sciences.						

DETAILS OF COURSE:

Unit	Content
1	Geology as an interdisciplinary science. Branches of Geology and their basic understanding. Earth's place in the solar system, physical features on its surface, other basic features (mass, shape, size, density, etc.). Physical and historical geology. Development of Geology: catastrophism, The birth of modern Geology.
2	Basic understanding of minerals, rocks and its types, gemstones, groundwater, hydrocarbons and coal. Basic understanding of volcanoes, earthquakes, tsunamis, glaciers, landslides, mudflows, avalanches and droughts.
3	Geological time scale. physiographic and geological sub-divisions of India. Evolution of life on earth through ages. Physical and chemical properties of earth's spheres: hydrosphere, atmosphere and biosphere. Distribution of land and water on earth's surface.
4	Introduction to remote sensing, GIS, GPS and their applications in earth sciences. Mineral exploration and its different stages. Basic understanding of geophysical and geological methods of exploration.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Understanding the earth, Press, F. and Siever, R., W.H. Freeman & Co.
2	An Introduction to Physical Geology, Tarbuck, Lutgens, Tasa, Eleventh Edition, Pearson Publication.
3	Fundamentals of Geophysics, Lowrie, W., Cambridge University Press.
4	An Introduction to the Rock-Forming Minerals, Deer, W.A., Howie, R.A. and Zussman, J., ELBS.
5	Rutley's Elements of Mineralogy, Read, H.H., Springer.
6	A Textbook of Geology, Mukerjee, P.K., World Press.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-301.1	3	3	3	3	2	3	2	2	3	3	2
GT-301.2	3	3	3	3	2	3	2	2	3	3	2
GT-301.3	3	3	3	3	2	3	2	2	3	3	2
GT-301.4	3	3	3	3	2	3	2	2	3	3	2
Average	3	3	3	3	2	3	2	2	3	3	2

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-301.1	3	3	3	3
GT-301.2	3	2	2	2
GT-301.3	3	3	2	3
GT-301.4	3	2	3	2
Average	3	2.5	2.5	2.5

PHYSICAL GEOLOGY (GT-302)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To provide basic understanding of general geology and physical geology.						
COURSE OUTCOMES						
1.Students will get knowledge about internal structure and atmospheric layers of Earth.						
2. Students will learn about various theories of origin of Earth along with historical development to the idea of plate tectonics and the concept of plate boundaries.						
3. Students will get to know about causes, effects and tectonic developments of earthquakes and volcanism.						
4. Students will learn about concepts of groundwater and a brief introduction to a vast field of mass movements.						

DETAILS OF COURSE:

Unit	Content
1	Introduction to physical Geology. Internal structure of Earth: crust, mantle, core and their constitution; atmosphere: layers and composition of atmosphere.
2	Different hypotheses of earth's origin. Continental drift and seafloor spreading theories, introduction to plate tectonics, types of plate boundaries, ocean basin features.
3	Earthquakes: terminology, classification, effects of earthquakes, earthquake intensity scale, focus, epicenter, cause of earthquakes. Volcanoes: type of volcanoes, terminology and products of volcanoes.
4	Introduction to groundwater: types of water, occurrence of groundwater, aquifer and their types. Introduction to mass movements: types of mass movements. Weathering and its types, erosion. Soil and its type.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Physical Geology, Holmes, A., Ronal, Wiley Publication.
2	Essentials of Geology, Marshak, S., John Wiley & Sons.
3	Understanding the Earth, Press, F. and Siever, R., W. H. Freeman.
4	Earth: Geologic Principles and Histories, Chernicoff, S., Fox,. H.A. and Tanner, L.H., Houghton Mifflin.
5	Physical Geology, Moore, J.S. and Wicander, R., Brooks-Cole.
6	Textbook of Physical Geology, Mahapatra, G.B., CBS Publication.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-302.1	3	3	3	3	3	3	3	3	3	3	3
GT-302.2	3	3	3	2	3	3	2	2	3	3	3
GT-302.3	3	3	3	3	3	2	3	3	2	3	2
GT-302.4	3	3	3	3	3	3	2	2	3	2	3
Average	3	3	3	2.75	3	2.75	2.5	2.5	2.75	2.75	2.75

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-302.1	3	3	3	3
GT-302.2	3	2	3	2
GT-302.3	3	2	2	3
GT-302.4	3	3	3	3
Average	3	2.5	2.75	2.75

STRUCTURAL GEOLOGY (GT-303)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To disseminate the knowledge about the concept of geologic structure in rocks.						
COURSE OUTCOMES						
1. Students will get knowledge about unconformities and basement-cover relationships.						
2. Students will learn about morphology, classification and mechanism of folding and its relationship with other geological structures.						
3. Students will get knowledge about faults, joints and their tectonic significance.						
4. Students will learn about basic concepts, development and petrological features of tectonites.						

DETAILS OF COURSE:

Unit	Content
1	Introduction to structural geology and its importance in geology. Concept of unconformity: definition of unconformity and its types, recognition of unconformities and its geological significance. Primary and secondary structures.
2	Folds: introduction, morphology of folds, geometric and genetic classifications of folds, Mechanism and causes of folding. Recognition of folds in the field.
3	Faults: introduction, morphology of faults, geometric and genetic classifications of faults. Joints: definition, types and classification. Tectonic significance of joints and faults.
4	Concept of foliation and cleavage: mechanism of development, foliations in gneisses and mylonitic zones. Concept of lineation: basic terminology, lineations related to plastic deformation, lineations in the brittle regime.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Folding and Fracturing of Rocks, Ramsay, J.G., McGraw-Hill.
2	An Outline of Structural Geology, Hobbs, M B.E., Means, W.D. and Williams, P.F., Hobbs, M B.E., Means, W.D. and Williams, P.F., John Wiley & Sons.
3	Structural Geology: An Introduction to Geometrical Techniques, Ragan, D.M., ,John Wiley & son.
4	Fundamentals of Structural Geology, Pollard, D.D. and Fletcher, R.C., Cambridge University Press.
5	Structural Geology, Billings, M.P., Prentice Hall India.
6	Structural Geology, Haakon Fossen, Cambridge University Press.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-303.1	3	2	3	3	2	3	2	3	3	3	2
GT-303.2	3	2	3	2	2	2	3	2	3	2	2
GT-303.3	3	2	3	2	3	2	3	3	3	2	2
GT-303.4	3	2	3	3	2	2	3	2	3	3	2
Average	3	2	3	2.5	2.25	2.25	2.75	2.5	3	2.5	2

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-303.1	3	2	3	3
GT-303.2	3	3	2	3
GT-303.3	3	3	2	3
GT-303.4	3	2	3	2
Average	3	2.5	2.5	2.75

CRYSTALLOGRAPHY AND MINERALOGY (GT-304)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To introduce the basic concepts of crystallography and mineralogy.						
COURSE OUTCOMES						
1.Students will get knowledge about various groups of minerals and their physical properties.						
2.Students will get knowledge about basic concepts of optical mineralogy and optical classification of minerals.						
3.Students will learn about basic concepts of crystallography.						
4.Students will get to know about microscopic variations in crystals and analytical methods.						

DETAILS OF COURSE:

Unit	Content
1	Mineral, definition, different groups of minerals: silicates, carbonates, sulphates, oxides and other mineral groups, physical properties of minerals, branches of mineralogy.
2	Principles of optical mineralogy: petrological microscope, nicol prism polarizer, optical properties of isotropic and anisotropic minerals in polarized light, optic figures, optical sign, uniaxial and biaxial minerals.
3	Crystal: definition, form, unit cell, element of symmetry, parameter and indices, lattice concept, holohedral symmetry classes, crystal systems.
4	Crystal defects, polymorphism, isomorphism, pseudomorphism, and twinning, magnetic properties of minerals, silicate structures, brief introduction to analytical methods in mineral science.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Rutley's Elements of Mineralogy, Read, H.H., Twenty-Sixth Edition, George Allen & Unwin Publishers Ltd – 1970.
2	A Handbook of minerals, Crystals, Rocks and Ores, Parmod, A.O., New India Publishing Agency – 2009.
3	Modern Crystallography 1: Fundamentals of Crystals, Symmetry, and Methods of Structural Crystallography (Modern Crystallography), Vainshtein, B.K., Springer.
4	Dana's Manual of Mineralogy, Klein, C., Cornelius, S.H., and Dana, J.D., John Wiley & Sons.
5	An Introduction to the Rock-Forming Minerals, Deer, W.A., Howie, R.A. and Zussman, J., ELBS.
6	Crystallography and Crystal Chemistry, Bloss, F.D., Mineralogical Society of America.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-304.1	3	2	3	3	2	3	2	3	3	3	2
GT-304.2	3	2	3	2	2	3	3	2	3	2	2
GT-304.3	3	3	3	3	3	2	3	3	3	2	2
GT-304.4	3	2	3	3	2	2	3	2	3	3	2
Average	3	2.25	3	2.75	2.25	2.5	2.75	2.5	3	2.5	2

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-304.1	3	2	3	3
GT-304.2	3	3	3	3
GT-304.3	3	3	2	3
GT-304.4	3	2	3	2
Average	3	2.5	2.75	2.75

SURVEYING (GT-305)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To impart basic understanding of different types of survey methods, their working and significance.						
COURSE OUTCOMES						
1.Students will get knowledge about basic concepts of table surveying.						
2.Students will learn various methods of distance measurements and levelling.						
3.Students will learn about concepts of bearing and compasses.						
4.Students will learn methods of contouring and theodolite surveying						

DETAILS OF COURSE:

Unit	Content
1	Fundamental of surveying: definition, principles of surveying, types of surveying, uses of surveying. Plain table surveying: instruments of plane table, working operations, methods of plane table surveying - radiation method, intersection method, traversing method, re-section method, merits and demerits of plane table.
2	Measurement of distances: direct measurement, instruments for measuring distance, errors in chaining and tape corrections. Levelling: principles of levelling, different terms of levelling, types of levels and staff, temporary adjustment of levels.
3	Bearings: whole circle bearing (W.C.B), quadrantal bearing, reduced bearing, fore bearing and back bearing, instruments of measurement of bearing- prismatic compass and surveyor's compass, errors in compass (Prismatic or Surveyor's). Total station method: principal and working.
4	Contouring: methods of contouring, interpolation of contours, characteristics of contours. Theodolite surveying: instrumentation and working. Tacheometric surveying: introduction, instrument used in tacheometry, principle of tacheometry, methods of tacheometry.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Surveying Vol.I, B.C.Punmia, McGraw Hill.
2	Surveying Vol.I, T.P.Kanitkar, Pune Vidyarthi Griha Prakashan.
3	Surveying Vol.2, B.C. Punmia, McGraw Hill.
4	Surveying Vol.2, T.P. Kanitkar, Pune Vidyarthi Griha Prakashan.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-305.1	3	3	3	3	3	3	2	3	3	3	2
GT-305.2	3	2	3	2	2	2	3	2	3	2	2
GT-305.3	3	2	3	2	3	2	3	3	2	2	2
GT-305.4	3	2	2	3	2	2	3	2	3	2	2
Average	3	2.25	2.75	2.5	2.75	2.25	2.75	2.5	2.75	2.25	2

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-305.1	3	2	3	3
GT-305.2	3	3	2	3
GT-305.3	3	3	2	3
GT-305.4	2	2	3	2
Average	2.75	2.5	2.5	2.75

PRACTICAL (GT-306) (Based on GT-301,GT-302 & GT-304)						
Lecture	**Credit**	**Assessment Method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam duration**
12	**6**	**Practical**	**75**	**25**	**100**	**3 Hrs.**
COURSE OBJECTIVE						
To impart knowledge and skills for identification of minerals in hand specimens and under microscope.						
COURSE OUTCOME						
Students acquire knowledge about procedure of mineral identification based upon macroscopic and microscopic study.						

LIST OF PRACTICALS:

- Study of crystal forms in different crystal systems.
- Identification of hand specimens using physical properties.
- Study of properties of minerals under microscope in polarized light.
- Identification of Minerals using X-ray diffraction.
- Determination of hardness, specific gravity, of Minerals and classification on that basis.

PRACTICAL (GT-307) (Based on GT-303 & GT-305)						
Lecture	**Credit**	**Assessment Method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam duration**
12	**6**	**Practical**	**75**	**25**	**100**	**3 Hrs.**
COURSE OBJECTIVE						
To impart knowledge and skills surveying methods and study, drawing structures maps.						
COURSE OUTCOME						
Students acquire knowledge of surveying methods and study, drawing structures maps.						

LIST OF PRACTICALS:

- Performing surveys using different methods and techniques, such as: plane table, compass survey, dumpy level, theodolite, total station etc.
- Interpretation and calculations based on data collected by various Survey techniques.
- Contour, stratum contour, dip and strike problem; Completion of outcrop pattern. Geological maps-cross-section through different types of structures and geological history, Identification of folds and faults in models and geological structures in hand specimens.

GEOMORPHOLOGY (GT-401)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To introduce the different types of landforms and their related processes.						
COURSE OUTCOMES						
1.Students will get knowledge about basic concepts of geomorphology and denudational processes.						
2.Students will learn basic concepts of river and aeolian geomorphology and landforms associated with them.						
3.Students will get to know basic concepts of coastal and glacial geomorphology and associated landforms.						
4.Students will get knowledge about tectonic geomorphology and applied geomorphology.						

DETAILS OF COURSE:

Unit	Contents
1	Introduction: development, scope, geomorphic concepts. Landforms: role of lithology, endogenous and exogenous forces responsible, climatic and tectonic factors. Denudational processes: weathering and its types, erosion, transportation, weathering products and soils profiles, types, duricrusts, desert varnish, mass wasting processes and its classification.
2	Fluvial Geomorphology: stream and river processes. Drainage basin: drainage pattern, network characteristics, processes of transport, channel geometry, erosional and depositional features. Desert Geomorphology: deserts and global wind patterns, erosion, transportation and depositional processes of wind.
3	Glacial Geomorphology: formation of glacier ice from snow, morphological and thermal classification of glaciers, glacial landforms. Coastal geomorphology: ocean waves, currents and swash, longshore and rip currents, littoral drift, marine erosional and depositional landforms.
4	Tectonic Geomorphology: geomorphic indicators of tectonic activity and use of geomorphic elements such as drainage patterns, fluvial terraces, paleosols and alluvial fans in neo-tectonic interpretation. Applied Geomorphology: applications in various fields of earth sciences viz. mineral prospecting, geohydrology, civil engineering and environmental studies; geomorphology and GIS. Geomorphology of India: geomorphic features and zones

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Physical Geology, Holmes, A., Ronald Press.
2	Principles of Geomorphology, Thornbury, W.D., Balkema Publishing House.
3	Fundamentals of Geomorphology, Huggett, R., Routledge Press.
4	Cenozoic Geomorphology, Bloom, A., Eastern Economy Publishers.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-401.1	3	2	3	3	2	3	2	3	3	3	3
GT-401.2	3	3	3	2	2	2	3	3	3	2	2
GT-401.3	3	2	3	3	3	2	3	3	3	2	3
GT-401.4	3	3	3	3	2	2	3	2	3	3	2
Average	3	2.5	3	2.75	2.25	2.25	2.75	2.75	3	2.5	2.5

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-401.1	3	2	3	3
GT-401.2	3	3	2	3
GT-401.3	3	3	3	3
GT-401.4	3	2	3	3
Average	3	2.5	2.75	3

GEOCHEMISTRY (GT-402)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To introduce basic principles of geochemistry						
COURSE OUTCOMES						
1.Students will be able to understand objectives and history of geochemistry and fundamentals of thermodynamics.						
2.Students will learn about partitioning in minerals and trace elements.						
3.Students will learn about the geochemistry of radioactive elements.						
4.Students will get to know about the geochemistry of stable isotopes.						

DETAILS OF COURSE:

Unit	Content
1	Objective and history of geochemistry: geochemical classification of elements. Cosmic abundance of elements and stability, fundamentals of thermodynamics, law of thermodynamics, thermodynamics and kinematics.
2	Principles of ionic substitution in minerals: element partitioning in mineral / rock formation. Physico-chemical factors in sedimentation. Trace elements. Geochemical cycle. Geochemistry of hydrosphere and biosphere.
3	Geochemistry of uranium, thorium, rubidium and strontium; principles of U-Pb, Rb-Sr, K-Ar , C-14 methods in dating.
4	Significance of stable isotope geochemistry in geology, isotope fractionation in nature; stable isotopes of oxygen, carbon and hydrogen and their determination.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Introduction to Geochemistry, Mason, B. and Moore, C.B., 1991, Wiley Eastern.
2	Introduction to Geochemistry, Krauskopf, K.B., 1967, McGraw Hill.
3	Principles of Isotope Geochemistry, Faure, G., 1986, John Wiley.
4	Geochemistry,Wedepohl,K.H.Holt, Rinehart and Winston Inc. USA.
5	Geochemistry, Brownlow, A.H. Prentice-Hall.
7	Geochemical Thermodynamics, Nordstrom, D.K. and Munoz, J.L, Blackwell.
8	Hand Book of Exploration Geochemistry, Govett, G.J.S., Elsevier.
9	Using Geochemical data, Rollinson, H., Longman Scientific & Technical NY.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-402.1	3	2	3	3	2	3	2	3	3	3	2
GT-402.2	3	3	3	2	2	2	3	2	3	2	2
GT-402.3	3	2	3	3	3	3	3	3	2	2	2
GT-402.4	3	3	3	3	2	2	3	2	3	3	3
Average	3	2.5	3	2.75	2.25	2.5	2.75	2.5	2.75	2.5	2.25

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-402.1	3	2	3	3
GT-402.2	3	3	3	3
GT-402.3	3	3	2	3
GT-402.4	3	3	3	2
Average	3	2.75	2.75	2.75

BASIC PETROLOGY (GT-403)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To provide basic knowledge of rock types, their origin, textures and structures.						
COURSE OUTCOMES						
1.Students will get knowledge about origin, differentiation of magmas and various structures associated with it.						
2.Students will learn about texture, structures, classification and composition of igneous rocks.						
3.Students will get to know about types and agents of metamorphism and classification of metamorphic rocks.						
4.Students will learn about nature, origin, textures and classification of clastic and non-clastic sedimentary rocks.						

DETAILS OF COURSE:

Unit	Content
1	Origin of magmas, differentiation of magma: fractional crystallization, liquid immiscibility, magma mixing and assimilation. Bowen's reaction series. Intrusive igneous activity: nature of intrusive bodies, tabular intrusive bodies, dikes and sills, massive intrusive bodies, batholith, lopolith, laccoliths, phacoliths.
2	Igneous Rocks: definition, classification of igneous rocks, mode of occurrence of igneous rocks, texture of igneous rocks, structures of igneous rocks, chemical composition and mineral composition of igneous rocks, IUGS classification of igneous rock. Description of certain important igneous rocks.
3	Metamorphic rocks: metamorphism and their types, agents of metamorphism: heat, pressure, differential stress, chemically active fluids. Classification of metamorphic rocks: foliated and non- foliated rocks, texture of metamorphic rocks, structure of metamorphic rocks.
4	Sedimentary rocks: nature and origin of sedimentary rocks, concept of size, size scales. mode of sediment transport. shape and roundness, sphericity. Sedimentary Fabric, porosity, permeability. Classification of sedimentary structures, geometry of sedimentary bodies. Elementary ideas about sandstones, conglomerates, shales, limestones and dolomites. Basic classification of clastic and non- clastic sedimentary rocks.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Petrology: The Study of Igneous, Sedimentary and Metamorphic Rocks, Raymond, L.A., McGraw Hill College.
2	Igneous and Metamorphic Petrology, Best, M.G., Wiley-Blackwell.
3	Introduction to Metamorphic Petrology, Yardley, B.W.D., Longman Scientific and Technical.
4	Sedimentary Petrology, Tucker, H.E., Wiley-Blackwell.
5	Sedimentary Rocks, Pettijohn, F.J., Harper-Collins.

6	Principles of Metamorphic Petrology, Vernon, R.H., and Clarke, G., Cambridge University Press.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-403.1	3	3	3	3	2	3	2	3	3	3	2
GT-403.2	2	2	3	2	2	2	3	2	3	2	2
GT-403.3	3	3	3	2	3	2	3	3	3	2	2
GT-403.4	3	2	3	3	2	2	3	2	3	3	2
Average	2.75	2.5	3	2.5	2.25	2.25	2.75	2.5	3	2.5	2

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-403.1	3	2	3	3
GT-403.2	3	3	2	3
GT-403.3	3	3	2	3
GT-403.4	3	2	3	2
Average	3	2.5	2.5	2.75

ENERGY MINERAL RESOURCES OF INDIA (GT-404)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To introduce students with the major energy mineral resources of India.						
COURSE OUTCOMES						
1.Students will get acknowledged about the energy scenario, production, demand and consumption of important mineral resources in the world and India.						
2.Students will learn about origin, types, physical and chemical properties of coal and its geographical and geological distribution in India.						
3.Students will get to know about origin, migration and entrapment of petroleum along with brief overview on oil and gas potential of India.						
4.Students will get acknowledged to concepts of nuclear energy and nuclear energy scenario of India and its future prospects.						

DETAILS OF COURSE:

Unit	Content
1	A brief overview of energy mineral resources of India and their contribution to the total energy demands of the country, linkage of industrialization with energy consumption, sources of renewable and non-renewable energy, suitability of different parts of India for harnessing different types of renewable energy. Importance of sustainable energy resources in the development of the country.
2	Coal: definition, types, coalification process, rank of coal, properties of coal: moisture, ash content, volatile matter, present day peat bogs and swamps, important gondwana and tertiary coal fields of India, coal production.
3	Source rock, reservoir rock, traps, migration of oil and gas, characteristics of reservoir rocks and cap rock, major oil and gas fields of India, India's oil and gas reserves-position in the world and future prospects.
4	Radioactivity and nuclear energy, important atomic minerals, their mode of occurrence and association, U and Th deposits of India, production, reserves and future scenario. Nuclear power production and its potential in India. Peaceful uses of nuclear energy, nuclear environmental hazards.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Economic mineral deposits, Bateman, A.M., Chapman and Hall.
2	Ore Deposits of India, Gokhale and Rao, Thomson Press, Delhi.
3	India's mineral resources, Krishnaswami S., Oxford & IBH.
4	A Handbook of minerals, Crystals, Rocks and Ores, Parmod, A.O., New India Publishing Agency – 2009.
5	Economic Geology – Economic Mineral Deposits of India,, Prasad, U., CBS Publishers

	Ltd.
6	Textbook of coal (Indian Context), Chandra, D., Singh R.M. and Singh. M.P., Tata book Agency, Varanasi.
7	Coal and Organic Petrology, Singh, M.P. (Ed), Hindustan Publication Ltd. New Delhi.
8	Introduction to Petroleum Geology, Holson, G.D., Tiratsoo, E.N., Gulf Publication Houston, Texas – 1985.
9	Geology of Petroleum, Laverson, A.I., W. H. Freeman and company.
10	Petroleum Geology, North, F.K., Kluwer Academic Publisher.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-404.1	3	2	3	3	2	3	2	3	3	3	3
GT-404.2	3	2	3	2	2	2	3	2	3	2	3
GT-404.3	3	2	3	2	3	2	3	3	3	2	3
GT-404.4	3	2	3	3	3	3	3	2	3	3	3
Average	3	2	3	2.5	2.5	2.5	2.75	2.5	3	2.5	3

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-404.1	3	2	3	3
GT-404.2	3	3	3	3
GT-404.3	3	3	3	3
GT-404.4	3	3	3	2
Average	3	2.75	3	2.75

COMPUTATIONAL AND STATISTICAL METHODS IN GEOLOGY (GT-405)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To provide basic concepts of computing techniques and statistical methods applicable to geological problems.						
COURSE OUTCOMES						
1.Students will get acknowledged about the role of mathematical techniques in geo-sciences with a quick rewind of basic computer concepts.						
2.Students will get to learn various methods of data handling and representation.						
3.Students will get knowledge of basic concepts of computer language and graphical representation of data.						
4.Students will learn about statistical techniques and their application in geology.						

DETAILS OF COURSE:

Unit	Content
1	Role of mathematical and numerical techniques in geo-sciences, qualitative and quantitative data in geology; application of computer in general database of geology. Computer system hardware: operating system, DOS and its use.
2	Spreadsheets: workbook, worksheet, cell and cell reference, type of data, Functions and formulas, cell range and reference in formula; protecting worksheets; sorting and filtering data; numerical integration by simpson's method, trapezoidal method. Utility of open source and other common softwares in calculating statistical parameters and presenting them in graphic manner.
3	Graphs: collection and selection of data, linear and logarithmic scale, linear graphs, 2d and 3d graphs, bar graphs, scatter plots, pie diagrams etc, use of graphs in geoscience. Data types, expressions and statements, interactive statements, input/output statements subroutine and functions. Utility of google-earth software in understanding earth features and geomorphic-tectonic units, least square fit to the given data.
4	Statistical techniques: mean, mode, median, cumulative frequency distribution, skewness & kurtosis, graphical representation on histograms and curves, regression analysis, linear regression, correlation and correlation coefficients, application of these methods in geology.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Statistics of Earth science Data, Borradaile, G.J., Springer.
2	Elementary Numerical Analysis, Atkinson, K., Han John, W., John Wiley & Sons.
3	Applied Numerical Methods, Yang, W.Y., Cao, W., Chung, T.S., John Wiley & Sons.

4	Numerical Recipes: The Art of Scientific Computing, Press, W.H., Teukolsky, S.A., Vellerling, W.T., Flannery,B.P., Cambridge University Press.
5	Statistics and Data Analysis in Geology, Davis, J.C., 3rd Ed., John Wiley & Sons.
6	Computer Oriented Numerical Methods, Rajaraman, V., Prentice Hall of India

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-405.1	3	2	3	3	2	3	2	3	3	3	2
GT-405.2	3	3	3	2	2	2	3	2	3	2	2
GT-405.3	3	2	3	2	3	2	3	3	3	2	3
GT-405.4	3	3	3	3	2	3	3	2	3	3	3
Average	3	2.5	3	2.5	2.25	2.5	2.75	2.5	3	2.5	2.5

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-405.1	3	2	3	3
GT-405.2	3	3	2	3
GT-405.3	3	3	2	3
GT-405.4	3	2	3	2
Average	3	2.5	2.5	2.75

PRACTICAL (GT-406) (Based upon GT-402 & GT-403)						
Lecture	**Credit**	**Assessment Method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam duration**
12	**6**	**Practical**	**75**	**25**	**100**	**3 Hrs.**
COURSE OBJECTIVE						
To introduce students about identification of rock samples based on macroscopic and microscopic properties.						
COURSE OUTCOME						
Students will get acknowledged about identification of rock samples based on macroscopic and microscopic properties.						

LIST OF PRACTICALS:

- Study of different rock types in hand specimens.
- Microscopic study of mineral assemblages of different igneous, metamorphic and sedimentary rocks.
- Exercise based on CIPW norms.

PRACTICAL (GT-407) (Based upon GT-401,GT-404 & GT-405)						
Lecture	**Credit**	**Assessment Method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam duration**
12	**6**	**Practical**	**75**	**25**	**100**	**3 Hrs.**
COURSE OBJECTIVE						
To introduce students to computational and statistical methods application in earth science.						
COURSE OUTCOME						
Students will get acknowledged about computational methods and its use in solving statistical and other problems in earth science.						

LIST OF PRACTICALS:

- Spreadsheets for solving mathematical and statistical problems in earth science.
- Spreadsheets used in statistical exercises based on geo-scientific data.
- Creating graphs from tabular data: linear, 2d and 3d.
- Trigonometry: dip, apparent dip, strike, slope and other related problems.
- Exercises based on energy mineral resources of India.
- Exercises based on morphometry of river channels (drainage pattern, stream order, sinuosity)

PALAEONTOLOGY-I (GT-501)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To introduce basic concepts in paleontology: invertebrate, vertebrate and plant fossils.						
COURSE OUTCOMES						
1. Students will get introduced to the study of fossils and evolutionary history of life.						
2. Students will get acknowledged with morphology and classification of major vertebrate and invertebrate fossil species.						
3. Students will learn about concepts of micropalaeontology and palaeobotany.						
4. Students will get knowledge of palynology and its application in geosciences.						

DETAILS OF COURSE:

Unit	Content
1	Fundamentals: definition, objectives and scope, nature of fossil record and their uses, classification of animals, their habits and habitats, evolution of life through the ages, migration, dispersal and extinction of life.
2	Invertebrate paleontology: morphology, classification, evolutionary trends, geological history and geographical distribution of brachiopods, pelecypods, gastropods, cephalopods, trilobita, echinoides, coelenterates and graptolites, vertebrate paleontology- basic concepts, broad classification of groups.
3	Micropaleontology: introduction, techniques of processing of samples, brief morphology and classification of foraminifera, ostracods, radiolarians and conodonts. Palaeobotany: introduction, gondwana flora.
4	Basics of palynology and its applications, applied aspects: age determination and correlation, palaeoecological interpretations with case histories, fossils as a tool in petroleum exploration.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	An Introduction to the Study of Fossil Plants, Walton, J., Adam & Charles Black.
2	Paleontology Invertebrate, Woods, H., CBS Publications.
3	Vertebrate Paleontology, Benton,M.J., Chapman & Hall.
4	Paleontology, Colbert, R.L., John Willey & Sons.
5	Invertebrate Paleontology, Schrock Twenhofel, McGraw Hill.
6	Biostratigraphy: Microfossils & Geological Time, McGowran, B., Cambridge University Press.
7	Microfossils,Second Edition, Howard A. Armstrong & Martin D. Brasier, Blackwell Publication.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-501.1	3	3	3	3	2	3	2	3	3	3	3
GT-501.2	3	2	3	2	3	2	3	2	3	2	2
GT-501.3	3	3	3	2	3	2	3	3	3	2	3
GT-501.4	3	2	3	3	3	3	3	2	3	3	2
Average	3	2.5	3	2.5	2.75	2.5	2.75	2.5	3	2.5	2.5

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-501.1	3	2	3	3
GT-501.2	3	3	2	3
GT-501.3	3	3	2	3
GT-501.4	3	2	3	2
Average	3	2.5	2.5	2.75

PLATE TECTONICS (GT-502)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**

COURSE OBJECTIVE

To impart in-depth understanding of types of plate boundaries and different geological processes and features at plate boundaries.

COURSE OUTCOMES

1. Students will get knowledge about plate tectonics and their movement along with structural and seismological features.
2. Students will learn about the origin and evolution of constructive and conservative plate boundaries and structures related to them.
3. Students will get a deep insight on destructive plate boundaries and associated features.
4. Students will get acknowledged to concepts of orogenesis and a detailed description of Indian plate with special emphasis on himalayan orogeny.

DETAILS OF COURSE:

Unit	Content
1	Introduction to plate tectonics: historical background, evidence of plate motion, plate driving force, lithosphere, asthenosphere, types of place boundaries and sense of displacements of plates, oceanic and continental types of lithosphere, constituents, major structural seismological features of the earth interior.
2	Constructive plate boundaries: origin and evolution, internal and external structure, composition; gravity anomaly. Conservative plate boundaries: structure and evolution, transforms faults and plate motions, seismicity, palaeomagnetism and its application in plate palaeo positions.
3	Destructive plate boundaries: surface manifestations, geophysical and geological characteristics: gravity anomaly, sedimentological, metamorphic and magmatic characteristics; associated geological features: oceanic trenches, island arc, volcanic arcs, accretionary wedges, fore and back arc basin.
4	The Wilson cycle; orogenesis: plate tectonics and mountain building processes, Indian plate: configuration and characters of Indian plate margins and palaeo positions of Indian plate, Himalayan orogeny and tectonic models.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Plate Tectonics and Crustal Evolution, Condie, K.C., Butterworth-Heinemann.
2	Understanding the Earth, Brown, G.C., Hawkesworth, C.J. and Wilson, R.C.I. (Eds.), Cambridge University Press.
3	Global Tectonics, Kearey, P. and Vine, F.J., Blackwell.
4	Plate Tectonics: How it Works, Cox, A., Hart, R.B., Wiley-Blackwell.
5	Geology of the Himalayas, Gansser, A., John Wiley & Sons.
6	Dynamic Earth: Plates, Plumes and Mantle Convection, Davies, G.F., Cambridge

	University Press.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-502.1	3	2	3	3	2	3	2	3	3	3	3
GT-502.2	3	2	3	2	2	2	3	2	3	2	2
GT-502.3	3	2	3	2	3	3	3	3	2	2	2
GT-502.4	3	2	3	3	2	2	3	2	3	3	3
Average	3	2	3	2.5	2.25	2.5	2.75	2.5	2.75	2.5	2.5

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-502.1	3	2	3	3
GT-502.2	3	3	2	3
GT-502.3	2	3	2	2
GT-502.4	3	2	3	2
Average	2.75	2.5	2.5	2.5

IGNEOUS PETROLOGY (GT-503)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To provide in-depth knowledge of igneous rocks including their fabric, geochemical characteristics and petrogenesis.						
COURSE OUTCOMES						
1. Students will get detailed knowledge about generation and differentiation of magma.						
2. Students will learn detailed classification of igneous rocks and methods associated with it.						
3. Students will get introduced to vast concepts of phase rule and various phase diagrams to understand the crystallization behavior of igneous rocks; Trace elements as petrogenetic indicators.						
4. Students will learn about the relationship of magmatism with plate tectonics and global tectonic processes.						

DETAILS OF COURSE:

Unit	Content
1	Generation of magma: magma from partial melting in mantle, magma generation in crust, magma differentiation: fractional crystallization, gravitational differentiation, liquid immiscibility, magma mixing, assimilation and contamination of magma.
2	Classification and occurrence of igneous rocks: acidic rocks, intermediate rocks, basic rocks, ultramafic rocks, alkaline rocks, carbonatites. concept of CIPW norms, variation diagrams in igneous petrology.
3	Phase diagrams: binary and ternary phase diagrams, geochemical characteristics of igneous rocks as petrogenetic indicators: Rb-Sr Isotope evolution in igneous rocks; Sm–Nd systematics as petrogenetic indicators.
4	Magmatism and global tectonic processes: magmatism at constructive plate margin, mid oceanic ridges, ocean floor magmatism, magmatism at destructive plate margin, subduction zone magmatism, island arc systems, intraplate magmatism: concept and continental flood basalts.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Igneous andMetamorphic Petrology, Best, M.G., Second Edition, Backwell.
2	Igneous Petrogenesis: A Global Tectonic Approach,Willson, M., Unwin-Hyman.
3	An Introduction to Igneous and Metamorphic Petrology, Winter, J., Prentice Hall.
4	Igneous Petrology, Hall, A., John Wiley & Sons.
5	Igneous Rocks and Processes – A Practical Guide, Gill, R., Wiley Blackwell.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-503.1	3	2	3	3	2	3	2	3	3	3	2
GT-503.2	3	2	3	2	2	2	3	2	3	2	3
GT-503.3	3	3	3	3	3	2	3	3	3	2	3
GT-503.4	3	2	3	3	2	2	3	2	3	3	3
Average	3	2.25	3	2.75	2.25	2.25	2.75	2.5	3	2.5	2.75

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-503.1	3	2	3	3
GT-503.2	3	3	2	3
GT-503.3	3	3	3	3
GT-503.4	3	2	3	2
Average	3	2.5	2.75	2.75

SEDIMENTOLOGY (GT-504)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To provide in-depth knowledge of sedimentary processes including depositional environments.						
COURSE OUTCOMES						
1. Students will get acknowledged with detailed classification, textures and structures associated with coarse grained siliciclastic rocks and a vast family of sandstones.						
2. Students will learn about classification, textures, structures of clay bearing rocks and a deep insight on carbonaceous sedimentary rocks.						
3. Students will get knowledge about chemical sedimentation in sea and rocks associated with it with a brief introduction to the techniques of heavy mineral separation and palaeo current analysis.						
4. Students will learn about broad concepts of sedimentary environments and facies.						

DETAILS OF COURSE:

Unit	Content
1	Gravels, conglomerates and breccias: composition, texture, structure and classification orthoconglomerate paraconglomerate, intra formational conglomerates, diagenesis of conglomerates pseudo conglomerates, pseudo breccia sandstones: fabric, structure, mineralogy, classification of sandstones, greywackes, matrix problem, soda problem, occurrence and geological signifacence, arkose, definition, fabric and composition, lithic sandstones and quartz arenites; definition, origin and geological significance. Diagenesis of sandstone: cementation, decementation, matrix and cement.
2	Shales, argillites and siltstones: definition, textures, structures. Clay minerals: composition and structure, occurrence and origin clay minerals. Diagenesis of shale: compaction, diagenetic classification of shales, residual clays; red, balck siliceous and calcareous shales, marls, loess and its origin. Limestones and dolomites: shallow and deep sea carbonates, fresh water, carbonates. Textures and structures of carbonates. Classification of evaporitic and aeolian
3	Chert: definition, origin and classification glauconite, pyrite and barite nodules, oncolites. provenance, mineral stability maturity of sediments: compositional and textural. Heavy minerals: definition, method of separation and geological significance. Paleocurrent analysis and its significance. Lithification and diagenesis.
4	Physico-chemical condition of sedimentation: Nature of depositing medium, depth of water, current velocity, salinity and temperature, classification of sedimentary environments, Alluvial fans, braided and meandering fluvial systems, lacustrine, eolian and glacial deposits, deltas, clastic shelf, continental slope and pelagic sediments: tectonic setting and sedimentology. Sedimentary facies. Flysch molasse sedimentary basin in plate tectonic settings.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Origin of Sedimentary Rocks, Blatt, H., Middleton, G.V. and Murray, T.G., Prentice Hall.
2	Principles of Sedimentology and Stratigraphy, 4th Ed., Boggs, S., Prentice Hall.
3	Sedimentology and Sedimentary Basins, Leeder, M.R., Prentice Hall.
4	Sedimentary Environments – Processes, Facies and Stratigraphy, Reading, H.G., Wiley-Blackwell.
5.	Sedimentary rocks, Pettijohn, F.J., CBS Publishers.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-504.1	3	3	3	3	2	3	2	3	3	3	3
GT-504.2	3	2	2	2	2	2	3	2	3	2	3
GT-504.3	3	3	3	2	3	2	3	3	3	2	2
GT-504.4	3	2	3	3	2	3	3	2	3	3	2
Average	3	2.5	2.75	2.5	2.25	2.5	2.75	2.5	3	2.5	2.5

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-504.1	3	2	3	3
GT-504.2	3	3	2	3
GT-504.3	3	3	2	3
GT-504.4	3	2	3	2
Average	3	2.5	2.5	2.75

GEOPHYSICAL PROSPECTING (GT-505)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To introduce basic concepts of geophysical methods and their applications in solving geological problems.						
COURSE OUTCOMES						
1. Students will get introduced to geophysical methods of prospecting along with a detailed study of gravity methods.						
2. Students will learn about principles, interpretations and applications of magnetic method of prospecting.						
3. Students will get to know about reflection and refraction of seismic waves and prospecting techniques related to them.						
4. Students will get acknowledged to principles and applications of electrical and electromagnetic method of prospecting.						

DETAILS OF COURSE:

Unit	Content
1	Introduction: overview and importance of various geophysical methods in geological studies, gravity method: basic principles, gravity anomalies, gravimeters, data acquisition procedures, data reduction and processing, interpretation of bouguer anomalies for basic geometrical shapes, depth rules, applications.
2	Magnetic method: basic principles, magnetic anomalies, magnetometers, data acquisition procedures, data reduction and processing, interpretation of magnetic anomalies for basic geometrical shapes, depth rules, applications.
3	Seismic methods: refraction, reflection and attenuation of seismic waves, geophones and hydrophones, recording instruments, seismic refraction method, travel time curves for flat interfaces, interpretation of refraction profiles, seismic reflection method, CDP shooting, elementary ideas about processing and interpretation of seismic reflection data: application.
4	Electrical method: apparent resistivity, sounding and profiling, different electrode configurations, field procedures, resistivity meters, data interpretation using curve matching method, applications. Electromagnetic methods: basic concepts, dip angle techniques, measurement of amplitude and phase, various transmitter and receiver loop configurations, applications.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Applied Geophysics, Telford, W.M., Geldart, L.P. and Sheriff, R.E., Cambridge University Press.
2	An Introduction to Geophysical Exploration, Blackwell.
3	Principles of Applied Geophysics, Parasnis, D.S., Kearey, P. Brooks, M. and Hill, I.,

	Chapman and Hall.
4	Introduction to Geophysical Prospecting, Dobrin, M.B. and Savit, C.H., McGraw-Hill.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-505.1	3	2	3	3	3	3	2	3	3	3	2
GT-505.2	3	3	3	2	2	3	3	2	3	2	2
GT-505.3	3	3	3	2	3	2	3	3	3	2	2
GT-505.4	3	2	3	3	3	2	3	2	3	3	3
Average	3	2.5	3	2.5	2.75	2.5	2.75	2.5	3	2.5	2.25

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-505.1	3	2	3	3
GT-505.2	3	3	2	3
GT-505.3	3	3	2	3
GT-505.4	3	2	3	2
Average	3	2.5	2.5	2.75

PRACTICAL (GT-506) (Based on GT-501 & 503)						
Lecture	**Credit**	**Assessment Method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam duration**
12	**6**	**Practical**	**75**	**25**	**100**	**3 Hrs.**
COURSE OBJECTIVE						
To impart knowledge of microscopic interpretation of Igneous rocks and study of fossils.						
COURSE OUTCOME						
Students come to know about the procedure of microscopic study of igneous rock thin sections and study of fossils.						

LIST OF PRACTICALS:

- Megascopic study of important invertebrate, vertebrate and plant fossils, Microscopic study of important invertebrate and vertebrate fossils and palynomorphs.
- Microscopic studies of acidic, basic and ultramafic igneous rocks.
- Geochemical variation diagram studies.
- CIPW normative calculations based on geochemical data.

PRACTICAL (GT-507) (Based on GT-502, GT-504 & GT-505)						
Lecture	**Credit**	**Assessment Method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam duration**
12	**6**	**Practical**	**75**	**25**	**100**	**3 Hrs.**
COURSE OBJECTIVE						
To provide in-depth practical knowledge of sedimentary rocks and geophysical methods.						
COURSE OUTCOMES						
Students will get knowledge about sediments and sedimentary rocks, and geophysical methods.						

LIST OF PRACTICALS:

- Grain size analysis using sieves and its statistical analysis.
- Determination of roundness of elastic particles using comparison chart method.
- Statistical analysis of orientation data.
- Thin section study of sandstones and limestone.
- Recognition of major clay minerals from x-ray diffractograms.
- Geophysical practicals & exercises.

FIELD TRAINING-I (GT-508)					
Credit	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**Field Training**	**100**	**50**	**150**	**-----**
COURSE OBJECTIVE					
To impart understanding of small scale mapping methods, sampling in the field and using different tools and instruments in the field.					
COURSE OUTCOME					
Students will get knowledge about methods of Geological mapping, sampling and learn use of tools and instruments in the field and learn about preparing field training reports.					

STRATIGRAPHY (GT-601)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To provide basic understanding of principles of stratigraphy, stratigraphic contacts geological time scale and stratigraphic sequences of India						
COURSE OUTCOMES						
1. Students will get knowledge about basic principles of stratigraphy and geological time scale.						
2. Students will learn about conformable and unconformable contacts in detail and basic concepts of correlation.						
3. Students will get acknowledged with various branches of stratigraphy with special emphasis on sequence stratigraphy.						
4. Students will get detailed knowledge about major stratigraphic systems of India.						

DETAILS OF COURSE:

Unit	Content
1	Define stratigraphy: scope of stratigraphy, principles of stratigraphy, Geological time scale, purpose, scope and their development.
2	Stratigraphic contacts: conformity, contacts in conformable strata. Unconformity: angular unconformity, disconformity, paraconformity, and nonconformity. Correlation: scope of correlation, types of correlation-lithological, biological and chrono-correlation.
3	Stratigraphic units: classification and nomenclature of units (lithostratigraphy, biostratigraphy, chronostratigraphy and geochronology). Facies: transgression and regression. Systems tracts: lowstand, transgressive, highstand, falling stage.
4	Broad outline of some of the major stratigraphic sequences of India, Dharwar System, Cuddapah System, Vindhyan System, Spiti Group, Salt range, Deccan Traps, Kutch area, Gondwana Group, Siwalik System, assam area stratigraphic units of India.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Principles of Stratigraphy, Lemon, R.L., Merrill Publishing.
2	Fundamentals of Historical Geology and Stratigraphy of India, Boggs, S., Jr. Wiley.
3	Fundamentals of Historical Geology and Stratigraphy of India, Kumar, R., New age International Publisher.
4	Geology of India and Burma, Krishan, M.S., CBS Publications.
5	Geology of India, Wadia, D.N., Tata Mc-Graw Hill.
6	Geology of India, Vol. I and II, Ramakrishnan, M. and Vaidyanathan, R., Geological Society of India.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-601.1	3	2	3	3	2	3	2	3	3	3	3
GT-601.2	3	2	3	2	2	2	3	2	3	2	3
GT-601.3	3	2	3	2	3	2	3	3	3	2	3
GT-601.4	3	2	3	3	2	2	3	2	3	3	2
Average	3	2	3	2.5	2.25	2.25	2.75	2.5	3	2.5	2.75

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-601.1	3	2	3	3
GT-601.2	3	3	3	3
GT-601.3	3	3	2	3
GT-601.4	3	3	3	2
Average	3	2.75	2.75	2.75

STRUCTURAL GEOLOGY-II (GT-602)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To introduce the students to various geological structures and their mechanism of formation.						
COURSE OUTCOMES						
1. The students can learn about the stress and strain analytical techniques and their geological significance.						
2. The students can learn about geometrical analysis of various structures and mechanisms of folding.						
3. The students will get to know about principles and geological significance of shear zones.						
4. The students will learn detailed descriptions of tectonites and an overview of superposed folding.						

DETAILS OF COURSE:

Unit	Content
1	Stress: Stress in homogeneous and inhomogeneous media and analytical techniques. Strain: homogeneous strain and techniques of strain analysis including fry method, grain centre method and Rf / Φ method, types of strain ellipses and ellipsoids, their properties and geological significance.
2	Geometrical analysis of various structures: geometry and analysis of fractures, joints and faults, geometry of folds and their classification schemes, mechanism of folding and internal strain accumulation.
3	Shear Zones: shear sense indicators, shear zone kinematics. role of fluids and techniques of their analysis, geological importance, basic idea on the structure and tectonics of Himalaya.
4	Analysis of foliation and lineation in rocks: geometry, mechanics and significance. Techniques of structural analysis in areas of superposed folding.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Principles of Structural Geology, Suupe, J., Prentice-Hall.
2	Structural Geology, Twiss, R.J. and Moores, E.M., W.H. Freeman & Co.
3	Structural Geology of rocks and regions, Davis, G.H. and Reynolds, S.J., John Wiley & Sons, Inc.
4	Structural Geology: Fundamental and Modern developments, Ghosh, S.K. 1993, Pergamon.
5	Techniques of Modern Structural Geology, Volume 3: Applications of Continuum Mechanics in Structural Geology (Modern Structural Geology), Ramsay, J.G., Lisle, R.J., Academic Press.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-602.1	3	2	3	3	2	3	2	3	3	3	3
GT-602.2	3	2	3	2	2	2	3	2	3	2	3
GT-602.3	3	2	3	2	3	2	3	3	3	2	2
GT-602.4	3	2	3	3	2	2	3	2	3	3	2
Average	3	2	3	2.5	2.25	2.25	2.75	2.5	3	2.5	2.5

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-602.1	3	2	3	3
GT-602.2	3	3	2	3
GT-602.3	3	3	2	3
GT-602.4	3	2	3	2
Average	3	2.5	2.5	2.75

METAMORPHIC PETROLOGY (GT-603)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To provide in-depth knowledge of phase rule, classification of metamorphic rocks and metamorphic assemblages.						
COURSE OUTCOMES						
1. Students will get knowledge about agents and types of metamorphism along with various classification schemes of metamorphic rocks.						
2. Students will recall concepts of phase rule and utilize in understanding the recrystallization behavior of metamorphic rocks.						
3. Students will learn about phase diagrams and petrogenetic grid for metamorphic assemblages.						
4. Students will get knowledge about mineral assemblages and chemographic reactions in various metamorphic facies.						

DETAILS OF COURSE:

Unit	Content
1	Type of metamorphism and controlling factors, different types of metamorphic rocks, textural and structural classification of metamorphic rocks.
2	Phase rule, metamorphic reactions and phase equilibria in metamorphic rocks, graphical representation of various mineral assemblages in different P-T conditions, chemographic projections.
3	Phase diagrams and petrogenetic grid for metamorphic assemblages in various grades of metamorphism thermodynamics of metamorphic reactions, mineral assemblages and metamorphic isograds.
4	Mineral assemblages and chemographic relation for different parent rock types in zeolite, prehnite, pumpellyite, greenschist, amphibolite, granulite, eclogite, and blueschist facies and sub-facies, mineral paragenesis.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Igneous and Metamorphic Petrology, Best, M.G., Blackwell.
2	Petrogenesis of Metamorphic Rocks, Bucher, K., Grapes, R., Springer.
3	Metamorphic Phase Equilibria and Pressure-Temperature-Time Paths, Spear, F.S., Mineralogical Society of America Monograph.
4	An Introduction to Metamorphic Petrology, Yardley, B.W.D., Longman-ELBS.
5	An Introduction to Igneous and Metamorphic Petrology", Winter, J.D., Prentice-Hall.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-603.1	3	3	3	3	2	3	2	3	3	3	2
GT-603.2	3	3	3	2	3	2	3	2	3	2	3
GT-603.3	3	2	3	2	3	2	3	3	3	2	3
GT-603.4	3	2	2	3	2	3	3	2	3	3	3
Average	3	2.5	2.75	2.5	2.5	2.5	2.75	2.5	3	2.5	2.75

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-603.1	3	2	3	3
GT-603.2	3	3	2	3
GT-603.3	3	3	3	3
GT-603.4	3	3	3	2
Average	3	2.75	2.75	2.75

APPLIED GEOCHEMISTRY (GT-604)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To introduce geochemistry as a tool for understanding various earth processes.						
COURSE OUTCOMES						
1. Students will get to learn about chemical compositions of earth and basic concepts of surface chemistry.						
2. Students recall concepts of thermodynamics and chemical equilibrium and learn about their applications in geology.						
3. Students will learn about aqueous solutions and isotope geochemistry.						
4. Students will learn about applications of geochemistry in exploration and various fields of geology.						

DETAILS OF COURSE:

Unit	Content
1	Chemical composition of earth, distribution of elements in igneous, sedimentary and metamorphic rocks, internal divisions and differentiation of earth. surface chemistry, colloids in igneous, sedimentary and metamorphic conditions.
2	Chemical equilibrium, equilibrium kinetics, chemical thermodynamics and its applications in geology. Solution and mineral equilibria with its significance in geology.
3	Aqueous solutions: carbonate equilibria, silicate equilibria. Sedimentation and diagnosis-organic and inorganic geochemistry,, radiogenic and stable isotopes, different isotopic systematics, geochronology.
4	Analytical techniques for rock, sediments and water compositions. Geochemical techniques for mineral exploration in different geological environments, geochemical surveys and data analysis.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Introduction to Geochemistry, Kraushopk, K.B., and Bird, D.K., McGraw-Hill.
2	Geochemistry: An Introduction, Albarede, F., Cambridge University Press.
3	Essentials of Geochemistry,Walther, J.V., Jones & Bartlett, Longman Pearson Education.
4	Modern Analytical Geochemistry, Gill, R., Addison Wesley, Longman Pearson Education.
5	Treatise of Geochemistry, Holland, H.D. (Ed.), Elsevier.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-604.1	3	2	3	3	3	3	2	3	3	3	2
GT-604.2	3	2	3	2	2	2	3	2	3	2	2
GT-604.3	3	2	3	2	3	3	3	3	3	2	2
GT-604.4	3	2	3	3	2	2	3	2	3	3	2
Average	3	2	3	2.5	2.5	2.5	2.75	2.5	3	2.5	2

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-604.1	3	2	3	3
GT-604.2	3	3	2	3
GT-604.3	3	3	2	3
GT-604.4	3	2	3	2
Average	3	2.5	2.5	2.75

ECONOMIC AND ORE GEOLOGY (GT-605)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To impart basic understanding of different types of mineral deposit and processes of their formation.						
COURSE OUTCOMES						
1. Students will get introduced to economic geology and learn about geological aspects of ore bodies.						
2. Students will learn about ore genesis and mineralization associated with various rock types and series.						
3. Students will learn about processes of ore formation and their classification as endogenic and exogenic processes.						
4. Students will get knowledge of geographical and geological distribution of important economic deposits of India.						

DETAILS OF COURSE:

Unit	Content
1	Introduction: basic terms and definitions, historical background, scope of economic geology, importance of mineral deposits in national economy, ore deposits and ore minerals: classification and structure/texture of ore minerals, morphology of ore bodies.
2	Ore genesis: physico- chemical conditions of ore formation. Fluid inclusion studies, mineralization associated with ultramafic, mafic and acidic rocks, greenstone belts, komatiites, anorthosites and kimberlites and submarine volcanism. Metamorphic and metamorphosed processes responsible for ore mineral genesis.
3	Endogenic processes of ore formation: early and late magnetic segregation and injection, immiscible liquid segregation, different types of hydrothermal ore formation, volcanic exhalative process, exogenic processes of ore formation, mechanical accumulation, sedimentary precipitates, residual concentration, oxidation and supergene enrichment.
4	Geology and distribution of important economic deposits of India: bauxite, iron, manganese, copper, lead, zinc, gold, chromites, diamond, coal and petroleum. Metallogeny and mineral belts: global distribution of minerals in time and space.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Economic Mineral Deposits, Bateman, A.M. and Jensen, M.L., John Wiley & Sons.
2	The Geology of Ore Deposits, Guilbert, J.M. and Charles F.P. Jr., Waveland.
3	Ore Geology and Industrial Minerals: An Introduction", Evans, A.M., Blackwell Science, 3rd Ed.
4	Mineral Resources of India, Bannerjee, D.K., The World Press.
5	Ore Genesis: A Holistic Approach, Mookherjee, A., Allied Publishers.

6	Geology of Mineral Deposits, Smirnov, V.I., MIR Publishers.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-605.1	3	2	3	3	2	3	2	3	3	3	2
GT-605.2	3	2	3	2	2	2	3	2	3	2	2
GT-605.3	3	2	3	2	3	2	3	3	3	2	2
GT-605.4	3	2	3	3	2	2	3	2	3	3	2
Average	3	2	3	2.5	2.25	2.25	2.75	2.5	3	2.5	2

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-605.1	3	2	3	3
GT-605.2	3	3	2	2
GT-605.3	3	3	2	3
GT-605.4	2	2	3	2
Average	2.75	2.5	2.5	2.5

PRACTICAL (GT-606) (Based on GT-601 & GT-602)						
Lecture	**Credit**	**Assessment Method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam duration**
12	**6**	**Practical**	**75**	**25**	**100**	**3 Hrs.**
COURSE OBJECTIVE						
To provide in-depth practical knowledge of stratigraphy and structural geology.						
COURSE OUTCOME						
Students get acknowledged about the practical of stratigraphy and structural geology.						

LIST OF PRACTICALS:

- Techniques of strain analysis: determination of finite strain of deformed objects using long- to short axis, center-to-centre, Fry and Rf/ Φ methods.
- Determination of finite strain from deformed fossils.
- Dip isogon method of fold analysis.
- Determination of strain in ductile shear zones and analysis of brittle fault zones.
- Structural analysis of folded terrains.
- Practical & exercises on stratigraphy.

PRACTICAL (GT-607) (Based on GT-603, GT-604 & GT-605)						
Lecture	**Credit**	**Assessment Method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam duration**
12	**6**	**Practical**	**75**	**25**	**100**	**3 Hrs.**
COURSE OBJECTIVE						
To provide in-depth practical knowledge of metamorphic rocks, geochemical data analysis techniques and interpretation of mineral exploration data.						
COURSE OUTCOME						
Students come to know about the procedure of microscopic study of thin sections and distribution of important mineral deposits.						

LIST OF PRACTICALS:

- Microscopic/petrographic studies of metamorphic rocks.
- Sampling of rocks, sediments and water for geochemical analysis.
- Digestion of rock samples, preparation of solutions for analysis.
- Analysis of major and trace elements in silicate rocks.
- Preparation of standards for geochemical analysis.
- Preparation of various solutions with differing ionic strength.
- Basic principles and demonstration of analytical instruments.
- Exercises on geochemical data interpretation.
- Locating different important mineral deposits on an outline map of India.
- Megascopic study of ore specimens/industrial minerals.
- Microscopic study of important ore minerals.
- Preparation of polished ore specimen.

REMOTE SENSING TECHNOLOGY (GT-701)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
Introduce the principles of remote sensing technology and its application in the field of Earth Sciences.						
COURSE OUTCOMES						
1. Students will get introduced to remote sensing technology and atmospheric interactions.						
2. Students will learn about characteristics and physical parameters of aerial photography along with basic concepts of satellite remote sensing.						
3. Students will get acknowledged to satellite programs worldwide and image processing and enhancement techniques.						
4. Students will get to know about applications of remote sensing in various fields of geology.						

DETAILS OF COURSE:

Unit	Content
1	Introduction: development of remote sensing technology, advantages, basic processes of remote sensing, basic elements of EM spectrum and atmospheric windows, propagation of radiation through the atmosphere and interaction, remote sensing platforms;
2	Aerial photographs: types of aerial photographs, their characteristics, scale, height determination and relief displacement, stereoscopes and photo-mosaics. Satellite remote sensing: Imagery vs aerial photograph, active and passive sensors, MSS, LISS, CCD and thermal scanners.
3	Major Indian satellite programs. Basics of microwave remote sensing. fundamentals of digital image processing: characteristics of remote sensing data, pre-processing, enhancements, classification. Principles of image interpretation: concept of FCC, visual and digital interpretation- interpretation keys.
4	Photo Interpretation in geology: image characteristics of geological structures and various rock types, landforms and lineaments. Remote Sensing Applications: natural hazards and disaster mitigation, natural resources management and environmental monitoring.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Remote Sensing Geology, 2nd Edition, Gupta, R. P., Springer-Verlag Berlin Heidelberg, New York.
2	Remote Sensing and Image Interpretation, 4th Edition, Lillesand T. M, and Keifer, R. W., Wiley, New York.
3	Remote Sensing-Principles and Interpretation, 3rd Edition, Sabins, FF Jr., Freeman & Co,New York.
4	Photogeology, Miller, V. C., and Miller, C. F., McGraw-Hill, New York.
5	Image Interpretation in Geology, 2nd Edition, Drury, S. A., London, Allen and Unwin.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-701.1	3	3	3	3	3	3	2	3	3	3	3
GT-701.2	3	3	3	2	2	3	3	3	3	2	3
GT-701.3	3	3	3	3	3	2	3	3	3	2	3
GT-701.4	3	3	3	3	3	2	3	2	3	3	3
Average	3	3	3	2.75	2.75	2.5	2.75	2.75	3	2.5	3

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-701.1	3	3	3	3
GT-701.2	3	3	3	3
GT-701.3	3	3	2	3
GT-701.4	3	2	3	2
Average	3	2.75	2.75	2.75

MINERAL EXPLORATION (GT-702)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To introduce basic concepts of mineral exploration and better understanding of mineral resources.						
COURSE OUTCOMES						
1. Students will get introduced to mineral exploration and applications of geological mapping in it.						
2. Students will learn basic concepts of geological and geochemical prospecting.						
3. Students will get to know the role of geophysical methods and logging tools in mineral exploration.						
4. Students will get acknowledged with a numerical approach to mineral exploration and various methods of ore reserve estimation as well as application of various software in mineral exploration.						

DETAILS OF COURSE:

Unit	Content
1	Introduction: basic definitions, historical development and future opportunities and complexities. Geological mapping in mineral exploration, overview of various stages of mineral exploration: activities, data and tools.
2	Basic concepts of geological prospecting: geological indicators, lithological and structural controls of mineralization, geobotanical observations. Basic concepts of geochemical prospecting: planning, Soil Sampling, biogeochemical observations analysis and interpretation.
3	Different techniques in mineral exploration: drilling, sampling, core logging, geological plans and sections. Overview of geophysical methods useful in mineral prospecting: airborne survey, magnetic survey, gravity method, electromagnetic method, integration of geological and geophysical data.
4	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. Remote Sensing, GIS and computer software applications in mineral exploration.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Introduction to Mineral Exploration, Moon, C.J., Whateley, M.K.G. and Evans, A.M., Blackwell Science, 2nd Ed.
2	Mineral Exploration: Recent Strategies, Rajendran, S., Srinivasamoothy, K. and Aravindan S., New India Pub.
3	Mineral Prospecting and Exploration, T.C Bagchi, Kalyani Publication.
4	Modelling and Geochemical Exploration of Mineral Deposits, Talapatra, A.K., Capital Publishing.
5	Magmatic Sulfide Deposits: Geology, Geochemistry and Exploration, Naldrett, A.J.,

	Springer-Verlag.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-702.1	3	2	3	3	2	3	2	3	3	3	2
GT-702.2	3	2	3	2	2	2	3	2	3	2	2
GT-702.3	3	2	3	2	3	2	3	3	3	2	2
GT-702.4	3	2	3	3	2	2	3	2	3	3	2
Average	3	2	3	2.5	2.25	2.25	2.75	2.5	3	2.5	2

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-702.1	3	3	3	3
GT-702.2	3	3	3	3
GT-702.3	3	3	3	3
GT-702.4	3	3	3	3
Average	3	3	3	3

MICROPALAEONTOLOGY AND PALYNOLOGY (GT-703)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To impart basic understanding of the significance of different aspects of Micropalaeontology and Palynology.						
COURSE OUTCOMES						
1. Students will get introduced to micropalaeontology and sampling techniques along with detailed description of few microfossils.						
2. Students will learn detailed descriptions of a few important inorganic shelled microfossils with emphasis on their ecology and life cycle.						
3. Students will get acknowledged to organic shelled microfossils and the role of microfossils in stratigraphic correlations.						
4. Students will understand the applications of microfossils in hydrocarbon exploration, paleobathymetry and stable isotope studies.						

DETAILS OF COURSE:

Unit	Content
1	Micropalaeontology, its definition and scope, surface and subsurface sampling, processing of samples for preparation of mineral matter walled and organic walled microfossils. Detailed morphology, geological distribution and ecology of Chitinozoans, Pteropods, and Diatoms.
2	Detailed morphology, geological distribution and ecology of Foraminifera, Ostracoda, Conodonts, Radiolarians, and Silicoflagellates.
3	Morphology of fossil spores, pollen grains, dinoflagellates and acritarchs. Use of microfossils in biostratigraphy and palaeoenvironmental interpretations.
4	Applications of microfossils and palyno fossils in hydrocarbon exploration; CAI (conodont alteration index) and spore coloration index. Paleobathymetry study using benthic foraminifera. Microfossils, stable isotopes and ocean-atmosphere history.

SUGGESTED BOOKS:

Sr. No	Name of Books/ Authors
1.	Microfossils, Second Edition, Howard Armstrong and Martin Brasier, Blackwell Pub.
2.	Principles of Palaeoecology, Ager, D.V., McGraw Hill.
3.	Palaeoecology, Kennety, P and Ross,C.A, Longman.
4.	Aspects of Palynology, Robert H. Tschudy, Wiley-Interscience, New York.
5.	Essentials of Palynology, P K K Nair, Asia Pub. House, New York.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-703.1	3	2	3	3	2	3	2	3	3	3	2
GT-703.2	3	2	3	2	2	2	3	2	3	2	2
GT-703.3	3	2	3	2	3	2	3	3	3	2	2
GT-703.4	3	2	3	3	2	2	3	2	3	3	2
Average	3	2	3	2.5	2.25	2.25	2.75	2.5	3	2.5	2

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-703.1	3	2	3	3
GT-703.2	3	3	2	3
GT-703.3	3	3	2	3
GT-703.4	3	2	3	2
Average	3	2.5	2.5	2.75

HYDROGEOLOGY (GT-704)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To provide understanding about the hydrogeological properties of water bearing formations and chemical parameters of water.						
COURSE OUTCOMES						
1. Students will get introduced to basic concepts of hydrogeology along with physical parameters of water bearing formations.						
2. Students will learn about the theory of groundwater flow and mathematical approach to groundwater movements.						
3. Students will understand the role of various geological methods in hydrogeological investigations.						
4. Students will learn physiochemical properties of groundwater and graphical representation of ground water quality.						

DETAILS OF COURSE:

Unit	Content
1	Water on earth: types of water, meteoric, juvenile, magmatic and sea water. Hydrological cycle and its components, water balance. Water-bearing properties of rocks: porosity, permeability, specific yield and specific retention. Vertical distribution of water, zone of aeration and zone of saturation, classification of rocks according to their water-bearing properties. Aquifers: classification of aquifers, concepts of drainage basins and groundwater basins. Aquifer parameters: transmissivity and storage coefficient, water table and piezometric surface
2	Theory of groundwater flow: Darcy's law and its applications: determination of permeability in laboratory and in field, constant head permeameter, falling head permeameter, tracer test, problem exercise on darcy's law, permeability test and transmissivity.
3	Basic geologic and hydrogeologic Investigations: surface methods :remote sensing, electrical resistivity method and seismic refraction method and subsurface methods: geologic log, drilling time log, radiation log, resistivity logging, temperature logging, caliper logging.
4	Groundwater Quality: Physical and chemical properties of water, quality criteria for different uses. graphical presentation of groundwater quality data:vertical bar graph method, vector diagram, pattern diagram, circular diagram, trilinear diagram, water quality and pollution sources, isotopes and their uses, water level fluctuations.

SUGGESTED BOOKS:

Sr. No.	Name of Books/ Authors
1	Fundamentals of Groundwater, F.W.Schwartz and H.Zhang, Wiley India Pvt. Ltd.
2	Groundwater Hydrology, D.K.Todd, Wiley India Pvt. Ltd.
3	Physical and Chemical Hydrogeology, P.A.Domencio and F.W.Schwartz., Springer.
4	Environmental Isotopes in Hydrogeology, I.Fritz, CRC Press.

5	Geochemistry, Groundwater and Pollution, C.A.J.Appelo and D.Postma, A.A Balkema Publisher.
6	Groundwater Science, C.R.Fitts, Academic Press.
7	Environmental Hydrology, A.d.Ward and S.W.Trimble, CRC Press.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-704.1	3	3	3	3	2	3	2	3	3	3	3
GT-704.2	3	3	3	2	3	3	3	2	3	3	3
GT-704.3	3	3	3	3	3	2	3	3	3	3	3
GT-704.4	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	2.75	2.75	2.75	2.75	2.75	3	3	3

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-704.1	3	3	3	3
GT-704.2	3	3	3	3
GT-704.3	3	3	3	3
GT-704.4	3	2	3	2
Average	3	2.75	3	2.75

PETROLEUM GEOLOGY (GT-705)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To introduce the students to basic concepts of Petroleum Geology						
COURSE OUTCOMES						
1. Students can learn about the origin of petroleum along with source rock considerations.						
2. Students will get acknowledged with reservoir rocks and their types.						
3. Students will understand the mechanism of hydrocarbon migration and entrapment.						
4. Students will get to know future prospects of energy in the form of unconventional resources of hydrocarbons as well as a deep insight on India's oil and gas potential.						

DETAILS OF COURSE:

Unit	Content
1	Elements of petroleum geology: source rocks, definition of source rock, nature and type of source rock kerogen sediments, its composition and origin; transformation of organic matter, maturation, thermal cracking, diagenesis, catagenesis and metagenesis in the formation of source rocks. Hydrocarbon source rock evaluation: palynofacies and types of Dispersed Organic Matter (DOM), Thermal Alteration Index (TAI).
2	Reservoir rocks: classification and nomenclature of reservoir rocks, clastic reservoir rocks, carbonate reservoir rocks, unconventional, fractured and miscellaneous reservoir rocks. marine and non-marine reservoir rocks.
3	Hydrocarbon migration: primary and secondary migration, migration and accumulation of hydrocarbons, Factors affecting primary and secondary migration. Entrapment of hydrocarbons: mechanics of entrapment of hydrocarbons. Types of traps: structural, stratigraphic and combination type of traps.
4	Unconventional Resources: oil shale, shale gas, tar sands, gas hydrates. India's oil and gas resources: source, reservoir rock and types of trap in major oil and gas fields of India.

SUGGESTED BOOKS:

Sr. No	Name of Books/ Authors
1	Geology of Petroleum, 2nd Ed. Levorsen, A.I., W.H. Freeman C. San Francisco.
2	Petroleum Geochemistry and Geology, 2ndEdn, Hunt, J.M., W. H. Freeman, San Francisco.
3	Petroleum Geology, North, F.K., Unwin Hyman (Pub.), Boston, USA.
4	Elements of Petroleum Geology, Richard, C. Selley, Academic Press, London.
5	Petroleum Geology. 1983, Developments in Petroleum Science, Ser. 16, Chapman, R.E. Elsevier, Amsterdam.
6	Developments in Petroleum Geology, G.D.Hobson (Ed.), Applied Science Publishers, London.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-705.1	3	3	3	3	3	3	2	3	3	3	3
GT-705.2	3	3	3	3	3	2	3	3	3	3	3
GT-705.3	3	3	3	2	3	3	3	3	3	3	3
GT-705.4	3	3	3	3	2	3	3	2	3	3	3
Average	3	3	3	2.75	2.75	2.75	2.75	2.75	3	3	3

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-705.1	3	3	3	3
GT-705.2	3	3	3	3
GT-705.3	3	3	3	3
GT-705.4	3	2	3	3
Average	3	2.75	3	3

PRACTICAL (GT-706) (Based on GT-701 & GT-702)						
Lecture	**Credit**	**Assessment Method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam duration**
12	**6**	**Practical**	**75**	**25**	**100**	**3 Hrs.**
COURSE OBJECTIVE						
To provide in-depth practical knowledge of remote sensing and mineral exploration methods.						
COURSE OUTCOME						
Students get knowledge about remote sensing and mineral exploration methods.						

LIST OF PRACTICALS:

- Exercises based on the studies of remote sensing images.
- Exercise on GPS data collection and Travers.
- Study of aerial photographs and photogrammetical calculations.
- Regional exploration data analysis and ore reserve estimation.
- Exercises related to trenching, pitting and drilling data.

PRACTICAL (GT-707) (Based on GT-703, GT-704 & GT-705)						
Lecture	**Credit**	**Assessment Method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam duration**
12	**6**	**Practical**	**75**	**25**	**100**	**3 Hrs.**
COURSE OBJECTIVE						
To provide in-depth practical knowledge of micropaleontology, palynology, hydrogeology and petroleum geology.						
COURSE OUTCOME						
Students get knowledge about practical related to micropaleontology, palynology, hydrogeology and petroleum geology.						

LIST OF PRACTICALS:

- Exercises based on the knowledge of micropaleontology, palynology.
- Exercises based on the knowledge of hydrogeology
- Exercises based on the knowledge of petroleum geology.

FIELD TRAINING-II (GT-708)					
Credit	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**Field Training**	**100**	**50**	**150**	**-**
COURSE OBJECTIVE					
To impart understanding of advanced mapping methods and techniques, sampling in the field using different tools and instruments.					
COURSE OUTCOME					
Students get acknowledged about large scale mapping methods and techniques, sampling in the field using different tools and instruments.					

ENVIRONMENTAL GEOSCIENCES (GT-801)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**

COURSE OBJECTIVE

To let students be exposed to environmental mitigation and management and current practices with examples.

COURSE OUTCOMES

1. Students will get knowledge about environmental geology and land use planning.
2. Students will learn about methods and importance of solid waste management.
3. Students will learn about various hazards in geological perspective and their mitigation.
4. Students will get acknowledged with acts and amendments to protect the environment in India.

DETAILS OF COURSE:

Unit	Content
1	Fundamental concepts of environmental geology: environmental geoscience, its scope, objective, and aims; role of geosciences in our society. Land use planning: definition and objective of land use planning and their types, landscape aesthetics.
2	Solid Waste: causes of solid waste, their types and effects of solid waste, waste disposal. Solid waste management: reduce, reuse, recycle and their method of management.
3	Hazard: types of hazards (landslides, volcanoes, earthquakes, droughts, cyclones, floods), causes of hazards and their mitigations.
4	Environmental impact assessment (EIA): aims and objectives of EIA, methodology of EIA. Environmental legislation: air act, water act, environmental protection act, forest act, wildlife act and waste management rules.

SUGGESTED BOOKS:

Sr. No.	Name of Books/ Authors
1.	Natural Disasters, Alexander, D., UCL Press Ltd, UniColegeLonds.
2.	Environmental geomorphology, Coates Dr., Sate Univ of NY Binghamton.
3.	Mitigation of Natural hazards and disasters: international perspectives, Haque, C. Emdad, Springer, Dordrecht.
4.	EA Environmental geosciences, Keller, Prentice hall, New Jersey.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-801.1	3	3	3	3	3	3	3	3	3	3	3
GT-801.2	3	3	3	3	2	2	3	2	3	3	3
GT-801.3	3	3	3	3	3	3	3	3	3	3	3
GT-801.4	3	3	3	3	2	3	3	2	3	3	2
Average	3	3	3	3	2.5	2.75	3	2.5	3	3	2.75

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-801.1	3	3	3	3
GT-801.2	3	3	3	3
GT-801.3	3	3	2	3
GT-801.4	3	2	3	2
Average	3	2.75	2.75	2.75

COAL GEOLOGY AND TECHNOLOGY (GT-802)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To familiarize the students about physical, petrological and technological properties of coal.						
COURSE OUTCOMES						
1. Students will get familiarized with the origin, types and diagenesis of coal.						
2. Students will learn about building components of coal and its chemical analysis.						
3. Students will understand methane genesis in coal and its technological properties.						
4. Students will know the geographical and geological distribution of coal in India and their utilization.						

DETAILS OF COURSE:

Unit	Content
1	Origin of coal, allochthonous and autochthonous theories, origin of peat swamps, climatic, paleogeography and tectonic requirements, types of coal, physical properties of coal, rank and grade, classification of coal, constituents of coal. Diagenesis of peat and coalification process, causes, role of time, temperature, physical changes associated with increased coal rank.
2	Lithotypes, microlithotypes and macerals and their physical, chemical and optical properties. Chemical characterization: proximate and ultimate analysis, trace elements in coal.
3	Cleats in coal. Coal bed methane (CBM): elementary idea about generation of methane in coal beds and coal bed methane exploration, coal as a source rock for hydrocarbon. Technological properties of coal: coal gasification, coal liquefaction, coal carbonisation.
4.	Application of coal geology in hydrocarbon exploration, vitrinite reflectance. Environmental impacts of coal mining and burning, mitigation measures to avoid or reduce those impacts. Gondwana and Tertiary coal deposits in India; geology of important coalfields of India

SUGGESTED BOOKS:

Sr. No.	Name of Books/ Authors
1	Text book of Coal Petrology,. Stach, E., Mackowsky, M.T.H., Taylor, G.H., Chandra, D., Teichmuller, M., and Teichmuller, R., Gebruder Borntraeger, Stuttgart.
2	Textbook of Coal (Indian context), Gebruder Borntraeger, Stuttgart Chandra, D., Singh, R.M. Singh, M.P. (2000)., Tara Book Agency, Varanasi.
3	International Committee for Coal and Organic Petrology (ICCP). The new inertinite classification (ICCP System 1994). Fuel 80, 459–471.
4	International Committee for Coal and Organic Petrology, (ICCP). The new vitrinite classification (ICCP System 1994). Fuel 77, 349–358.
5	Coal and organic Petrology, Singh, M.P., Hindustan Publishing Corporation, New Delhi.

6	Applied Coal Petrology. The Role of Petrology in Coal Utilization, Suárez-Ruiz, I., Crelling J.C. (Eds.), Elsevier, Academic Press. USA.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-802.1	3	3	3	3	3	3	2	3	3	3	3
GT-802.2	3	3	3	2	3	3	3	3	3	2	3
GT-802.3	3	3	3	2	3	3	3	3	3	2	3
GT-802.4	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	2.5	3	3	2.75	3	3	2.5	3

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-802.1	3	3	3	3
GT-802.2	3	3	2	3
GT-802.3	3	3	3	3
GT-802.4	3	3	3	3
Average	3	3	2.75	3

MINING GEOLOGY (GT-803)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
This course is designed to give the geology students an introductory idea about the various types of geological field operations, which are carried out in opencast/underground mines.						
COURSE OUTCOMES						
1. Students are introduced to historical development and principles of mining.						
2. Students will learn about methods, tools, advantages and limits of surface and subsurface mining.						
3. Students will understand the role of geological operations in mining along with a brief description of blasting techniques.						
4. Students will learn about mineral dressing and environmental hazards of mining in detail.						

DETAILS OF COURSE:

Unit	Content
1	Introduction: Historical development, Importance and future scopes, basic understanding of mining industry and processes. Principles of mining industry, mining policy and legislation.
2	Surface methods of mining: mechanical and aqueous extraction. Subsurface mining: basic infrastructures and common terms. Ocean bottom mining.
3	Geological operations in mining: preparation of mine plans, bench mapping, underground mine mapping, modeling of ore body, drilling, sampling, explosives & blasting. Mine Economic appraisals
4	Elements to mineral dressing & mineral beneficiation, mines safety measures. Environmental issues: nature & remedies, mine waste & their management.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Mining Engineers hand books, Roberts Peele, John Wiley & Sons.
2	Mining Geology, Mckinstry,H.E, Asia publishing house.
3	Courses in mining Geology, Arogyaswami,R.P.N., Oxford IBH.
4	Elements of mining, Clark,G.B., John Wiley & Sons.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-803.1	3	3	3	3	3	3	2	3	3	3	3
GT-803.2	3	3	3	2	3	2	3	2	3	2	3
GT-803.3	3	3	3	2	3	2	3	3	3	2	3
GT-803.4	3	3	3	3	3	3	3	2	3	3	2
Average	3	3	3	2.5	3	2.5	2.75	2.5	3	2.5	2.75

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-803.1	3	3	3	3
GT-803.2	3	3	3	3
GT-803.3	3	3	3	3
GT-803.4	3	2	3	2
Average	3	2.75	3	2.75

GIS TECHNOLOGY (GT-804)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To provide basic understanding about GIS Technology and its application in Earth Sciences						
COURSE OUTCOMES						
1. Students will get introduced to GIS technology and its scopes.						
2. Students will understand data representation models in GIS and collaboration of remote sensing and GIS as a tool in geology.						
3. Students will get to know about GIS analysis operations.						
4. Students will learn concepts of GPS and map projections along with applications of GIS in geosciences.						

DETAILS OF COURSE:

Unit	Content
1	Introduction: definition, basic concepts, historical background and future scopes of GIS technology. Components of GIS: hardware, software and their specifications for GIS.
2	GIS data types and models: spatial, non spatial, raster, vector, their advantage and disadvantages; spatial data capture and maintenance. Integration of raster-vector data models and integration of remote sensing with GIS, concepts of thematic layers and topology.
3	GIS analysis operations: overview, geometrics and measurement operations, spatial and non-spatial queries; neighborhood operations, spatial arrangement and connectivity functions. Overlays operation, display and interfaces functions, precision and accuracy, errors in GIS, their detection and optimization.
4	Triangulated irregular network (TIN), Digital elevation model (DEM) and their applications. Map production in GIS, concept of Global positioning system (GPS) and GIS as multidisciplinary tools and their applications in geoscience.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Introduction to Geographic Information Systems, Chang K., McGraw-Hill Education.
2	Geographic Information Systems and Science, Paul A. Longley, Wiley Publication.
3	Integrating GIS and the Global Positioning System, Karen Steede-Terry, ESRI Publication, New York.
4	Geographic Information Systems: An Introduction, Tor Bernhardsen, Wiley Publication.
5	Geographic Information Systems: A Management Perspective, S. Aronoff, WDL Publication.
6	Thinking About GIS: Geographic Information System Planning for Managers, Roger Tomlinson, ESRI Press.
7	GPS Satellite Surveying, 2nd Edition, A. Leick, Wiley Publication.
8	Principles of Geographic Information System, Rolf A., ITC, Netherlands.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-804.1	3	3	3	3	3	3	2	3	3	3	3
GT-804.2	3	3	3	3	3	3	3	2	3	3	3
GT-804.3	3	3	3	2	3	3	3	3	3	3	3
GT-804.4	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	2.75	3	3	2.75	2.75	3	3	3

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-804.1	3	3	3	3
GT-804.2	3	3	3	3
GT-804.3	3	3	2	3
GT-804.4	3	3	3	2
Average	3	3	2.75	2.75

ENGINEERING GEOLOGY (GT-805)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To introduce the students to the basics of engineering geology for applications in civil engineering projects.						
COURSE OUTCOMES						
1. Introduction of students to fundamental concepts of engineering geology and learning to apply these in various civil engineering projects.						
2. Students will get detailed knowledge about engineering properties of rock and their utilization in the concept of rock mass classification.						
3. Students will understand causes, classification and analytical techniques of landslides.						
4. Students will learn about geological investigations useful in civil engineering projects as well as concepts of soil mechanics.						

DETAILS OF COURSE:

Unit	Content
1	Introduction to engineering geology: basic concepts, scope. relationship of engineering geology with other branches of geology. Dam: terminology of dam, types of dam, criteria for site selection, geological considerations for dam. Tunnel: terminology of tunnel, types of tunnel, geological considerations for tunnel.
2	Engineering properties of rocks. Laboratory tests: uniaxial compression test, triaxial compression test, tensile strength test and in-situ test, Standard penetration test (SPT), Point load test. Concept of rock mass classification: utilities, Rock mass rating (RMR) classification.
3	Landslides: causes of landslides (rainfall and climatic conditions, erosion, earthquake, human actions) and their classifications, techniques for analysis of landslides. Physical characters of building and decorative stones, concrete aggregates.
4	Engineering geological investigations related to highways, buildings and bridges. Soil Mechanics: introduction to soils, types of soils and properties of soils. Engineering geological maps: types of maps and their applications.

SUGGESTED BOOKS:

Sr. No	Name of Books/ Authors
1	Geology & Engineering', R.F. Legget & A. Hathway, Geo Science World.
2	Principles of Engineering Geology & Geotechnics, D.P. Krynine & W. R. Judd, CBS Publisher.
3	Fundamentals of Engineering Geology, F.G. Bell, Elseveir.
4	Principles of Engineering Geology, P.B. Attewell & I.W. Fermer, Chapman & Hall.
5	Engineering Geology, Q. Zaruba & E. Mencl, Elsevier.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-805.1	3	3	3	3	3	3	3	3	3	3	3
GT-805.2	3	3	3	3	3	3	3	3	3	3	3
GT-805.3	3	3	3	3	3	3	3	3	3	2	3
GT-805.4	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	2.75	3

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-805.1	3	3	3	3
GT-805.2	3	3	3	3
GT-805.3	3	3	3	3
GT-805.4	3	3	3	2
Average	3	3	3	2.75

PRACTICAL (GT-806) (BASED ON GT-801 & GT-804)						
Lecture	**Credit**	**Assessment Method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam duration**
12	**6**	**Practical**	**75**	**25**	**100**	**3 Hrs.**
COURSE OBJECTIVE						
To provide in-depth practical knowledge of environmental geology and GIS technology in the light of geological problems						
COURSE OUTCOME						
Students get knowledge about practical's of environmental geology and GIS technology in the light of geological problems.						

LIST OF PRACTICALS:

- Exercises based on the studies of environmental geology.
- Practical hands on various GIS softwares.
- Exercises on use of various tools of ARCGIS.
- Exercises on GIS technology in the light of geological problems.

PRACTICAL (GT-807) (Based on GT-802, GT-803 & GT-805)						
Lecture	**Credit**	**Assessment Method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam duration**
12	**6**	**Practical**	**75**	**25**	**100**	**3 Hrs.**
COURSE OBJECTIVE						
To provide in-depth practical knowledge of coal geology, mining geology and engineering geological problems.						
COURSE OUTCOME						
Students get acknowledged about practical's of coal geology, mining geology and engineering geological problems.						

LIST OF PRACTICALS:

- Exercises based on the application of coal geology, and engineering geology on geoscientific data analysis and interpretation.
- Lithological cross sections from core drilling data.
- Numerical exercises based on engineering geology.
- Exercises of maps and stereographic projections used in engineering geology.

WELL LOGGING (GT-901)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To introduce well-logging tools, methods, interpretation procedures to Geology students.						
COURSE OUTCOMES						
1. Students will be introduced to well logging and learn about various logging tools.						
2. Students will understand electrical logging tools and methods of operation and a brief introduction to log interpretation.						
3. Students will get to know about porosity logs and various types of gamma rays based logging.						
4. Students can understand concepts of well logging via case studies as well as learning temperature logging in detail.						

DETAILS OF COURSE:

Unit	Content
1	History and introduction to well logging. Logging data acquisition. Geophysical wire-line logging tools: Gamma ray tool, SP tool, Neutron tool, Gamma ray tool, Acoustic logging tool.
2	Electrical Logging: principle, type, method and tools, normal and lateral tools, induction tools, focussed logging tools. Log interpretation: archie law, formation factor, water saturation.
3	Porosity Logs: principle of porosity calculations using sonic logging, gamma ray logging and neutron-density logging, log characteristics, combined neutron-density log characteristics.
4	Temperature logging and its application, relation between well log signature and deposition conditions, permeability estimations and cross-plots, well logging case studies.

SUGGESTED BOOKS:

Sr. No.	Name of Books/ Authors
1	The Geological Interpretation of Well Logs, Rider, M., Rider-French Consulting Ltd.
2	Formation Evaluation, Lynch, E.J., John Cotler Books.
3	Fundamentals of well-log interpretation, Serra, O., Elsevier.
4	Log Interpretation Principles / Applications, Schlumberger.
5	Handbook of Well Log Analysis, Pirsson, S.J., Prentice Hall.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-901.1	3	2	3	3	2	3	2	3	3	3	2
GT-901.2	3	2	3	2	2	2	3	2	3	2	2
GT-901.3	3	2	3	2	3	2	3	3	3	2	2
GT-901.4	3	2	3	3	2	2	3	2	3	3	2
Average	3	2	3	2.5	2.25	2.25	2.75	2.5	3	2.5	2

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-901.1	3	2	3	3
GT-901.2	3	3	2	3
GT-901.3	3	3	2	3
GT-901.4	3	2	3	2
Average	3	2.5	2.5	2.75

ADVANCED STRATIGRAPHY, PALEOGEOGRAPHY AND PALEOECOLOGY (GT-902)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**

COURSE OBJECTIVE

To introduce the students with applied aspects of stratigraphy with reconstruction of Palaeogeography and Palaeoecology.

COURSE OUTCOMES

1. Students can learn about stratigraphic principles and different branches of stratigraphy.
2. Students are given detailed knowledge about sequence stratigraphy and associated branches along with a deep insight on palaeogeographical reconstructions of India.
3. Students will get to know about the relationship of stratigraphy with environment and ecology in context with major events.
4. Students are acknowledged with complete description of Gondwana and Deccan systems along with tertiary hydrocarbon resources.

DETAILS OF COURSE:

Unit	Content
1	Controls on development of stratigraphic records. Stratigraphic principles and nomenclature. Biostratigraphy: zonations and significance. Basics of Chronostratigraphy, Magnetostratigraphy, Cyclostratigraphy, Pedostratigraphy.
2	Sequence Stratigraphy: definition, factors and controls of sequence stratigraphy. Basin analysis through sequence stratigraphy. Event stratigraphy**:** global bio-events, extinctions and radiations, global geo-events. Palaeogeography: palaeogeographic reconstructions, palaeogeography of India during Gondwana duration, Paleogene and Neogene.
3	Palaeobiogeography: concepts, recognition, factors controlling geographic distribution of species. Palaeoecology: concepts of palaeoecology, application of community analysis in palaeoenvironmental reconstruction, mass extinctions, glacial cycles, global climate change. Temporal pattern of communities-evolutionary changes in fauna and flora with environments.
4	Gondwana sequence of India: classification, distribution, stratigraphic succession, climatic vicissitude and economic significance of Gondwana sequence of India. Deccan volcano-sedimentaries, Tertiary stratigraphy of India with special emphasis on hydrocarbon resources.

SUGGESTED BOOKS:

Sr. No	Name of Books/ Authors
1	Sequence stratigraphy, Emery, D. & Myers, K.J., Oxford, Blackwell Science.
2	Geology of India and Burma, Krishnan, M.S., CBS Publisher..
3	Fundamentals of Historical Geology and Stratigraphy, Ravinder Kumar, CBS Publisher.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-902.1	3	3	3	3	3	3	3	3	3	3	3
GT-902.2	3	3	3	3	3	3	3	2	3	2	2
GT-902.3	3	3	3	3	3	3	3	3	3	2	3
GT-902.4	3	3	3	3	3	3	3	3	3	3	2
Average	3	3	3	3	3	3	3	2.75	3	2.5	2.75

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-902.1	3	3	3	3
GT-902.2	3	3	2	3
GT-902.3	3	3	2	3
GT-902.4	3	2	3	3
Average	3	2.75	2.5	3

ORGANIZATIONAL BEHAVIOR AND BUSINESS MANAGEMENT (GT-903)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To introduce the students to the basic concept of organizational behaviour.						
COURSE OUTCOMES						
1. The students are introduced to the organisational Behaviour and other similar fields of study.						
2. Students will be able to apply theories of perception, learning, leadership and motivation in their respective geo-organizations.						
3. Students can understand about organizational structure and human resource development.						
4. Students will learn about the field of business, financial management and marketing management.						

DETAILS OF COURSE:

Unit	Content
1	Introduction to organizational behaviour: nature of organizational behaviour, O.B. and other similar fields of study. Psychology, sociology, anthropology, political science. Approaches to O.B.. challenges and opportunities for organizational behaviour.
2	Perception: concept of perception, perceptual process, factors influencing perception. Learning: concepts of learning, components of learning process, factors affecting learning. Leadership: meaning of leadership, leadership theory, charismatic leadership theory, trait theory, behavioural theory. Motivation: concept of motivation, motivation and behaviour, theories of motivation, Maslow's need hierarchy theory.
3	Concept and forms of organisation structure. Concept of organisational culture, creating and sustaining organisational culture. Nature of organisational change, factors affecting organisational change, resistance to Change, overcoming resistance change. Human resource development: meaning and concept. Personnel management: meaning, nature, importance and functions of personnel management.
4	Business: concept, nature and objectives. Social responsibility of business. Environment: meaning of environment, constituents of environment, Economic, social, political, legal and technological environment. management: definition, nature and significance. Functions of management. Planning, organising, staffing, directing and controlling. Financial management: objectives and functions of financial management. Marketing Management: nature, scope and importance of marketing management, modern marketing concepts. Role of marketing in economic development, meaning, nature and scope of international marketing.

SUGGESTED BOOKS:

Sr. No.	Name of Books/ Authors
1	Organisational Behaviour, Stephen P. Robbins, Pearson Education.
2	Organisational Behaviour, Jit S. Chandan, Vikas Publishing House Pvt. Ltd.
3	Organisational Behaviour, L.M. Prasad, Sultan Chand & Sons, New Delhi.
4	Human Relations & Organisational Behaviour, R.S. Dwivedi, Oxford, IBH.
5	Personnel Management, C.B. Mamoria, Himalayan Publications, New Delhi.
6	Business Environment, Francis Cherunilam, Himalaya Publishing House.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-903.1	3	3	3	3	3	3	2	3	3	3	3
GT-903.2	3	3	3	3	2	2	3	3	3	2	3
GT-903.3	3	3	3	3	3	3	3	3	3	2	3
GT-903.4	3	3	3	3	2	2	3	3	3	3	3
Average	3	3	3	3	2.5	2.5	2.75	3	3	2.5	3

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-903.1	3	3	3	3
GT-903.2	3	3	2	3
GT-903.3	3	3	2	3
GT-903.4	3	3	3	2
Average	3	3	2.5	2.75

GEO-HAZARDS AND DISASTER MANAGEMENT (GT-904)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**

COURSE OBJECTIVE

Students will be taught geological hazards and their role in disaster management to meet the demands of all the states in the country and to fill vacancies arising in each district of the country.

COURSE OUTCOMES

1. Students will get knowledge about the basic principles, mitigation and management of natural hazards.
2. Students will learn about mitigation and management of landslides as well as earthquakes along with seismic scenarios of India.
3. Students will learn about floods and tsunami mitigation and management.
4. Students do case studies of droughts and learn basic principles of drought mitigation and management.

DETAILS OF COURSE

Unit	Content
1	Introduction: disasters, types, natural disasters, impact of disasters on environment, basic principles and elements of disaster mitigation and management.
2	Earthquakes: introduction to earthquake, causes of earthquakes, earthquake intensity scales, seismic activity in India, action plan for earthquakes, actions to be taken before, after and during earthquake. Landslides: introduction to landslide, Causes of landslides, types of landslide and their mitigations.
3	Floods: introduction to flood, causes of floods, flood mitigation practice, vulnerability analysis, risk assessment, action plan for floods, actions to be taken before, after and during floods. Tsunami: introduction of tsunami, causes of tsunami and their mitigations.
4	Droughts: introduction to droughts, causes of droughts, types of droughts and their mitigations, soil erosion and desertification.

SUGGESTED BOOKS:

Sr. No	Name of Books/ Authors
1	Engineering geology, Krynine and Judd WR, McGraw-Hill Book Company, New York.
2	Rock slope engineering, Hoek and Bray, J, Spon Press; 3 edition.
3	Applied Geomorphology, Thornbury, John Wiley and sons,. Inc., New York.
4	EA Environmental geosciences, Keller, prentice hall, New Jersey.
5	Natural Hazard risk assessment and public policy, Petak,WJ and Atkinson, A.D., Springer-Verlag. New York.
6	Natural Disasters and Mitigation, Roy .P.S, Van Western C.J, Jha V.J., IIRS, Dehradun.
7	Mitigation of natural hazards and disasters: international perspectives, Haque, C.Emdad, Springer, Dordrecht.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-904.1	3	3	3	3	3	3	3	3	3	3	3
GT-904.2	3	3	3	2	2	2	3	3	3	3	3
GT-904.3	3	3	3	2	3	2	3	3	3	3	3
GT-904.4	3	3	3	3	2	3	3	3	3	3	3
Average	3	3	3	2.5	2.5	2.5	3	3	3	3	3

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-904.1	3	2	3	3
GT-904.2	3	3	2	3
GT-904.3	3	3	3	3
GT-904.4	3	3	3	2
Average	3	2.75	2.75	2.75

GEOSCIENTIFIC INSTRUMENTATION & ANALYTICAL TECHNIQUES (GT-905)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
This course is designed to give the post-graduate geology students an introductory idea about the various types of instrumentation & analytical techniques used to obtain numerous geological data.						
COURSE OUTCOMES						
1. Students will learn about the evolution of technology and instrumentation in the field of Geosciences.						
2. Students will get knowledge about various sample and slide preparation as well as remote sensing and GIS technique.						
3. Students will learn about sedimentology techniques and various spectrometry and spectroscopy.						
4. Students will learn about groundwater and engineering geology techniques.						

DETAILS OF COURSE:

Unit	Content
1	Introduction: uses of analytical techniques, evolution with technological development, importance of sophisticated instruments and accurate analysis. Sample and sampling in geoscience, modal count techniques, techniques of photography in geosciences.
2	Preparation thin section and polished section making: cutting, grinding and polishing; powder sample preparation crushing & pulverizing. Techniques in microfossils slide preparation. Remote sensing and GIS techniques: aerial photograph studies, image interpretation and classification techniques.
3	Sedimentological techniques: sieves & sieve shaking. Sample etching & staining, heavy minerals & clay minerals methods, size & shape of sediments studies. Geochemistry techniques: flame photometer, UV spectrophotometer, (AAS) Atomic Absorption Spectrophotometry, ICP-Mass spectrometry, X-ray fluorescence spectrometry, Electron microscopy and electron-probe microanalysis, cathodoluminescence & thermoluminescence spectrometry.
4	Engineering geology techniques & instrumentation: in-situ and lab testing of strength of materials. Hydrogeological techniques & instrumentation: groundwater flow measurement, water quality measurement and water harvesting systems. Geophysical instrumentations: principles, working and data acquisition.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Laboratory handbook of petrographic techniques, Hutchinson,C.S. John Wiley
2	Using geochemical data, Hugh Rollinson, Routledge.
3	Modern geotechnical engineering, Alam Singh, IBI Publisher.
4.	Geophysical practice in mineral exploration and mapping, T.S. Ramakrishna, Geological Society of India

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-905.1	3	3	3	3	3	3	2	3	3	3	3
GT-905.2	3	3	3	2	3	2	3	2	3	2	3
GT-905.3	3	3	3	2	3	2	3	3	3	2	3
GT-905.4	3	3	3	3	2	3	3	2	3	3	3
Average	3	3	3	2.5	2.75	2.5	2.75	2.5	3	2.5	3

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-905.1	3	3	3	3
GT-905.2	3	3	3	3
GT-905.3	3	2	2	2
GT-905.4	3	3	3	3
Average	3	2.75	2.75	2.75

OCEANOGRAPHY AND MARINE GEOLOGY (GT-906)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**
COURSE OBJECTIVE						
To introduce concepts of oceanography and marine geology						
COURSE OUTCOMES						
1. Students will get introduced with oceanography and oceanographic settings in context with plate tectonics.						
2. Students will get knowledge about ocean circulation patterns and classification of marine environments.						
3. Students will get a deep insight on oceanic sediments along with marine geochemistry.						
4. Students will understand ocean based resources and international marine laws.						

DETAILS OF COURSE:

Unit	Content
1	Introduction: origin of oceans, world's oceans, geographical settings. Structural and oceanographic setting: plate tectonics and ocean systems, ocean morphology, marine stratigraphy, ocean crust, heat distribution and age of oceanic crust, structure, petrology and sources of oceanic crust, magnetization of the oceanic crust.
2	Ocean circulation patterns: wave dynamics, oceanic currents, surface and deep circulation, classification of marine environments, air-sea interaction, geologic effects of bottom currents, marginal marine environments.
3	Oceanic sediments and microfossils: terrigenous, biogenic and authigenic sediments, calcareous and siliceous microfossils, chemical sediments, carbonate and silicate equilibria, CCD (carbonate compensation depth), marine biogeochemistry.
4.	Paleoceanography: approaches to paleoceanographic reconstructions, various proxy indicators for paleoceanographic interpretation. Reconstruction of monsoon variability by using marine proxy records. Opening and closing of ocean gateways and their effect on circulation and climate during the Cenozoic. Sea level processes and Sea level changes.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Essentials of Oceanography, Tom Garrison, Cengage Learning.
2	The Oceans, Johnson and Flemming, Sverdrup.
3	Introduction to Physical oceanography, Reddy, M.P.M, World Press.
4	Marine geology, Keen, M.J, Elsevier.
5	Climatology and Oceanography, Mamoria, Chairperson and Sisodia, M.S, SBPD Publication.
6	Introduction to Marine Geology and Geomorphology, King, C, Crane Russak.
7	Oceanography, Lal, D. S., Sharada Pustak Mahal.
8	Oceanography: A brief Introduction, Siddhartha, K, Kisalaya Publication Pvt. Ltd.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-906.1	3	3	3	3	3	3	2	3	3	3	3
GT-906.2	3	3	3	2	3	3	3	3	3	2	3
GT-906.3	3	3	3	2	3	2	3	3	3	3	3
GT-906.4	3	3	3	3	2	2	3	2	3	3	3
Average	3	3	3	2.5	2.75	2.5	2.75	2.75	3	2.75	3

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-906.1	3	3	3	3
GT-906.2	3	3	3	3
GT-906.3	3	3	2	3
GT-906.4	3	2	3	2
Average	3	2.75	2.75	2.75

METEOROLOGY (GT-907)						
Lecture	**Credit**	**Assessment method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam Duration**
4	**4**	**Theory**	**100**	**50**	**150**	**3 hrs.**

COURSE OBJECTIVE

This course is designed to give the post-graduate geology students an introductory idea about the various branches of meteorology.

COURSE OUTCOMES

1. Students are introduced to the basics of meteorology and thermal structure of atmosphere.
2. Students will learn fundamental principles of climatology along with classification schemes.
3. Students understand the role of meteorology in aviation and some basics of weather forecasting.
4. Students will learn working principles of meteorological satellites.

DETAILS OF COURSE:

Unit	Content
1	Introduction: basic definitions and processes, historical development and scopes of meteorology. Thermal structure of the atmosphere and its composition. Radiation: basic laws of rayleigh and mie scattering. Vertical stability of the atmosphere: dry and moist air parcel.
2	Climatology: fundamental principles of climatology. Earth's radiation balance. Cloud formation and classification, precipitation and water balance. Air masses, monsoon, jet streams, tropical cyclones, and ENSO. Classification of climates: Koppen and Thornthwaite scheme of classification. Global climate change.
3	Aviation meteorology: Role of meteorology in aviation, weather hazards associated with takeoff cruising and landing, inflight, icing, turbulence, visibility, fog, clouds, rain, gusts, wind shear and thunderstorms, nowcasting and very short range forecasting.
4	Satellite meteorology: meteorological satellites, polar orbiting and geostationary satellites, visible and infrared radiometers, multiscanner radiometers. Identification of synoptic systems, fog and sandstorms, detection of cyclones, estimation of SST, cloud top temperatures, winds and rainfall, temperature and humidity soundings.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1	Essentials of Meteorology 2nd ed, C. Ahrens, World Press.
2	Atmosphere, Weather and Climate 8th ed, R. Barry, R. Chorley, Routledge.
3	Physical Meteorology, Houghton, H.G., The MIT Press.
4	Meteorology for scientists and engineers, Roland B. Stull, Brooks-Cole.

Mapping of Course Outcomes to Programme Outcomes

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
GT-907.1	3	3	3	3	3	3	2	3	3	3	3
GT-907.2	3	3	3	2	2	2	3	3	3	2	3
GT-907.3	3	3	3	3	3	3	3	3	3	2	3
GT-907.4	3	3	3	3	2	2	3	2	3	3	3
Average	3	3	3	2.75	2.5	2.5	2.75	2.75	3	2.5	3

Mapping of Course Outcomes to Programme Specific Outcomes

COs/PSOs	PSO1	PSO2	PSO3	PSO4
GT-907.1	3	2	3	3
GT-907.2	3	3	2	3
GT-907.3	3	3	2	3
GT-907.4	3	2	3	2
Average	3	2.5	2.5	2.75

PRACTICAL (GT-908) (BASED ON GT-901, GT -902 & GT-903)						
Lecture	**Credit**	**Assessment Method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam duration**
12	**6**	**Practical**	**75**	**25**	**100**	**3 Hrs.**
COURSE OBJECTIVE						
To provide in-depth knowledge of well log interpretation, stratigraphy and organization behavior.						
COURSE OUTCOME						
Students get knowledge about well log interpretation, stratigraphy and organization behavior.						

LIST OF PRACTICALS:

- Well log interpretation exercises using computer applications or manually for calculating clay volume, porosity, formation water resistivity and water saturation from a given well log.
- Exercises based on advanced stratigraphy, paleogeography & palaeoecology.
- Exercises based on organizational behavior and business management in the geosciences applications and related industries.

PRACTICAL (GT-909) (Based on two elective subjects opted)						
Lecture	**Credit**	**Assessment Method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam duration**
12	**6**	**Practical**	**75**	**25**	**100**	**3 Hrs.**
COURSE OBJECTIVE						
To provide in-depth knowledge of practicals related to the elective subjects.						
COURSE OUTCOME						
Students get knowledge about practicals related to elective subjects.						

LIST OF PRACTICALS:

GT-904:

- Exercises on Geo hazard management.
- Hazard zonation maps of India.

GT-905:

- Practical hands on microfossils slide preparation techniques.
- Rock thin section and slide preparation.
- Sample digestion procedures in geochemistry.
- Exercise on sedimentological techniques.
- Engineering geology instrumentation exercises.
- Exercise on Hydrogeological techniques and instrumentation.
- Practical hands on various spectrophotometry techniques.

GT-906:

- Wave Data Analysis – Rose Diagrams.
- Structural features of world oceans.
- Bathymetric section of ocean.
- Exercise on distribution of economic mineral deposits in world oceans.
- Computation of Longshore currents
- Computation of relative currents.
- Beach Profiles.

GT-907:

- Analysis of temperature data.
  (a) Vertical profiles.
  (b) Horizontal profiles.
  (c) Identification of Upwelling and sinking.
- Determination of Heat budget parameters.
  (a) Latent heat.
  (b) Sensible heat.
  (c) Evaporation.
- Practical exercises based on data analysis of Meteorological station.
- Computation of Atmospheric Heat Budget.

M.Tech. Applied Geology (5-Year Integrated Course) 10th semester

Course No.	Course Title	Total	Credits
GT-1001	Project work	150	4
GT-1002	Dissertation	150	4
GT-1003	Viva voce	150	4
	Total	**450**	**12**

CHOICE BASED OPEN ELECTIVE

GEOSCIENCE AND SOCIETY (GT-808) (OE- 205)						
Lecture	**Credit**	**Assessment Method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam duration**
2	**2**	**Theory**	**35**	**15**	**50**	**3 hrs**
COURSE OBJECTIVE						
To provide an overview of Earth Sciences including earth processes, resources and geo-hazards.						
COURSE OUTCOMES						
After completion of the course the students will get to know about the basics of geology, its related disciplines and its relation with mankind.						

DETAILS OF COURSE:

Unit	Content
1	Introduction to geo-science and its various branches, Earth and its place in the solar system. origin and structure of Earth. Geological time scale. Origin and evolution of life through Earth history. Elementary idea of rocks, their types, rock cycle, minerals and gemstones. Elementary idea of various Earth processes, continental drift and plate tectonics. Orogenic and epeirogenic movements.
2	Elementary idea of geological considerations in site evaluation of engineering, construction, mining and other geological works. Environmental changes through the Earth history. Significance of earth resources to mankind and society. Hydrological cycle and water budget of an Earth.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Authors
1.	Understanding the earth, Press, F. and Siever, R., W.H. Freeman & Co.
2.	Palaeontology, Jain, P.C. and Anantharaman, M.S., Vishal Publication.
3.	An Introduction to Physical Geology, Tarbuck, Lutgens, Tasa, Eleventh Edition, Pearson Publication.
4.	Principles of engineering Geology and Geotechnics, Krynine/Judd, Jain Book Agency.
5.	Ground water Hydrology, Tod David K, PHI Learning.

CHOICE BASED OPEN ELECTIVE

NATURAL HAZARDS (GT-910) (OE- 305)						
Lecture	**Credit**	**Assessment Method**	**External Assessment**	**Internal Assessment**	**Total**	**Exam duration**
2	**2**	**Theory**	**35**	**15**	**50**	**3 hrs**

COURSE OBJECTIVE

Students will be taught geological hazards and their role in disaster management to meet the demands of all the states in the country and to fill vacancies arising in each district of the country.

COURSE OUTCOMES

After completion of the course the students will get to know about the types and causes of natural hazards and their related consequences. The course also provides understanding about various mitigation measures that can be taken during such a hazardous situation.

DETAILS OF COURSE:

Unit	Content
1	Introduction to hazards, hazards classification and distribution, natural hazards and their effects, hazard prediction and early warning, role of community and stakeholders. Earthquakes: classification, distribution, causes and effects. Tsunami: types, effects, prediction and early warning systems.
2	Landslides: classification, distribution, causes, effects and prevention/mitigation of landslides. Volcanic hazards: types, distribution, causes and effects of volcanoes and related hazards. Floods: types and factors leading to floods, flood control/mitigation measures. Cyclones, thunderstorms and lightning, prediction and early warning, droughts and desertification.

SUGGESTED BOOKS:

Sr. No.	Name of Books/Author
1	Natural Disasters, Patrick Leon Abbott, Mcgraw-Hill Education.
2	Citizens Guide to Disaster Management: How To Save Your Own Life & Help Others, Laxmi Publication.
3	Disaster Management, Mukesh Kapoor, Moti Lal Banarsi Dass Publication.
4	Earthquake and Natural Disasters, Manik Kar, Moti Lal Banarsi Dass Publication.
5	Disasters Guidelines, NIDM.

6	Disasters Guidelines, NDMA.

Mapping Programme Outcomes with Course Outcomes (M.Tech. Applied Geology):

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 301	3	3	3	3	2	3	2	2	3	3	2
CO 302	3	3	3	2.75	3	2.75	2.5	2.5	2.75	2.75	2.75
CO 303	3	2	2	2.5	2.25	2.25	2.75	2.5	3	2.5	2
CO 304	3	2.25	3	2.75	2.25	2.5	2.75	2.5	3	2.5	2
CO 305	3	2.25	2.75	2.5	2.75	2.25	2.75	2.5	2.75	2.25	2
CO 401	3	2.5	3	2.75	2.25	2.25	2.75	2.75	3	2.5	2.5
CO 402	3	2.5	3	2.75	2.25	2.5	2.75	2.5	2.75	2.5	2.25
CO 403	2.75	2.5	3	2.5	2.25	2.25	2.75	2.5	3	2.5	2
CO 404	3	2	3	2.5	2.5	2.5	2.75	2.5	3	2.5	3
CO 405	3	2.5	3	2.5	2.25	2.5	2.75	2.5	3	2.5	2.5
CO 501	3	2.5	3	2.5	2.75	2.5	2.75	2.5	3	2.5	2.5
CO 502	3	2	3	2.5	2.25	2.5	2.75	2.5	2.75	2.5	2.5
CO 503	3	2.25	3	2.75	2.25	2.25	2.75	2.5	3	2.5	2.75
CO 504	3	2.5	2.75	2.5	2.25	2.5	2.75	2.5	3	2.5	2.5
CO 505	3	2.5	3	2.5	2.75	2.5	2.75	2.5	3	2.5	2.25
CO 601	3	2	3	2.5	2.25	2.25	2.75	2.5	3	2.5	2.75
C0 602	3	2	3	2.5	2.25	2.25	2.75	2.5	3	2.5	2.5
CO 603	3	2.5	2.75	2.5	2.5	2.5	2.75	2.5	3	2.5	2.75
CO 604	3	2	3	2.5	2.5	2.5	2.75	2.5	3	2.5	2
CO 605	3	2	3	2.5	2.25	2.25	2.75	2.5	3	2.5	2

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO 701	3	3	3	2.75	2.75	2.5	2.75	2.75	3	2.5	3
CO 702	3	2	3	2.5	2.25	2.25	2.75	2.5	3	2.5	2
CO 703	3	2	3	2.5	2.25	2.25	2.75	2.5	3	2.5	2
CO 704	3	3	3	2.75	2.75	2.75	2.75	2.75	3	3	3
CO 705	3	3	3	2.75	2.75	2.75	2.75	2.75	3	3	3
CO 801	3	3	3	3	2.5	2.75	3	2.5	3	3	2.75
CO 802	3	3	3	2.5	3	3	2.75	3	3	2.5	3
CO 803	3	3	3	2.5	3	2.5	2.75	2.5	3	2.5	2.75
CO 804	3	3	3	2.75	3	3	2.75	2.75	3	3	3
CO 805	3	3	3	3	3	3	3	3	3	2.75	3
CO 901	3	2	3	2.5	2.25	2.25	2.75	2.5	3	2.5	2
CO 902	3	3	3	3	3	3	3	2.75	3	2.5	2.75
CO 903	3	3	3	3	2.5	2.5	2.75	3	3	2.5	3
CO 904	3	3	3	2.5	2.5	2.5	3	3	3	3	3
CO 905	3	3	3	2.5	2.75	2.5	2.75	2.5	3	2.5	3
CO 906	3	3	3	2.5	2.75	2.5	2.75	2.75	3	2.75	3
CO 907	3	3	3	2.75	2.5	2.5	2.75	2.75	3	2.5	3