

Annexure-I (Revised as on 29.5.2012)

**DEPARTMENT OF APPLIED GEOLOGY
INDIAN SCHOOL OF MINES, DHANBAD**



COURSE STRUCTURE AND SYLLABUS

FOR

**5-YEAR INTEGRATED M. SC. (TECH.) &
3-YEAR M. SC. (TECH.)**

IN

APPLIED GEOLOGY

(Proposed for 2012-13 Session onwards)

Course structure for Five-year Integrated M. Sc. (Tech.) in Applied Geology

I Semester

Course No.	Courses	L T P	Credit
Theory			
AMC 11101	Mathematics-I	3 – 1 – 0	07
ACC 11101	Chemistry	3 – 0 – 0	06
MMC 11102	Manufacturing Process	1 – 4 – 0	06
ECE 11101	Electronics Engineering	3 – 0 – 0	07
CSE 11301	Computer Programming (S)	3 – 0 – 0	06
DMS/AP 11301	Disaster Management [DMS 2-0-0] & Energy Resources [AP 1-0-0] (S)	3 – 0 – 0	06
HSC 11103	English for Science & Technology	3 – 0 – 0	06
Practical			
ACC 12201	Chemistry Practical	0 – 0 – 3/2	1.5
ECE 11201	Electronics Engineering Practical	0 – 0 – 3/2	1.5
CSE 12301	Computer Programming Practical (S)	0 – 0 – 3/2	02
	Total	19 – 5 – 5	48

II Semester

Course No.	Courses	L T P	Credit
Theory			
AMC 12101	Mathematics-II	3 – 1 – 0	07
APC 11101	Physics	3 – 0 – 0	06
MMC 11101	Engineering Graphics	1 – 4 – 0	06
EEC 11101	Electrical Technology	3 – 1 – 0	07
MMC 11103	Engineering Mechanics	3 – 1 – 0	07
GLD/CMD 11301	Earth System Science (S) [AGL 2-0-0 & ESE 1-0-0]	3 – 0 – 0	06
HSC 12305	Value Education, Human Rights and Legislative Procedure (S)	3 – 0 – 0	06
SWC 12701	Co-Curricular Activities (Only for Second Semester)	0 – 0 – 0	03
Practical			
APC 12201	Physics Practical	0 – 0 – 3/2	1.5
EE 12201	Electrical Technology Practical	0 – 0 – 3/2	1.5
	Total	19 – 7 – 3	48+ 3

III Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 13101	Geology – I (Mineralogy)	3 – 0 – 0	06
GLC 13102	Geology – II (Crystallography & Optical Mineralogy)	3 – 0 – 0	06

GLC 13103	Geology – III (Sedimentary Petrology and Stratigraphy)	3 – 0 – 0	06
AMR13101	Methods of Applied Mathematics - I	3 – 1 – 0	07
ACC 13120	Inorganic Chemistry – I	3 – 0 – 0	06
Practical			
GLC 13201	Mineralogy Practical	0 – 0 – 2	02
GLC 13202	Crystallography Practical	0 – 0 – 2	02
ACC 13220	Inorganic Chemistry – I Practical	0 – 0 – 3	03
GLC13804	Project	0 – 0 – 2	02
Total		15 – 1 – 9	40

IV Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 14104	Geology – IV (Physical and Structural Geology)	3 – 0 – 0	06
GLC 14105	Geology – V (Economic Geology)	3 – 0 – 0	06
GLC 14106	Geology – VI (Paleontology)	3 – 0 – 0	06
GLC 14107	Geology – VII (Igneous and Metamorphic Petrology)	3 – 0 – 0	06
EIR 14101	Microprocessors and their Applications	3 – 0 – 0	06
Practical/Project/Seminar/Dissertation/Viva-voce			
GLC 14204	Structural Geology Practical	0 – 0 – 2	02
GLC 14205	Economic Geology Practical	0 – 0 – 2	02
GLC 14206	Paleontology Practical	0 – 0 – 2	02
GLC14207	Petrology Practical	0 – 0 – 2	02
GLC 14908	Local Geological Field Excursion (S)*	0 – 0 – 0	02
GLC 14809	Project	0 – 0 – 2	02
SWC 34701	Co-curricular activity	0 – 0 – 0	03
Total		15 – 0 – 10	43

*Local Geological Field Excursion (2 weeks) with credit in IVth Semester.

V Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 15111	Mineralogy	3 0 0	06
GLC 15112	Structural Geology	3 0 0	06
GLC 15113	Geochemistry	3 0 0	06
GLC 15114	Sedimentology	3 0 0	06
GLC 15115	Stratigraphy	3 0 0	06
Practical			
GLC 15211	Mineralogy Practical	0 0 2	02
GLC 15212	Structural Geology Practical	0 0 2	02
GLC 15213	Geochemistry Practical	0 0 2	02
GLC 15214	Sedimentology Practical	0 0 2	02
GLC 15806	Project	0 0 4	04
Total		15 0 12	42

VI Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 16116	Igneous Petrology	3 – 0 – 0	06
GLC 16117	Metamorphic Petrology	3 – 0 – 0	06
GLC 16118	Micropaleontology and Vertebrate Paleontology	3 – 0 – 0	06
MER22131	Surveying	3 – 0 – 0	06
AMR 14101	Numerical and Statistical Methods	3 – 1 – 0	07
Practical/Project/Seminar/Dissertation/Viva-voce			
GLC 16216	Igneous Petrology Practical	0 – 0 – 2	02
GLC 16217	Metamorphic Petrology Practical	0 – 0 – 2	02
GLC 16218	Micropaleontology and Vertebrate Paleontology Practical	0 - 0 - 2	02
MER 22231	Surveying Practical	0 – 0 – 2/2	01
GLC 16919	Sedimentary Terrain Mapping (S) *	0 – 0 – 0	02
GLC 16520	Viva-voce	0 – 0 – 0	02
GLC16821	Project	0 0 4	04
Total		15 – 1 – 11	46

* 2 weeks duration, during winter vacation with credit in VIth Semester.

VII Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 17121	Ore Geology	3 0 0	06
GLC 17122	Geostatistics	3 0 0	06
GLC 17123	Geodynamics	3 0 0	06
MER 23131	Rock Mechanics	3 0 0	06
GPC 17151	Geophysical Prospecting	3 0 0	06
Practical			
GLC 17221	Ore Geology Practical	0 0 2	02
GLC 17222	Geostatistics Practical	0 0 2	02
MER 23231	Rock Mechanics Practical	0 0 2	02
GPC 17251	Geophysical Prospecting Practical	0 0 2	02
GLC 17824	Summer Internship/Industrial Training *	0 0 0	02
GLC 17825	Project	0 0 6	06
Total		15 0 14	46

* Summer Internship/Industrial Training on Economic Geology (minimum two weeks duration) during vacation after VI Semester with credit in VIIth Semester.

VIII Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 18125	Remote Sensing and GIS	3 0 0	06
GLC 18126	Geomorphology	3 0 0	06

GLC 18127	Exploration Geology	3	0	0	06
GLC 18128	Petroleum Geology	3	0	0	06
MER 22132	Mining Technology	3	0	0	06
Practical/Project/Seminar/Dissertation/Viva-voce					
GLC 18225	Remote Sensing and GIS Practical	0	0	2	02
GLC 18226	Geomorphology Practical	0	0	2	02
GLC 18227	Exploration Geology Practical	0	0	2	02
GLC 18228	Petroleum Geology Practical	0	0	2	02
GLC 18929	Geological Mapping Training (S) *	0	0	0	02
GLC 18530	Viva-Voce	0	0	0	02
GLC 18831	Project	0	0	6	06
	Total	15	0	14	48

*Geological Mapping Training of two weeks duration with credit in VIIIth Semester.

IX Semester

Course No.	Courses	L	T	P	Credit
Theory					
GLC 19131	Hydrogeology	3	0	0	06
GLC 19132	Coal Geology	3	0	0	06
GLC 19133	Computer Applications in Geology	3	0	0	06
GLC 19134	Mineral Economics	3	0	0	06
PER 51102	Petroleum Reservoir Engineering and Field Development	3	1	0	07
Practical/Project/Seminar/Dissertation/Viva-voce					
GLC 19231	Hydrogeology Practical	0	0	2	02
GLC 19232	Coal Geology Practical	0	0	2	02
GLC 19233	Computer Applications in Geology Practical	0	0	2	02
GLC 19535	Topical Seminar	0	0	0	02
GLC 19836	Summer Internship/ Industrial Training *	0	0	0	02
GLC 19837	Project	0	0	8	08
	Total	15	1	14	49

* Summer Internship/ Industrial Training (minimum 2 weeks duration) during vacation after VIII Semester with credit in IXth Semester.

X Semester

Course No.	Courses	L	T	P	Credit
Theory					
GLC 10137	Engineering Geology	3	0	0	06
GLC 10138	Environmental Geology	3	0	0	06
GLE 101xx	Elective (Any one of the following)	3	0	0	06

GLE 10140	Sequence Stratigraphy and Basin analysis			
GLE 10141	Coal Bed Methane and Gas hydrate Exploration			
GLE 10142	Contaminant Hydrogeology			
GLE 10143	Nuclear Geology			
GLE 10144	Kinematics of Rock Deformation			
GLE 10145	Geotechnical Engineering			
FMC 10151	Mineral Beneficiation	3	0	0
MSC 10151	Industrial Management	3	0	0
Practical/Project/Seminar/Dissertation/Viva-voce				
GLC 10237	Engineering Geology Practical	0	0	2
FMC 10251	Mineral Beneficiation Practical	0	0	2
GLC 10846	Project	0	0	8
GLC 10547	Seminar on Project	0	0	0
GLC 10548	Composite Viva-voce	0	0	0
	Total	15	0	12
				48

Course structure for Three-year M. Sc. (Tech.) in Applied Geology

I Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 21111	Mineralogy	3 0 0	06
GLC 21112	Structural Geology	3 0 0	06
GLC 21113	Geochemistry	3 0 0	06
GLC 21114	Sedimentology	3 0 0	06
GLC 21115	Stratigraphy	30 0	06
Practical			
GLC 21211	Mineralogy Practical	0 0 3	03
GLC 21212	Structural Geology Practical	0 0 3	03
GLC 21213	Geochemistry Practical	0 0 3	03
GLC 21214	Sedimentology Practical	0 0 3	03
	Total	15 0 12	42

II Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 22116	Igneous Petrology	3 – 0 – 0	06
GLC 22117	Metamorphic Petrology	3 – 0 – 0	06
GLC 22118	Micropaleontology and Vertebrate Paleontology	3 – 0 – 0	06
MER 22131	Surveying	3 – 0 – 0	06
AMR 14101	Numerical and Statistical Methods	3 – 1 – 0	07
Practical/Project/Seminar/Dissertation/Viva-voce			
GLC 22216	Igneous Petrology Practical	0 – 0 – 3	03
GLC 22217	Metamorphic Petrology Practical	0 – 0 – 3	03
GLC 22218	Micropaleontology and Vertebrate Paleontology Practical	0 – 0 – 3	03
MER 22231	Surveying Practical	0 – 0 – 2/2	01
GLC 22919	Sedimentary Terrain Mapping (S) *	0 – 0 – 0	02
GLC 22520	Viva-voce	0 – 0 – 0	02
	Total	15 – 1 – 10	45

* 2 weeks duration, during winter vacation with credit in IInd Semester.

III Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 23121	Ore Geology	3 0 0	06
GLC 23122	Geostatistics	3 0 0	06
GLC 23123	Geodynamics	3 0 0	06
MER 23131	Rock Mechanics	3 0 0	06
GPC 23151	Geophysical Prospecting	3 0 0	06
Practical			
GLC 23221	Ore Geology Practical	0 0 3	03
GLC 23222	Geostatistics Practical	0 0 3	03
MER 23231	Rock Mechanics Practical	0 0 2	02
GPC 23251	Geophysical Prospecting Practical	0 0 3	03
GLC 23824	Summer Internship/Industrial Training *	0 0 0	02
	Total	15 0 11	43

* Summer Internship/Industrial training on Economic Geology during vacation after IInd Semester with credit in IIIrd Semester.

IV Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 24125	Remote Sensing and GIS	3 0 0	06
GLC 24126	Geomorphology	3 0 0	06
GLC 24127	Exploration Geology	3 0 0	06
GLC 24128	Petroleum Geology	3 0 0	06
MER 22132	Mining Technology	3 0 0	06
Practical/Project/Seminar/Dissertation/Viva-voce			
GLC 24225	Remote Sensing and GIS Practical	0 0 3	03
GLC 24226	Geomorphology Practical	0 0 3	03
GLC 24227	Exploration Geology Practical	0 0 3	03
GLC 24228	Petroleum Geology Practical	0 0 3	03
GLC 24929	Geological Mapping Training (S) *	0 0 0	02
GLC 24530	Viva-Voce	0 0 0	02
	Total	15 0 12	46

*Geological Mapping Training of two weeks during winter vacation.

V Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 25131	Hydrogeology	3 0 0	06
GLC 25132	Coal Geology	3 0 0	06
GLC 25133	Computer Applications in Geology	3 0 0	06
GLC 25134	Mineral Economics	3 0 0	06
PER 51102	Petroleum Reservoir Engineering and Field Development	3 1 0	07
Practical/Project/Seminar/Dissertation/Viva-voce			
GLC 25231	Hydrogeology Practical	0 0 3	03
GLC 25232	Coal Geology Practical	0 0 3	03
GLC 25233	Computer Applications in Geology Practical	0 0 3	03
GLC 25535	Topical Seminar	0 0 0	02
GLC 25836	Summer Internship/Industrial Training *	0 0 0	02
Total		15 19	44

* Summer Internship/Industrial Training (minimum 2 weeks duration) during vacation after IVth Semester with credit in Vth Semester.

VI Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 26137	Engineering Geology	3 0 0	06
GLC 26138	Environmental Geology	3 0 0	06
GLE 261xx	Elective (Any one of the following)	3 0 0	06
GLE 26140	Sequence Stratigraphy and Basin analysis		
GLE 26141	Coal Bed methane and Gas hydrate Exploration		
GLE 26142	Contaminant Hydrogeology		
GLE 26143	Nuclear Geology		
GLE 26144	Kinematics of Rock Deformation		
GLE 26145	Geotechnical Engineering		
FMC 26151	Mineral Beneficiation	3 0 0	06
MSC 26151	Industrial Management	3 0 0	06
Practical/Project/Seminar/Dissertation/Viva-voce			
GLC 26237	Engineering Geology Practical	0 0 3	03
FMC 26251	Mineral Beneficiation Practical	0 0 3	03
GLC 26846	Dissertation	0 0 6	06
GLC 26547	Seminar on Dissertation	0 0 0	04
GLC 26548	Composite Viva-voce	0 0 0	02
Total		15 0 12	48

FIRST SEMESTER

AMC 11101	Mathematics-I	3 – 1 – 0
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Calculus-I: Successive differentiation of one variable and Leibnitz theorem, Taylor's and Maclaurin's expansion of functions of single variable, Functions of several variables, partial derivatives, Euler's theorem, derivatives of composite and implicit functions, total derivatives, Jacobian's, Taylor's and Maclaurin's expansion of functions of several variables, Maxima and minima of functions of several variables, Lagrange's method of undetermined multipliers, Curvature and asymptotes, concavity, convexity and point of inflection, Curve tracing.

Calculus-II: Improper integrals, convergence of improper integrals, test of convergence, Beta and Gamma functions and its properties, Differentiation under integral sign, differentiation of integrals with constant and variable limits, Leibnitz rule.

Evaluation of double integrals, Change of order of integrations, change of coordinates, evaluation of area using double integrals, Evaluation of triple integrals, change of coordinates, evaluation of volumes of solids and curved surfaces using double and triple integrals. Mass, center of gravity, moment of inertia and product of inertia of two and three-dimensional bodies and principal axes.

Trigonometry of Complex Number, 3D Geometry and Algebra: Function of complex arguments, Hyperbolic functions and summation of trigonometrical series.

3D Geometry: Cones, cylinders and conicoids, Central conicoids, normals and conjugate diameters.

Algebra: Convergency and divergency of Infinite series. Comparison test, D' Alembert's Ratio test, Raabe's test, logarithmic test, Cauchy's root test, Alternating series, Leibnitz test, absolute and conditional convergence, power series, uniform convergence.

ACC 11101	Chemistry	3 – 0 – 0
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Cement: Manufacturing, composition, setting and hardening of cement.

Glass :Types of Glasses, Manufacturing & properties of Glasses.

Polymer :Classification, structure-property relationship, conductive polymers.

Solid Fuel : Structure of coal, classification of coal, Effect of heat on coal, carbonization and pyrolysis. Recovery and purification of byproducts obtained from coke ovens; Distillation of coal tar; coal.

Liquid fuel: Composition of crude oil, processing of crude oil, distillation, sweetening and cracking (basic concepts), octane number, Cetane number. Additives to improve the quality of diesel and petrol, bio-diesel.

Gaseous fuel: Characteristics of good fuel; calorific value, theoretical calculations of calorific value of a fuel, natural gas and hydrogen gas.

Phase rule & Phase equilibrium: Phase rule; degree of freedom, one and two component systems, temperature and composition diagrams, liquid-liquid and liquid-solid phase diagrams.

Lubricants: General characteristics of lubricants, chemistry of lube oil and greases. Reclamation of lubricants.

Equilibrium: Electrochemistry; Electric potentials at interfaces, electrodes, batteries. electrochemical cells and their applications.

Corrosion: Chemical and electrochemical corrosion, classification, factors affecting corrosion, Form of corrosion and general methods of corrosion prevention.

MMC 11102	Manufacturing Processes	1 – 4 – 0
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Carpentry:- Classification of timber, seasoning & preservation to wood, description and application of the various tools used in carpentry, different joints and their practical uses.

Forming-Introduction to deformation and forming, types of forming processes and their applications, safety rule.

Casting: Introduction to foundry. pattern making, types of casting processes, purpose of runner and riser. application of casting, defects in casting. safety rules.

Fitting: Introduction to fitting jobs, fitting tools and their uses.safety rules.

Welding: Welding types, accessories. weldments.

Machine Tools: Types of cutting tools, types of machine tools and their specifications, safety rules.

Measurement: Use of measuring instruments etc for product measurement.

ECE 11101	Electronics Engineering	3-0-0
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Semiconductor Diodes and Applications – Introduction Characteristics, dc and ac resistances of a diode. Half wave and Full wave rectification. Zener Diodes and then use as regulators, Clippers and Clampers.

Bipolar Junction Transistor – Introduction, Transistor operation CB, CE and CC configuration, dc Biasing, Operating Point, Fixed Bias Circuit, Emitter – Stabilized Bias Circuit. Voltage Divider Bias.

BJT Transistor – Amplification in ac domain, Equivalent transistor model. Hybrid Equivalent model, RC coupled amplifier and its frequency response.

Operational Amplifiers – Introduction, Differential and Common Mode Operation, OPAMP Basics, Practical OPAMP Circuits.

Introduction to Field Effect Transistors and their applications.

Digital Electronics – Review of Basic Gates and Boolean Algebra, Introduction to Combinatorial Logic Design. Standard Representations of Logical Functions and their simplification. Combinatorial Logic Design, Half Adder and Full Adder.

CSE 11301	Computer Programming	3-0-0
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Programming in C

C Fundamentals: Introduction to C, Data types, Constants and variable declaration, Scope, Storage classes, Data input and output functions, Sample programs.

Operators & Expressions: Arithmetic, Relational, Logical, Bitwise operators, Conditional, Assignment, Library functions.

Control & Looping Statements: if, while, for, do-while, switch, break and continue statements, nested loops.

Arrays: Declaration, Initialization, Processing an array, 1D, 2D and multidimensional arrays, Strings and their Operations.

Functions: Defining functions, Function prototypes, Accessing a function, Passing arguments, Passing arrays and Recursive functions.

Pointers: Declaration, Operations on pointers, Passing pointers to a function, Pointers and arrays, Array of Pointers.

Structures & Unions: Defining a structure, Processing a structure, User defined data types, Structure and pointers, Passing structure to a function, Self referential structures, Unions.

File Management: File operations, Creating and processing a data file, Command line arguments.

Programming in JAVA

Fundamentals of Object-Oriented Programming: Basic concepts, Objects and classes, Data abstraction and encapsulation, Inheritance, Polymorphism and Dynamic binding.

JAVA Evolution: Java features, Java versus C and C++, Creating, compiling and running a Java program, Constants, Variables, Data types, Operators and Expressions, Decision making and branching, Decision making and looping, Classes, objects, and methods, Sample programs.

DMS/AP 11301	Disaster Management & Energy Resources	3-0-0
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Disaster Management

Concepts of Disaster, Types of Disaster and Dimensions of Natural and Anthropogenic Disasters (cyclone, flood, landslide, subsidence, fire and earthquake);

Principles and Components of Disaster Management, Organizational Structure for Disaster Management, Disaster Management Schemes;

Introduction to Natural Disasters and Mitigation Efforts: Flood Control, Drought Management, Cyclones, Terror Threats;

Pre-disaster risk and vulnerability reduction; Post disaster recovery and rehabilitation; Disaster related Infrastructure Development;

Role of Financial Institutions in Mitigation Effort;

Psychological and Social Dimensions in Disasters;

Disaster Management Support Requirements – Training, Public Awareness.

Energy Resources

Classification of energy resources and their availability; Renewable and non-renewable energy sources; World energy prospects; Environmental impacts; Energy, power and electricity; Energy scenario in India: Availability of conventional and nonconventional energy resources and future energy demand; Indian reserves and resources of natural oil and gas, coal and nuclear minerals; Potential of hydroelectric power, solar energy, thermal, nuclear, wind, tidal wave and biomass based power in India; Introduction to hydrogen energy and fuel cells

HSC 11103	English for Science and Technology	3 – 0 – 0
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Language Resource Development : Using appropriate grammatical lexical forms to express meaning-accuracy, range and appropriacy in grammatical lexical exercises.

Reading, Interpreting and Using Written, and Graphic Information : Using (reading and writing) academic texts, articles in technical journals, instruction manuals/laboratory instruction sheets, safety manuals and regulations, and reports; Using maps, graphs, plan diagrams, flow-charts, sketches, tabulated and statistical data.

Writing Appropriately in a Range of Rhetorical Styles i.e. Formal and Informal : Writing instructions, describing objects and processes; defining, narrating, classifying exemplifying, comparing, contrasting, hypothesizing, predicting, concluding, generalizing restating, and reporting; Note making (from books/journals); Writing assignments; summarizing, expanding, paraphrasing; Answering examination questions; Correspondence skills; Interpreting, expressing and negotiating meaning; Creating coherent written tests according to the conventions.

Receiving and Interpreting the Spoken Word : Listening to lectures and speeches, listening to discussions and explanations in tutorials; Note taking (from lectures); Interacting orally in academic, professional and social situation; Understanding interlocutor, creating coherent discourse, and taking appropriate turns in conversation; Negotiating meanings with others (in class room, workshop, laboratory, seminar, conference, discussion, interview etc.)

ACC 12201	Chemistry Practical	0 – 0 – 3/2
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1. Standards of HCl by Standard Sodium Carbonate solution
2. Determination of Temporary Hardness of tap water.
3. Estimation of Total Hardness of water.
4. Determination of Iron in Ferrous Ammonium Sulphate solution (Redox titration).
5. Determination of Copper in crystallized Copper-Sulphate.
6. Estimation of available Chlorine in Bleaching Powder.
7. Determination of Molecular Weight of Organic Acid by Titration method.
8. Estimation of Sodium Carbonate and bicarbonate in a mixture.
9. To determine the saponification number of an oil.
10. To determine the rate of hydrolysis of methyl /ethyl acetate.
11. To prepare Chrome Alum.

ECE 12101	Electronics Engineering Practical	0 – 0 – 3/2
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1. Study of Electronic Equipment & Components.
2. Study of diode characteristics.
3. Study of regulated power supply.
4. Study of BJT characteristics.

5. Study of op-amp characteristics.
6. Implementation of Boolean algebra using logic gates.
7. Adder Circuits.

CSE 12301	Computer Programming Practical	0 – 0 – 3/2
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Laboratory experiments will be based on the materials covered in the theory of this paper emphasizing the following topics.

1. Control statements
2. Arrays with applications
3. String Handling
4. Structure with applications
5. Pointers with applications
6. File handling in C
7. Programs on Java

SECOND SEMESTER

AMC 12101	Mathematics-II	3 – 1 – 0
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Vector Calculus and Fourier Series:

Vector Calculus: Scalar and vector fields, Level surfaces, differentiation of vectors, Directional derivatives, gradient, divergence and curl and their physical meaning, vector operators and expansion formulae, Line, surface and volume integrations, Theorems of Green, Stokes and Gauss, Application of vector calculus in engineering problems, orthogonal curvilinear coordinates, expressions of gradient, divergence and curl in curvilinear coordinates.

Fourier Series: Periodic functions, Euler's formulae, Dirichlet's conditions, expansion of even and odd functions, half range Fourier series, Parseval's formula, complex form of Fourier series.

Matrix Theory: Orthogonal, Hermitian, skew- Hermitian and unitary matrices, Elementary row and column transformations, rank and consistency conditions and solution of simultaneous equations, linear dependence and consistency conditions and solution of simultaneous equations, linear dependence and independence of vectors, Linear and orthogonal transformations, Eigen values and Eigen vectors, properties of Eigen values, Cayley-Hamilton theorem, reduction to normal forms, quadratic forms, reduction of quadratic forms to canonical forms, index, signature, Matrix calculus & its applications in solving differential equations.

Differential Equations: Differential Equations of first order and higher degree, Linear independence and dependence of functions. Higher order differential equations with constant coefficient, Rules of finding C.F. and P.I., Method of variation of parameter Cauchy and Legendre's linear equations, Simultaneous linear equations with constant coefficients, Linear differential equations of second order with variable coefficients; Removal of first derivative (Normal form), Change of independent variable, Applications of higher order differential equations in solution of engineering problems.

Partial Differential equations: Formation of P.D.E, Equations solvable by direct integration, Linear and non-linear equations of first order, Lagrange's equations, and Charpit's method, Homogeneous and non-homogeneous linear P.D.E. with constant coefficients, Rules for finding C.F. & P.I.

APC 11101	Physics	3 – 0 – 0
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Thermal Physics:

Concepts of distribution of molecular velocities; Distribution laws and statistics MB, FD and BE, mean free path; Transport phenomena-viscosity, diffusion; thermal conductivity, measurement of thermal conductivity; periodic and aperiodic flow of heat; Wiedemann-Franz law. Heat radiation; black body and black body radiation; Planck's distribution law and its application to classical distribution (Rayleigh-Jeans and Wiens) and total radiation (Stefan-Boltzmann) laws.

Modern Physics:

Brief idea of molecular spectra; Rigid rotator, spectra of simple molecules, rotation and rotation-vibration spectra. Brief idea of wave packet and wave function, Schrödinger equation, Particle in a Box. Free electron theory; qualitative idea of band theory of solids and Hall effect, Laser and laser systems (He-Ne and Ruby Lasers).

Electromagnetics and Electrical Phenomena in Rocks:

Maxwell's field equation, Equation of electromagnetic field, Propagation of electromagnetic waves in different isotropic media, energy of electromagnetic waves, Poynting's theorem & Poynting's vector. Rocks and minerals as dielectrics, electrical conductivity and electrical phenomena in rocks, Piezo-, ferro-, tribo-, and pyro-electricity.

MMC 11101	Engineering Graphics	1 – 4 – 0
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Introduction: Drawing instruments and their uses; Indian standards for drawing. Lettering and Types of lines used in engineering graphics.

Curves used in engineering practice: Conic sections, ellipse, parabola, hyperbola, cycloid, epicycloid, hypocycloid, involutes and spiral.

Projections: Orthographic projection, projection of points in different quadrants, projection of lines, projection of lines parallel to one and inclined to the other reference plane, projection of lines inclined to both the reference planes.

Multi view orthographic projections: First angle and third angle projections, conventions used, Conversion of three-dimensional views to orthographic views.

Projection of Solids and Development of surfaces

Isometric projections: Isometric views, conversion of orthographic views to isometric views.

EEC 11101	Electrical Technology	3 – 1 – 0
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Concepts of circuit elements: active and passive elements; resistance, inductance, capacitance; mutual inductance and coupling. Network theorems (KCL, KVL, Thevenin, Norton, Maximum power transfer). Mesh and nodal analysis of DC circuits.

Single-phase AC circuits and concept of phasor diagram, series and parallel resonance. Three-phase AC circuits with balanced and unbalance loads. Measurement of three-phase power by two-wattmeter method.

Single-phase transformer: construction, types, e.m.f equation, equivalent circuit diagram, hysteresis and eddy current losses, efficiency, applications.

DC Machines – construction and types, e.m.f and torque equation. DC generator – operation, e.m.f. equation, OCC, losses and efficiency, applications. DC motor – operation, torque equation, starting, losses and efficiency, applications.

Three-phase induction motor: construction, types, operation, torque equation, torque slip characteristics, starting methods, applications.

MMC 11103	Engineering Mechanics	3 – 1 – 0
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Fundamentals of Mechanics: Equivalent force systems, Equilibrium of rigid bodies.

Introduction to structural mechanics: Trusses, Frames, Machines, Beams, and Cables.

Friction force analysis: Sliding and Rolling friction, Screw, Belt and Collar friction

Properties of surfaces: Centroid of composite bodies, Pappus-Guldinus theorem, moment of inertia of composite bodies, parallel axis theorem, product of inertia, principal axes, Mohr's circles for moments and products of inertia.

Virtual work: Principle and applications, Stability of equilibrium.

Kinematics and kinetics of particles: Curvilinear motion, Dynamic equilibrium, Angular momentum, Revision of Conservation of Energy, Energy and Momentum methods for Single Particle and for a System of Particles, Impulsive motion.

Kinematics of rigid bodies: General plane motion, Instantaneous center of rotation, Planer motion relative to a rotating frame, Coriolis acceleration, Frame of reference in general motion.

Kinetics of rigid bodies: Application of the principle of impulse and momentum to the 3D motion of a rigid body, Kinetic energy in 3D, Euler's equations of motion, Motion of a Gyroscope, Eulerian angles.

GLD/CMD 11301	Earth System Science (S) [AGL 2-0-0 & ESE 1-0-0]	3 – 0 – 0
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Part A : **AGL** **(2-0-0)**

Space Science : Solar System, Age of the Earth, Origin of Solar system. Meteors and Meteorites.

Earth Dynamics : Interior of the Earth, Composition of the Earth, Seismic waves, Seismograph, Plate Tectonics, Basics of Earthquake Engineering, Landslides, Volcanoes.

Geological Oceanography: Sea waves, Tides, Ocean currents, Geological work of seas and oceans, Tsunami and its causes, Warning system and mitigation.

Hydrogeology: Water table, Aquifer, Groundwater fluctuations and groundwater composition, Hydrologic cycle.

Glaciology: Glacier types, Different type of glaciers, Landforms formed by glacier.

Geological bodies and their structures: Rock, mineral, batholith, dyke, sill, fold fault, joint, unconformity.

Part B : **ESE** **(1-0-0)**

Earth's Atmosphere : Structure and composition of atmosphere, Atmospheric circulation, Geological work of wind, Greenhouse effect and global warming, Carbon dioxide sequestration. Steps to maintain clean and pollution free atmosphere with governing laws, precautionary measures against disasters.

Biosphere: Origin of life, Evolution of life through ages, Geological time scale, biodiversity and its conservation.

Natural Resources : Renewable and non-renewable resources, Mineral and fossil fuel resources and their geological setting, mining of minerals and conservation, effect of mining on surface environment

HSC 12305	Value Education, Human Rights and Legislative Procedure (S)	3 – 0 – 0
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Social Values and Individual Attitudes, Work Ethics, Indian Vision of Humanism, Moral and Non-moral Valuation, Standards and Principles, Value Judgements.

Rural Development in India, Co-operative Movement and Rural Development.

Human Rights, UN declaration, Role of various agencies in protection and promotion of rights.

Indian Constitution, Philosophy of Constitution, Fundamental Rights and Fundamental Duties, Legislature, Executive and Judiciary : Their Composition, Scope and Activities.

The Legislature: Function of Parliament, Constitution of Parliament, Composition of the Council of the States, Composition of the House of People, Speaker.

Legislative Procedure: Ordinary Bills, Money Bills, Private Member Bills; Drafting Bills; Moving the Bills, Debate, Voting, Approval of the President/Governor.

Vigilance: Lokpal and Functionaries.

APC 12201	Physics Practical	0 – 0 – 3/2
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Measurement of thermal conductivity of bad conductors, Optical experiments on Diffraction using diffraction grating, Experiments on Semi-conductors – Measurement of band gap and Hall Effect, experiments using He-Ne Laser - Diffraction Experiments to measure diameter of circular aperture, Polarisation Experiments to measure Brewster's angle & refractive index.

EE 12201	Electrical Technology Practical	0 – 0 – 3/2
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Experiments on Thevenin's theorem, R-L-C series circuit, Single phase power measurement, Characteristics of fluorescent lamp and incandescent lamp, OC and SC tests of single phase transformer, Open-circuit characteristics of DC separately excited generator, External Characteristics of separately excited DC generator, Three-point starter of DC shunt motor, Speed control of DC motor.

THIRD SEMESTER

GLC 13101	Geology – I (Mineralogy)	3 – 0 – 0
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Definition of mineral. Physical properties of mineral. Common classification of minerals and their basis. Chemical bonding and compound formation. Closest packings, radius ratio and coordination polyhedra. Pauling's rules.

Classification, structure and chemistry of major silicates: Olivine group, Pyroxene group, Amphibole group, Feldspar group, Feldspathoids; Oxides of iron, manganese, chromium; Sulphides of Pb, Zn, Cu; mineral groups of sulfates, carbonates, halides, phosphates; and native minerals.

GLC 13102	Geology – II (Crystallography and Optical Mineralogy)	3 – 0 – 0
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Crystallography

Elementary ideas about crystal structure – faces, edges, solid angles, interfacial angles, Steno's rule, zones. External symmetry (symmetry operations in two and three dimensions). Miller indices, crystal forms. Spherical and stereographic projections. Crystallographic axes, axial ratio, 32 crystal classes and classification in seven systems. Fourteen space lattice. Crystal growth: twinning and defects.

Optical Mineralogy

Properties of Light, petrographic microscope, Uniaxial and biaxial indicatrix and minerals. Double refraction, Extinction angles, pleochroism, birefringence of minerals and their relation with mineral composition. Uniaxial and biaxial figures and optic sign determination, Optical properties of common rock forming silicate minerals. Dispersion. The U- stage.

GLC 13103	Geology – III (Sedimentary Petrology and Stratigraphy)	3 – 0 – 0
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Sedimentary Petrology

Sedimentation processes; Classification and description of some common sedimentary rocks (Conglomerate, Sandstone, Shale, Limestone).

Stratigraphy

Principles of stratigraphy; Broad stratigraphic subdivisions and associated rock types of important ore provinces, coal belts and oil fields of India.

AMR13101	Methods of Applied Mathematics - I	3 1 0
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Section-A: Analysis of Complex Variables

Limit, continuity and differentiability of function of complex variables. Analytic functions. Cauchy-Riemann's and Cauchy's integral theorem, Morera's theorem, Cauchy's integral formula, Expansion of function of complex variables in Taylor's and Laurent's series, singularities and poles. Residue theorem, contour integration, conformal mappings and its application, Bilinear Transformation.

Section-B: Special Functions

Solution in series of ordinary differential equations, Solution of Bessel and Legendre equations, recurrence relations and generating function for $J_n(x)$, orthogonal property and Integral representation of $P_n(x)$. Legendre polynomial, Rodrigue's formula, orthogonality properties and generating function for $P_n(x)$. Elliptic integrals and Error function and their properties.

Section-C: Laplace Transform and PDE

Laplace Transform of simple functions, first and second shifting theorems, t-multiplication and t-division theorems; Laplace transforms of derivatives, integrals and periodic functions. Inverse Laplace transform and convolution property. Use of Laplace transform in evaluating complicated and improper integrals and solution of ordinary differential equations related to engineering problems.

Partial Differential Equations

Classification of partial differential equations, solutions of one dimensional wave equation, one dimensional unsteady heat flow equation and two dimensional steady heat flow equation in Cartesian and polar coordinates by variable separable method with reference to Fourier trigonometric series and by Laplace transform technique.

ACC13120	INORGANIC CHEMISTRY	3 0 0
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Atomic Structure

Idea of de Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrodinger wave equation, significance of Ψ and Ψ^2 , quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, d orbitals, Aufbau and Pauli exclusion principles, Hund's multiplicity rule. Electronic configurations of the elements, effective nuclear charge.

Periodic Properties

Atomic and ionic radii, ionization energy, electron affinity and electronegativity – definition, methods of determination or evaluation, trends in periodic table and applications in predicting and explaining the chemical behaviour.

Chemical Bonding

Covalent Bond – Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions. Valence shell electron pair repulsion (VSEPR) theory to NH_3 , H_3O^+ , SF_4 , ClF_3 , ICl_2 and H_2O . MO theory, homonuclear and heteronuclear (CO and NO) diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.

Ionic Solids – Ionic structures, radius ratio effect and coordination number, limitation of radius ratio rule, lattice defects, semiconductors, lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarisability of ions, Fajan's rule. Metallic bond-free electron, valence bond and band theories.

Weak Interactions – Hydrogen bonding, van der Waals forces.

s-Block Elements

Comparative study, diagonal relationships, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, an introduction to alkyls and aryls.

p-Block Elements

Comparative study (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides, oxyacids and halides of groups 13-16, hydrides of boron-diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), tetrasulphurtetranitride, basic properties of halogens, interhalogens and polyhalides.

Chemistry of Noble Gases

Chemical properties of the noble gases, chemistry of xenon, structure and bonding xenon compounds.

GLC 13201	Mineralogy Practical	0 – 0 – 2
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1. Physical properties of common rock-forming and ore-forming minerals in hand specimen.
2. Study of common rock-forming minerals in thin section.
3. Study of optical properties of minerals under petrological microscope.
4. Determination of optic sign of minerals
5. Determination of 2V.

GLC 13202	Crystallography Practical	0 – 0 – 2
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1. Study of crystal models of different classes.
2. Stereographic projections of some important crystal classes, axial ratio calculations.
3. Miller indices and zone axis calculations.

ACC13220	INORGANIC CHEMISTRY PRACTICAL	0 0 3
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Semimicro Analysis- cation analysis, separation and identification of ions from Group I, II, III, IV, V and VI. Anion analysis.

FOURTH SEMESTER

GLC 14104	GEOLOGY - IV (Physical and Structural Geology)	3 0 0
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Physical Geology

Evolution of the earth; Exogenous and endogenous processes shaping the earth. Transportation and deposition; Geological work of running water, wind, glaciers, seas and ground water; Diastrophism; Earthquakes and volcanoes.

Structural Geology

Interpretation of topographic maps; Attitude of planar and linear structures; Effects of topography on outcrops. Unconformities, folds, faults and joints - their nomenclature, classification and recognition. Forms of igneous intrusions - dyke, sill and batholith. Effects of folds and fractures on strata/orebodies and their importance in exploration activities. Principles of stereographic projection. Introduction to Plate Tectonics.

GLC 14204	STRUCTURAL GEOLOGY PRACTICAL	0 0 2
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1. Interpretation of Topographic Maps
2. Interpretation of geological Maps - 1 : Altitude and Cross sections
3. Outcrop completion - 1 : One point problem and V - rule
4. Outcrop completion - 2 : Three point problem
5. Interpretation of geological Maps - 2 Unconformable beds
6. Interpretation of geological Maps - 3: Folded beds
7. Interpretation of geological Maps - 4: Faults and dykes
8. Stereographic projection - 1 : Planes and lines
9. Stereographic projection - 2 : Determination of angles and Bisectrix

GLC 14105	GEOLOGY –V (Economic Geology)	3 0 0
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1. Terminology: Syngenetic/epigenetic, stratiform/stratabound ores, Hypogene and supergene ores, ore and gangue minerals, grade and Tenor.
2. Classification of ore deposits:
3. Processes of Ore mineralisation:
 - (a) Ores of igneous affiliations:
 - (b) Magmatic associations with special types like ultramafic-mafic and felsic suites. Different categories of magmatic ore deposits.
 - (c) Ores formed by Sedimentary process. BIF, stratabound, stratiform types, polymetallic nodules.
 - (d) Residual and mechanical concentration and supergene processes.
 - (e) Ores formed by metamorphism. Metamorphism of ores and associated rocks. Skarn type mineralisation.
 - (f) Hydrothermal ore deposits. Vein type deposits; Lode gold and hydrothermal base metal deposits.
4. Mode of occurrence and controls of ore deposition.
5. Temporal pattern and distribution of types of ores through geologic time.
6. Distribution and brief geological aspects of important Indian metallic and non-metallic deposits.

GLC 14205	ECONOMIC GEOLOGY PRACTICAL	0 0 2
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Study of ore suite samples from different localities and associations

GLC 14106	GEOLOGY - VI (Paleontology)	3 0 0
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1. Definition and scope of paleobiology, process of fossilization, preservation potential of organisms. Elementary ideas about origin of life, evolution and fossil record. Systematic classification of organisms – their characters, environmental factors.
2. Ontogeny and variation in fossil assemblages. Identification of fossils: methods of description and illustration; taxonomic categories and codes of systematic nomenclature.
3. Morphology, environment and geological distribution of brachiopoda, mollusca, echinodermata, arthropoda, and anthozoa.
4. Introduction to Palynology and paleobotany; morphology of typical Gondwana flora.

5. Applications of paleontologic data in paleoecology, evolution, Stratigraphy, and paleogeographic reconstructions.

GLC 14206	PALEONTOLOGY PRACTICAL	0 0 2
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Study of the morphological characters of the common invertebrate genera belonging to phyla brachiopoda, mollusca, echinodermata, arthropoda, and anthozoa.
Study of common plant fossils.

GLC 14107	Geology – VII (Igneous and Metamorphic Petrology)	3 – 0 – 0
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Igneous Petrology

Earth's interior, Heat source in the Earth, Heat transfer, Geothermal gradient, Properties of silicate melts; nucleation and growth of crystals; equilibrium and fractional crystallization; Bowen's reaction series, magmatic differentiation processes; variation diagrams and trace element modeling. Texture, structure and classification of igneous rocks.

Metamorphic Petrology

Definition, Limits of metamorphism, Agents of metamorphism and changes, Types of metamorphism, types of protoliths, metamorphic facies classification and baric types. Description of common metamorphic rock types (their mineral assemblages and texture).

GLC 14207	PETROLOGY PRACTICAL	0 0 2
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Megascopic study of specimens of igneous, sedimentary and metamorphic rocks.
Introduction to different types of igneous, sedimentary and metamorphic textures and structures.
Introduction to thin section study of igneous, sedimentary and metamorphic rocks.

EIC 14152	MICROPROCESSORS AND THEIR APPLICATIONS	3 0 0
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Intel microprocessor 8085 CPU architecture, Instruction set of 8085, Assembly language of 8085, Addressing modes and different arithmetic, logical, data transfer and other instructions with simple programs, counter and time delays, BCD arithmetic, 16-bit operations, Stack and subroutines. Interrupt structure and serial I/O, Timing diagrams of different instructions, Memory and I/O interface. Introduction to 8086 CPU, Addressing modes of 8086, Assembly language programs, Interfacing memory and I/O devices, DOS routines, Minimum and Maximum modes of 8086. Interfacing different peripherals: 8155, 8255 PPI, 8254, 8279, 8259A, 8257 Chips to 8085 and 8086. Introduction to 8087 Math co-processor and I/O processor. Interfacing ADC, DAC and Key board, and different types of displays.

FIFTH SEMESTER

GLC 15111 / GLC 21111	MINERALOGY	3 0 0
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Crystal Field theory, Molecular band theory, Molecular orbital theory and Field theory. Silicate structures. Quartz and aluminosilicate groups, isostructuralism, polymorphism and polytypism
 Feldspathoids and feldspars: structures and twins. Feldspars phase relations (2 component diagrams), formation of intergrowths (nucleation and growth, spinoidal decomposition). Zeolite group
 Mafic silicates - olivine, pyroxene, pyroxenoid, amphibole, pyrobole groups: structures, chemical variations, temperature-pressure indicators, associations
 Phyllosilicates, mixed layer silicates: micas, chlorites, and clays.
 Soro and ring silicates.
 Garnet, perovskite, spinel and other oxides: mantle minerals and phase changes. Opaque oxides, carbonates, sulphides, phosphates and halites.
 Determinative mineralogy : Universal Stage, XRD, DTA, SEM, TM, Electron Microprobe analyses.
 Optical properties of minerals. Optic sign, 2-V angles, optical orientation and dispersion of biaxial minerals.

GLC 15211 / GLC 21211	MINERALOGY PRACTICAL	0 0 2/3
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The Polarizing microscope. Study of optical properties of minerals under petrological microscope, viz. Quartz and aluminosilicate groups; Feldspathoid and feldspar group; Mafic silicates; Phyllosilicates; Garnet group; oxides of iron, manganese, chromium; sulphides of lead, zinc and copper.

GLC 15112 / GLC 21112	STRUCTURAL GEOLOGY	3 0 0
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Methods of constructing profiles of folds: Convolute and evolute methods, Concentric-arc method, Kink-style construction, Dip-isogon method, Down-plunge projection method
 Tectonites: Different types and their significance. Petrofabric analysis. Relationship between deformation and metamorphism and criteria for recognition. Relative dating of orogenic belts.
 Principles of Structural Analysis. Interference patterns in superposed folding and structural geometry in superposed folding. Behavior of lineations in superposed deformations. Use of foliations and lineations in tectonic analysis. Different phases of analysis, analysis of slate belts with simple and multiple deformations. Mapping in gneiss terranes. Migmatite complexes, reworking of basement rocks, mantled gneiss domes.
 Analysis of shear zones: Different types, Shear zone rocks, Shear sense indicators. Balanced cross-sections of thrust-belts. Applications of balanced cross-sections.
 Analysis of fractures: Lineament-Array analysis and its significance for regional exploration programme, Joint-array Analysis and its significance, Fault-array Analysis.
 Introduction to stress and strain analysis.

GLC 15212 / GLC 21212	STRUCTURAL GEOLOGY PRACTICAL	0 0 2/3
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Preparation and interpretation of fence diagram. Structure contour maps, Isopach and isochore maps. Analysis of Fracture and Lineament array. Structural Geometry by stereographic projection. Construction profiles of folds. Preparation of balanced crossed-section. Analysis of shear zones.

GLC 15113 / GLC 21113	GEOCHEMISTRY	3 0 0
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Origin and abundance of elements in the solar system and in the Earth and its constituents. Geochemistry of atmosphere, hydrosphere.
 Geochemical classification of elements. Special properties of LILE, HFSE and rare earth elements.
 Concept of free energy, activity, fugacity and equilibrium constant, thermodynamics of ideal, non-ideal and dilute solutions. Principles of ionic substitution in minerals; element partitioning in mineral/rock formation and concept of simple distribution coefficients and exchange reaction distribution coefficients; element partitioning in mineral assemblages and its use in the pressure-temperature estimation.
 Chemistry of natural waters. Mineral stability in Eh-pH diagram. Elemental mobility in surface environment. Concept of geochemical-biogeochemical cycling and global climate.
 Oceans and atmosphere: their compositions, evolution, steady state, and global mass balance, rock water interaction: congruent and incongruent dissolution, redox reactions, ionic strength of electrolyte solutions. Debye-Huckel theory.

Discovery of Radioactivity and isotopes as well and its influence on Earth Sciences. Nuclide types, their abundances, and atomic weights. Decay mechanisms of radioactive atoms. Radioactive decay and growth. Basic principles of radiometric dating methods of Rocks: K – Ar and Ar – Ar methods, Rb – Sr and Sm – Nd methods, U – (Th–)Pb methods. Stable isotope systematics: Carbon, Oxygen, Hydrogen and Sulphur and their implication

GLC 15213 / GLC 21213	GEOCHEMISTRY PRACTICAL	0 0 2/3
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Basic sample preparation methods (Destructive and non-destructive), A- solution and B- Solution preparation. Wet chemical analyses and titrimetric analyses of major and some trace elements. Making applications and performing major and some trace elements using international standards with the help of XRF. Data presentation and associated problems.

GLC 15114 / GLC 21114	SEDIMENTOLOGY	3 0 0
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1. Scope and significance, nature and origin of sedimentary rocks, composition and classification.
2. Earth surface processes, Sediment transport in different systems, Sedimentary structures and their genetic significance and importance in rock record, Biogenic structures
3. Texture of sediments: Particle size of detrital rocks, definition, measurement, size parameters, grain size distribution and causal factors, grain size distributions and environmental analysis, Sphericity and roundness, packing and fabric, porosity and permeability.
4. Palaeocurrent analysis: Vector properties and palaeocurrent, scalar properties and palaeocurrent, presentation and interpretation of palaeocurrent data.
5. Petrology of important clastic and nonclastic rock groups. Methodology and significance of provenance studies, paleoclimatic and paleoenvironmental analysis.
6. Classification of environments, Environmental parameters, Sedimentary Facies Analysis; Its importance in paleoenvironmental reconstruction, tectonic control of sedimentation. Evolution of sedimentary basins.
7. Diagenesis; changes in mineralogy, fabric and chemistry: Mudstones, sandstones, carbonate rocks.
8. Cyclic sediments: Seismic and sequence stratigraphy.

GLC 15214 / GLC 21214	SEDIMENTOLOGY PRACTICAL	0 0 2/3
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Description of primary sedimentary structures from sketches and hand specimens. Representation of grain size distribution data; Plotting of cumulative distribution curves, Determination of different statistical parameters Interpretation of sedimentary environments. Observation of common siliciclastic and carbonate sedimentary rocks under thin section. Study of heavy minerals.

GLC 15115 / GLC 21115	STRATIGRAPHY	3 0 0
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Principles of Stratigraphy

Principles of stratigraphic correlation. Stratigraphic code of nomenclature.

Phanerozoic Stratigraphy of Peninsular India and Extra Peninsular India

1. Stratigraphy, tectonics, and basin evolution of Gondwana sedimentary units; Intracontinental and intercontinental correlations between Gondwana successions.
2. Traps: Deccan, Rajmahal, Sylhet and Rajahmundry Traps and their correlations.
3. Evolution and stratigraphy of Indian Coastlines: Marine Mesozoics of coastal India viz Cretaceous of Trichinopalli and Jurassic of Kutch.
4. Stratigraphic Boundary Status: Precambrian-Cambrian, Permo-Triassic, Cretaceous- Tertiary, Neogene-Quaternary.
5. Phanerozoics of Extra Peninsula: Spiti, Kashmir and Salt Range.
6. Lithostratigraphy of different sedimentary cycles vis-à-vis major geologic and tectonic events of the Himalayas.
7. Lithostratigraphy of Siwalik Sediments.
8. Tertiary formations of Kutch and Assam -Arakan geological provinces.

Precambrian Stratigraphy

9. Precambrian belts of India (South India, Central India, Rajasthan, Eastern Ghat, Singhbhum-Orissa): Age correlations, metamorphism, tectonics and evolution.
10. Archean-Proterozoic boundary problem in India.
11. Concept of Precambrian supercontinents
12. Important Proterozoic basins of Peninsular India: Sedimentation, correlation and evolution.

SIXTH SEMESTER

GLC 16116 / GLC 22116	IGNEOUS PETROLOGY	3 0 0
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Classification of igneous rocks. IUGS classification. Textures and structures of igneous rocks. Origin and evolution of magmas. Compositional variation in magmas. Crystallisation of magma and their representations in phase diagrams (binary system and ternary diagrams). Influence of volatiles and role of oxygen fugacities in magmatic crystallisations. Assimilation Fractional Crystallization (AFC) processes. Nature and type of partial melting in the mantle. Magmatic differentiation and fractionation models. Representation of chemical analysis of igneous rocks. Major and Trace element systematics in igneous rocks. Silica/alumina saturation, variation diagrams, their applications and limitations. Granites and their origin, I-, S-, A- type granites. Pegmatites, their nature, occurrence and petrogenesis. Alkaline rocks and their origin. Anorthosites and their petrogenesis. Lamprophyres and their petrography and origin. Ultramafic and layered rocks, nature and origin. Carbonatites, Petrography and their petrogenesis. Kimberlites and their origin. Lunar rocks. Magmatism in relation to plate tectonics. Petrographic and chemical characteristics of igneous rocks in the following tectonic setting: Mid Oceanic Ridge, Island Arcs, Oceanic plateaus, Continental Margins, Continental Rifts and Continental intraplates.

GLC 16216 / GLC 22216	IGNEOUS PETROLOGY PRACTICAL	0 0 2/3
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Textures of Igneous Rocks. Exercises on Crystal Fractionation of Igneous Rock Suites. Exercises on Partial Melting of Igneous Rock Suites. Exercises on the construction and interpretation of Spider diagrams of N-type MORBs, E-type MORBs, OIBs etc. Thin Section study of acid, basic and ultramafic rocks.

GLC 16117 / GLC 22117	METAMORPHIC PETROLOGY	3 0 0
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1. Nature and scope of metamorphism, Types of metamorphism, Metamorphic textures
2. Construction and interpretation of ACF, AKF and AFM diagrams, Schriener's rule and construction of petrogenetic grid
3. Types of metamorphic reactions and role of fluids, Nucleation and growth in solids kinetics of metamorphic reactions, Arrhenius relations, diffusion and interface controlled reactions
4. Metamorphic facies and grade; Iso-reaction grade, Concepts of geothermometry and geobarometry
5. Regional and thermal metamorphism of Pelitic rock, mafic rock and calc-silicate rocks, Granulites, eclogites,
6. Metamorphic differentiation and anatexis, P-T-t paths and metamorphic terrains in relation to plate tectonics, Paired metamorphic belts,
7. Ultra-high temperature and Ultra-high pressure metamorphism.

GLC 16217 / GLC 22217	METAMORPHIC PETROLOGY PRACTICAL	0 0 2/3
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Thin section study of important metamorphic rocks, Metamorphic textures and processes, Representation of pelitic assemblage in AFM diagrams, Representation of mafic assemblage in ACF diagrams, Construction of petrogenetic grid using AFM in simple pelitic systems.

GLC 16118 / GLC 22118	MICROPALAEONTOLOGY AND VERTEBRATE PALEONTOLOGY	3 0 0
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Micropalaeontology

Introduction to various groups of microfossils. Techniques of separation of microfossils from different types of sedimentary rocks.

Foraminifera and Ostracoda - their morphology, orientations, growth, reproduction, ecology and palaeoecology, classification, evolutionary trends and stratigraphic distribution.

Conodonts - Morphology, classification, biological affinity and stratigraphic distribution.

Application of micropalaeontology in fossil fuel exploration, and paleoclimate.

Introduction to palynology.

Vertebrate Palaeontology

Characteristic features of vertebrates - Skeletal elements of their fossil remains. Origin of vertebrates and their general evolutionary patterns; outline classification of vertebrates. Classificatory characters and divisions of the vertebrate; Agnathans, Fishes, Amphibia, Reptilia, Aves and Mammalia.

Evolution of mammalian dentition. Phylogeny of Equids, Proboscids and Hominids.
Origin, evolution and extinction of life; Dinosaurs and their extinction.

GLC 16218 / GLC 22218	MICROPALAEONTOLOGY AND VERTEBRATE PALEONTOLOGY PRACTICAL	0 0 2/3
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Disintegration of sediments and separation of microfossils. Morphology of some important foraminifera, ostracoda and vertebrate fossils.

AMR 14101	NUMERICAL AND STATISTICAL METHODS	3 1 0
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A. Numerical Methods

Solution of algebraic and transcendental equations by bisection, iteration, false position, secant and Newton Raphson methods, Generalised Newton's method for multiple roots.

Solution of a system of linear simultaneous equations by Gauss elimination, Gauss-Jordan, Crout's triangularisation, Jacobi and Gauss Seidel methods. Finite differences, Symbolic relations, differences and factorial notation of a polynomial, data smoothing, Interpolation and, extrapolation, Newton-Gregory forward and backward, Gauss forward and backward, Stirling, Bessel, Everett, Lagrange and Newton's divided difference formulae, Inverse interpolation by Lagrange and iterative methods, Cubic splines, Numerical differentiation and integration, Trapezoidal, Simpson's $1/3^{\text{rd}}$, Simpson's $3/8^{\text{th}}$, Weddle and Gaussian quadrature formulae.

Numerical solution of first order ordinary differential equation by Taylor's series, Picard's, Euler's, Modified Euler's, Runge-Kutta, Adams-Moulton and Milne's methods. Solution of simultaneous first order and second order ordinary differential equations with initial conditions by Taylor's series, Runge-Kutta and Milne's methods. Numerical solution of boundary value problems by finite difference and shooting methods.

B. Statistical Methods

Concept of a frequency distribution: Moments, skewness and kurtosis. Probability: Various approaches of probability-classical, frequency (statistical), subjective and axiomatic. Theorems on probability, conditional probability, Independence, Bayes Theorem.

Random variable-discrete and continuous. Distribution function and their properties, probability mass and density functions, Mathematical expectation, Moment generating function and its properties.

Probability distributions: Bernoulli, binomial, negative binomial, Poisson and normal distributions.

Theory of least squares and curve fitting.

Correlation-Simple, multiple and partial, Regression lines and regression coefficients, Multiple and partial regression.

Tests of Significance: Normal test, t-test, Chi-square and F-test.

MER 22131	SURVEYING	3 0 0
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Introduction to Surveying: Objective of surveying and its importance, Classification, principles of surveying, Application of Surveying in various fields of Engineering

Linear measurements: Conventional Instruments for measuring distances, ranging and chaining out of survey lines, Obstacle in chaining and errors in chaining, corrections Principles, offsets, booking field notes, problems

Linear measurements (EDMs): Theory and characteristics of electromagnetic waves, radio waves, infrared, laser waves, principle of distance measurement with EDMs

Angular measurements: Principle and construction of prismatic compass, bearing of lines, local attraction, magnetic declination and examples.

Theodolite: The essentials of transit theodolite, definition and terms, temporary adjustments, measurement of horizontal and vertical angles, different operations and sources of error, theodolite traversing, Omitted Measurements.

Total Station: Principle, working and construction. Corrections to be applied.

Leveling instruments: Definition, different type of leveling instruments, curvatures and refraction corrections, reciprocal leveling, errors in leveling and problem solving.

Contouring: General, Contour Interval, Characteristics, Methods of locating contours, Interpolation etc.

Global Positioning System (GPS): Theory, principles and applications.

GIS: Introduction to GIS, Its application in mapping.

Application of IT in Surveying.

MER 22231	SURVEYING PRACTICAL	0 0 2/2
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Study of linear measuring instruments and chain surveying, Study of Theodolite and traversing with Theodolite, Study of levels and ordinary leveling with tilting level, Profile leveling, Study of Total Station and measurement with total station, Study of Global Positioning System (GPS) and measurement with GPS.

SEVENTH SEMESTER

GLC 17121 / GLC 23121	ORE GEOLOGY	3 0 0
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Qualitative and Quantitative methods in the identification of Ore minerals.
 Ore textures and paragenesis. Industrial application of ore microscopy and process mineralogy.
 Ore forming processes.
 Nature of ore forming fluids. Different types of chemical reactions involved in hydrothermal alterations and supergene enrichment.
 Phase diagrams of ore minerals.
 Calculation of thermo-barometric parameters for oxide and sulphide phases.
 Fluid inclusions and their application in the genesis of ores. Isotopes and their bearing on ore genesis and application.

GLC 17221 / GLC 23221	ORE GEOLOGY PRACTICAL	0 0 2/3
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1. Introduction to ore microscopy: Concept of reflected light microscopy and description of optical properties of ore minerals.
2. Ore microscopic study of important oxide minerals and complex minerals.
3. Ore microscopic study of important sulfide minerals.
4. Textural and micro-structural features of ore mineral assemblages.
5. Determination of Paragenetic order of the ore minerals.
6. Characterization of Fluid Inclusions.
7. Applied Ore microscopy: Particle size measurement and applications in the liberation characteristics of complex mineral assemblages for mineral beneficiation and in other areas.

GLC 17122 / GLC 23122	GEOSTATISTICS	3 0 0
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1. Classical Statistics: Universe, Population and Sample; Concept of Random variable; Probability distributions, viz. Normal (Gaussian) and Lognormal distribution
2. Concepts of Geostatistics: Support, Autocorrelation, Random Function, Regionalised variable; Exploratory Data Analysis.
3. Semi-variogram: definition, properties, calculation of experimental semi-variograms in 1-, 2-, and 3-dimensions; Mathematical models of semi-variogram; Techniques of model fitting, Practical difficulties associated with semi-variography.
4. Extension and Estimation Variance: definition, formulation, and methods of calculation, viz. method of discretization and use of auxiliary functions; Dispersion variance – definition, formulation and its calculation.
5. Kriging: Introduction and definition; Linear kriging – Ordinary kriging and Simple kriging; Solving kriging system of equations for Point and Block Kriged Estimate and Kriging Variance – case with two samples, general case with many samples and in presence of nugget effect. Influence of Nugget effect on kriging weights; Properties of kriging, viz. Screen effect and Shadow effect.
6. Practice of Kriging: Geostatistical evaluation of mineral deposit, orebody modelling, calculation of mineral inventory, establishment of grade-tonnage relationships, role of kriging variance in optimization of exploration drilling and misclassified tonnages.
7. A brief introduction to Geostatistical Conditional Simulation.

GLC 17222 / GLC 23222	GEOSTATISTICS PRACTICAL	0 0 2/3
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Histogram plotting and estimation of mean, median, mode, skewness and kurtosis; Drill hole compositing, Fitting of Probability distributions to sample distribution, viz. Normal and Lognormal; Chi-squared goodness of

fit; Computation of Semi-variograms in 1-, and 2-dimensions; Semi-variogram modeling; Computation of estimation variance; Exercises on kriging.

GLC 17123 / GLC 23123	GEODYNAMICS	3 0 0
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1. Methods and sources of geotectonic information. Variation of physical properties in the earth. Internal structure of the earth. Detailed structures of core, mantle and crust, including their physical properties and composition.
2. Crustal types, main features of ocean basins and deep ocean floor. Characters of oceanic ridges. Stages in the evolution of ocean basins. Different types of continental margins and their characters.
3. Historical background of plate tectonics. Earlier hypotheses of orogenesis, continental drift, palaeomagnetic study, sea-floor spreading and distribution of tectonically active zones.
4. The concept of plate tectonics. Plate geometry and plate boundaries. Triple junctions. Plates in velocity space. Spherical coordinates and reference frame. Cartesian coordinates. Finding Euler's pole. Velocity due to rotation about an Euler's pole. Angular velocity vectors. Mechanisms of plate motion: mantle plume model, convection model, viscous drag and buoyancy model.
5. Tectonics of different plate boundaries. Different types of tectonic settings: extensional, compressional, and transformal. Petro-tectonic assemblages at different plate boundaries. Activation model and collision model of orogeny. Pacific and Andean type orogeny.
6. Configuration of the Indian plate and origin of the Himalayas.

MER 23131	ROCK MECHANICS	3 0 0
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Definition, importance and scope of the subject; Analysis of stress and strain at a point; Mohr's circle of stress and strain; stress field.
 Physical and mechanical properties of rocks; Compressive, tensile, shear and triaxial strength of rock; Behaviour of rock under stress/strain and creep in rocks rheological models.
 Theories of rock failure.
 Stress concentration around a single and multiple opening.
 Rock slope engineering - factors influencing slope stability, factor of safety of a slope, analysis of slope failure, monitoring of slope stability, improving slope stability.
 Rock bursts and bumps; Subsidence - causes, prediction, monitoring and prevention, Case histories in Indian scenario.
 Determination of in-situ stresses.
 Instrumentation and monitoring of stability of structure in rocks. Stabilization of weak and fractured ground - grouting and shotcreting.
 Numerical modeling for Geotechnical applications.
 Dynamic properties of rock and rock masses.

MER 23231	ROCK MECHANICS PRACTICAL	0 0 2
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Direct and indirect methods of determination compressive, tensile, shear and triaxial strength of rock; modulus of elasticity and Poisson's ratio; dynamic modulus of elasticity; porosity of rock; load cell, extensometer and convergence meter.

GPC 17151 / GPC 23151	GEOPHYSICAL PROSPECTING	3 0 0
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Methods of Geophysical Investigation.
Gravity method: Basis for gravity exploration, concept of geoid, international gravity formula, unit of gravity.
 Gravimeters: Spring-mass system as basic gravimeters, principles of working of unstable gravimeters, zero length spring, La-Coste-Romberg and Worden gravimeters. Drift. correction. Gravity effect due to buried sphere. Densities of common rocks and minerals.
Magnetic method: Magnetic susceptibility of rocks and their ranges, elements of earth magnetic field; Magnetometers: Fluxgate and Proton Precession Magnetometers Diurnal Correction; Magnetic effect due to isolated pole.
Seismic Method: Principles of Geometrical Optics, generation and propagation of seismic waves, seismic energy sources, geometry of refraction and reflection, interpretation of travel time curves for two layered earth- horizontal and dipping interface, field procedure-profile and broad side shooting, fan shooting, end on and split

spread arrangements.

Resistivity Method: Resistivities of common rocks and minerals, True and apparent resistivity, Electrode configurations-Schlumberger and Wenner, Electrical profiling Vertical Electrical Sounding, Interpretation of two layered VES curves.

Well logging: Objectives of well logging, Borehole environment, surface logging setup, sources of SP in wellbore, Archie's law and Darcy's law.

GPC 17251 / GPC 23251	GEOPHYSICAL PROSPECTING PRACTICAL	0 0 2/3
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Reduction of gravity data to base station; To calculate Free air and Bouguer anomaly at given station; Interpretation of Bouguer anomaly map.

Elements of Earth Magnetic Field; Reduction magnetic data to base station; Interpretation of Magnetic anomaly map.

Interpretation of VES curves for two layered earth and three layered earth.

Calculation of water saturation from SP, Resistivity and porosity logs.

Lithology identification from gamma ray and Resistivity logs.

To draw T-D curve for dipping refractor, and horizontal reflector.

To calculate formation water resistivity from SP log.

Interpretation of Dual Laterolog and Induction Log.

Calculation of NMO.

EIGHTH SEMESTER

GLC 18125 / GLC 24125	REMOTE SENSING AND GIS	3 0 0
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Remote Sensing

Principles of remote sensing. The nature and generation of electromagnetic radiation. Spectral bands, resolution and reflectance curves, interaction of EMR with atmosphere, rocks, minerals and soil, vegetation and water. Sensor systems and platforms.

Aerial remote sensing, aerial photography, properties of aerial photographs, elements of photointerpretation. Interpretation of geographical, geomorphological, structural and lithological features from aerial photographs. Radar remote sensing. Satellite remote sensing: LANDSAT, SPOT and IRS systems. Introduction to digital image processing.

Applications: Remote sensing in Geological mapping, Mineral Exploration, Ground water Exploration, Petroleum Exploration, Engineering Geology and Environmental studies.

GIS

Geographical Information System: Introduction and definitions; Technology and concepts; Components of GIS; Developments in GIS.

GIS data modelling, data analysis – Overlay, DEM and DTM; Topological modelling; Spatial operations, Map integration, Multi-criteria evaluation.

Steps in a GIS project: Identification of project objectives, Creation of project database, Analysis of data, and Data integration, and Presentation of map output.

Overview of GIS softwares, viz. ArcGIS, Geomatica and MapINFO.

GLC 18225 / GLC 24225	REMOTE SENSING AND GIS PRACTICAL	0 0 2/3
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Testing of Stereovision and examination of stereo aerial photograph under mirror stereoscope.

Spectral signature and analyses the given set of Spectral reflectance curves for Water, Soil and Vegetation within visible and near infrared wavelength.

Study and identification of major Geomorphologic features on stereo aerial photograph under Mirror stereoscope.

Study of given B&W imagery and noting down the details available on the Imagery along with scale and Latitude and Longitude.

Study of given False Color Composite (FCC) and interpreting various Geomorphologic terrain/features.

Digital Enhancement of Images in Geomatic S/W for betterment towards geological interpretation.

Handling of GIS softwares.

GLC 18126 / GLC 24126	GEOMORPHOLOGY	3 0 0
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Methods of geomorphologic investigations.
 Structural and lithological controls of landforms and drainage patterns.
 Physical, Chemical and Biological processes in weathering.
 Depositional and Erosional landforms: Fluvial, Aeolian, glacial and marine.
 Morphometric analysis of landforms.
 Impact of climate on geomorphology.
 Quaternary geology
 Neotectonics
 Geomorphology of India.
 Applications of geomorphology in environmental and engineering geology problems.

GLC 18226 / GLC 24226	GEOMORPHOLOGY PRACTICAL	0 0 2/3
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1. Topographic expression of different geomorphic features, structural and litho logical controls. Hypsometric analysis. Hill slope profile determination and analysis.
2. Morphometric analysis of different geomorphic systems.
3. Determination of stage of landform (youth, matured and old) from topographic map; Cumulative frequency curve, histogram.
4. Problems on drainage basin analysis.

GLC 18127 / GLC 24127	EXPLORATION GEOLOGY	3 0 0
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Geological Prospecting and Exploration: Definitions and Principles; Methods of Prospecting; Methods of Exploration. Radiometric survey.
 Sampling: theory and methods; Geological plans and sections for orebody evaluation; Exploration drilling, drill core logging and sampling
 Cut-off grade concepts and applications; Resources and Reserves.
 Estimation of reserves – methods and practice.
 Geochemical Exploration: Introduction, Geochemical cycle, geochemical mobility and association of elements. Pathfinder and target elements for geochemical exploration. Primary and secondary dispersions of elements; Determination of background, and geochemical anomalies;
 Geochemical methods of mineral exploration: Procedures for geochemical sampling; Interpretation of geochemical surveys.
 Indian case studies.
 Collection of data along Geological (G), Feasibility (F) and Economic (E) axes during various stages of exploration.

GLC 18227 / GLC 24227	EXPLORATION GEOLOGY PRACTICAL	0 0 2/3
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Exercises on channel sampling, Borehole correlation, Reserve calculation by Polygon method, Triangular method, Sectional method and Contouring method. Drill hole sample value compositing ore estimation.

GLC 18128 / GLC 24128	PETROLEUM GEOLOGY	3 0 0
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Petroleum: its different states of natural occurrence. Basic concepts of organic geochemistry. Origin of petroleum, Maturation of kerogen; Biogenic and Thermal effect. Distribution of Petroleum in space and time.
 Introduction to migration of oil and gas: geologic framework of migration; short and long distance migration, primary and secondary migration; geologic factors controlling hydrocarbon migration; forces responsible for migration, migration routes and barriers. Oil field water- characters and classifications
 Reservoir rocks: general attributes and petrophysical properties. Classification of reservoir rocks - Clastic and Carbonate reservoirs. A brief account on Reservoir Characterization.
 Hydrocarbon traps: definition; classification of hydrocarbon traps - structural, stratigraphic and combination; time of trap formation and time of hydrocarbon accumulation. Cap rocks - definition and general properties.
 Petroleum Geology of important Indian basins (offshore and onshore).
 Introduction to oil and gas exploration with reserve estimation.

GLC 18228 / GLC 24228	PETROLEUM GEOLOGY PRACTICAL	0 0 2/3
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Interpretation of geologic structures from surface geological maps and bore hole data; reconstruction of structural developments through different time planes. Preparation of structure contour and isopach maps of reservoir facies and drawing oil/water contact from bore hole data. Calculation of oil reserves in defined structure.

MER 22132	MINING TECHNOLOGY	3 0 0
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Introduction to mining, elements of mining, definitions and explanation of different mining terms.

Introduction to surface mining. Deposits amenable to surface mining. Concept of stripping and stripping ratios, determination of quarriable limits. Box cut – definition, objectives, types and their applicability. Production benches – objectives, formation and parameters. Classification of surface mining systems; Rippling, drilling and blasting. Shovel, dumper and dragline operation.

Introduction to underground coal mining: underground coal mining terms and their explanations, broad classification in underground coal mining methods, Bord and Pillar method – general description. Panel system of mining and its advantages and disadvantages, determination of size of panel. Development by SDL/LHD, Rib & Slice method of depillaring in one lift with caving in flat/moderately inclined seams.

Longwall method – general description and application, introduction to Longwall advancing and Longwall reterating method and their advantages and disadvantages, factors governing length of panel and length of Longwall face. Introduction to PSLW technology with shearer.

Introduction to underground metal mining; Deposits amenable to underground metal mining;, modes of entry to underground mineral deposits; Mine development: drifting, raising and winzing; Classification of underground metal mining methods: general description, applicability and operations involved.

NINTH SEMESTER

GLC 19131 / GLC 25131	HYDROGEOLOGY	3 0 0
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1. Geological structures favoring ground water occurrence. Classification of aquifers and aquifer systems.
2. Bernoulli's equation and its applications. Hydraulic head. Potentiometric surface and potential surface. Darcy's law. Hydraulic conductivity and transmissivity. Specific discharge, specific yield and storage coefficient.
3. Pump tests and evaluation of hydrologic properties through various methods for steady and unsteady flow. Flow net analysis.
4. Chemical characteristics of ground water in relation to various uses - domestic, industrial and irrigation. Saline water intrusions. Radioisotopes in hydrogeological studies. Ground water contamination.
5. Ground water basins. Ground water recharge. Infiltration. Data collection for basin investigations. Factors governing safe yield.
6. Ground water exploration. Geological, Meteorological and Geophysical methods. Hydrogeomorphic mapping, Types of wells, Well development and design.
7. Ground water problems and management related to mining, foundation work of cannels, tunnels. Problems of overexploitation. Ground water development in urban areas and rainwater harvesting. Artificial recharge methods. Ground water problems in arid regions and remediation.
8. Conjunctive use of ground water and surface water
9. Details of ground water provinces of India - their aquifer characteristics.

GLC 19231 / GLC 25231	HYDROGEOLOGY PRACTICAL	0 0 2/3
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Preparation of water - table maps and determination of ground water flow directions. 3-point problems. Determination of permeability by Falling Head and Constant Head method. Problems on pumping test.

GLC 19132 / GLC 25132	COAL GEOLOGY	3 0 0
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Coal and its properties: Different varieties and ranks of coal. Origin of coal. Type of depositional processes. Coalification process and its causes. Introduction to Organic Petrology and Organic Geochemistry. Sediments closely associated with coal (coal balls, tonsteins, seat-earths, under-clays, fire-clays and soils).

Lithotypes, microlithotypes and macerals: their physical, chemical and optical properties. Maceral analysis of coal: Mineral and organic matter in coal. Petrographical methods and tools of examination. Application of coal geology in hydrocarbon exploration.

Coal-bed methane: as energy resource. Maturation of methane in coals. Coal as a reservoir, Fundamentals of coal bed methane exploration and production

Methods of coal prospecting and estimation of coal reserves

Applications of coal petrography. Proximate and ultimate analyses. Industrial evaluation of coal characteristics with reference to coal classification.

Geology and coal petrography of different coalfields of India.

Uses of coal for various industries e.g. carbonization, liquefaction, power generation, gasification and coal-bed methane production.

Organic Petrology and organic geochemistry.

Introduction to Coal-based Nanomaterials.

Coal structures.

GLC 19232/ GLC 25232	COAL GEOLOGY PRACTICAL	0 0 2/3
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Megascopic identification of different varieties of coal. Identification of macerals and minerals under transmitted light and reflected light. Reflectance measurements and rank determination of coal. Location of coalfields on geographical maps with comments about quality of coal, seam formation curve. Estimation of coal reserve.

GLC 19133 / GLC 25133	COMPUTER APPLICATIONS IN GEOLOGY	3 - 0 - 0
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1. General Introduction to computers.
2. Database - definition, structure, and types; Geological database.
3. Computer Graphics and CAD.
4. Construction of geological maps and sections during AutoCAD and Coreldraw.
5. Elementary concepts on Knowledge Based Expert System, Decision Support System, Neural Network, Fuzzy Logic and Genetic Algorithm.
6. Use of Software Packages in Geology.

GLC 19233 / GLC 25233	COMPUTER APPLICATIONS IN GEOLOGY PRACTICAL	0 0 2/3
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1. Computer Programming
2. Database Preparation
3. Use of AutoCAD and Corel Draw for geological maps and sections.

GLC 19134 / GLC 25134	MINERAL ECONOMICS	3 0 0
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The study of mineral economics, review of economic concepts and theories. Minerals and economic development, mineral abundance - curse or blessing.

World resources of minerals; Classifications of mineral resources – IMM, JORC, SAMERC, ISP and UNFC schemes. Specifications for important minerals for industrial use. Mineral markets, Import-Export policies and International Trade. Royalty and Taxes. India's status in mineral production.

Demand analysis of minerals, changing patterns of mineral consumption and substitution. Exhaustible resource scarcity; scarcity and economic growth. Theory of mineral supply; optimal rate of mineral depletion; National mineral policies. Mines and Minerals (Development and Regulation) act. Mineral Concession Rules. Marine mineral resources and laws of sea.

Economics of mineral exploration; cost of exploration.

Role and content of mining plan.

Mineral price and pricing mechanism.

Feasibility study and valuation of mineral property.

Conservation of mineral resources – scope and limitations.

Raw materials grade control aspects in mines.

PER 51102	PETROLEUM RESERVOIR ENGINEERING AND FIELD DEVELOPMENT	3 1 0
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Characteristics of crude oil and natural gas, classification of crude and its physico-chemical properties.
 Petrophysical properties of reservoir rocks: porosity, permeability, fluid saturation. Fluid flow through porous media.
 Reservoir fluid properties. Reservoir fluid sampling and PVT studies.
 Material Balance, Reservoir energies & drives - Water influx; Gas, condensate and oil reservoirs.
 Thermodynamics of fluid system - Phase behavior of single and multiphase systems, Decline curve analysis.
 Well performance: productivity index, IPR. Water and gas coning, Open flow potential for gas wells.
 Applications of horizontal wells, ERD and multi-laterals.
 Oil & Gas field development: Principles, rationale and economics of development plan. Well spacing and patterns, Economics of field development

TENTH SEMESTER

GLC 10137 / GLC 26137	ENGINEERING GEOLOGY	3 0 0
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Engineering geology in theory and practice. Geological structures and discontinuities, engineering properties of rocks, engineering properties of jointed rocks, geomechanical classification of rock mass.
 Physico-mechanical properties of building stones and aggregate, alkali aggregate reaction.
 Geotechnical investigation for dam site, reservoir site; geotechnical study for road alignment; geotechnical evaluation of tunnel alignment, methods of tunneling, classification of ground for tunneling purposes, various types of support system; geotechnical investigations for bridge foundation and building foundation; Rock burst and bumps.
 Mass movements, slope stability problems, their predictions and optimum design of slope (natural slope, benches in mines, mine dumps); earthquakes and seismicity, seismic zones of India, soil liquefaction, earthquake resistance design of building, influence of geological condition of foundation and design of buildings.
 Shoreline engineering geology.

GLC 10237 / GLC 26237	ENGINEERING GEOLOGY PRACTICAL	0 0 2/3
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Exercises on Engineering Geology maps and sections of dam sites, Reservoir sites, Tunnels, Hill slopes, Open pit slopes. Determination of physical properties of rocks and soils.

GLC 10138 / GLC 26138	ENVIRONMENTAL GEOLOGY	3 0 0
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Introduction to Environmental Geology
 Changes in the environment caused by geological activities of man
 Inorganic and organic contaminants. Drinking water standards. Surface and ground water pollution.
 Geochemistry of toxic elements in natural waters.
 Environmental problems connected with exploitation of minerals and energy resources. Acid mine drainage.
 Land use and land degradation due to mining.
 Study of surface geological processes, earthquakes and volcanism with reference to their impact on environment. Soils, erosion and conservation. Introduction to Medical Geology.
 Geological solutions to environmental problems. Role of geology in waste disposal, Global warming, Climate change and Mitigation.
 Environmental planning, management and economics (EMP and EIA).

GLE 10140 / GLE 26140	SEQUENCE STRATIGRAPHY AND BASIN ANALYSIS	3 0 0
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Sequence Stratigraphy
 Historical developments, definitions and key concepts, base level changes, transgressions and regressions.
 Stratigraphic surfaces: Stratalterminations, sequence stratigraphic surfaces. Unconformity and correlative conformity.
 Systems Tracts: Lowstand, Transgressive, Highstand, Falling stage. Shelf-margin system tract (SMST)
 Unconformities: Type I, Type II and Type III.
 Sequence Models: Depositional sequence, Genetic stratigraphic sequence, Transgressive-Regressive sequence.
 Hierarchy of sequences and bounding surfaces.

Basin Analysis

Definition and scope of basin analysis. Basin mapping methods: structure and isopach contouring, lithofacies maps, palaeocurrent analysis, Geohistory analysis. Thermal history.

Regional and global stratigraphic cycles. Tectonic classification of sedimentary basins.

Characteristics of divergent margin basins, convergent margin basins, transform and transcurrent fault basins, basins developed during continental collision and suturing and cratonic basins. Review of Indian basins.

GLE 10141 / GLE 26141	COAL BED METHANE AND GAS HYDRATE EXPLORATION	3 0 0
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Coal bed methane

Coal bed methane generation and accumulation

Geological and petrographic influences on coal, Pore geometry, Micropore, Mesopore and macropore, cleat system

Sorption – principles, sorption isotherms – types and interpretation. CO₂, CH₄ and N₂ adsorption – desorption, hysteresis, langmuir isotherm, Swelling of coal matrix isotherm construction.

CH₄ content determination in coal seams.

Coal bed methane reservoir analysis, comparison between conventional gas reservoir and coal bed methane reservoir, Permeability klinkenberg, shrinkage, stress and depth effects on permeability, water composition as permeability indicator, gas flow diffusion in micropores, Darcy flow in cleats, sorption time, CBM reservoir characterization methods, enhanced recovery.

Water production and disposal, injection wells, carbon dioxide sequestration.

Potential coal bed basins and production, hydraulic fracturing of coal seams, CBM exploration.

In-situ gasification.

Introduction to shale gas.

Gas Hydrate

Gas hydrate, occurrence and origin; structure of gas hydrate, Types of gas hydrate;

Geological setting of Hydrate; Stability of gas hydrates; Gas hydrate reservoir;

Volume of gas in hydrate; inhibitors.

Geological exploration of gas hydrate

Prospect and potentialities of gas hydrate in India.

GLE 10142 / GLE 26142	CONTAMINANT HYDROGEOLOGY	3 0 0
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Introduction to contaminant hydrology

Low temperature aqueous geochemistry

Sources of contamination; chemical evolution of soil water and ground water

Solute transport in ground water; transformation, retardation and attenuation

Non-aqueous phase transport in ground water,

Monitoring contaminant migration

Site remediation technology and case studies

GLE 10143 / GLE 26143	NUCLEAR GEOLOGY	3 0 0
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Radioactivity and radioactive decay, Growth and decay mechanisms (α β γ decay) Decay units and dosage.

Neutron activation.

Mass spectrometry. Geochronology: Dating methods: K-Ar and Ar-Ar methods, Rb-Sr, Sm-Nd and Lu-Hf methods, Re-Os method. Fission track, ¹⁴C, U-Pb and Pb-Pb methods.

Application of Rb-Sr, Sm-Nd and Lu-Hf isotopes in petrogenetic studies.

Stable isotopes: Fractionation mechanisms, Oxygen and hydrogen in hydrosphere and atmosphere.

Oxygen/hydrogen isotopes in igneous, metamorphic & sedimentary rocks; their application for ore genesis and climate studies.

Carbon and its stable isotopes in biosphere, fossil fuels, igneous and metamorphic rocks. Application in ore genesis.

Sulphur isotopes: fractionation mechanisms (biogenic versus equilibrium process), application in fossil fuels, evolution of marine sulphur & ore genesis.

Application of isotopes in mineral exploration.

Mineralogy of U and Th bearing economic minerals, geochemistry of U-Th and their distribution in ore bodies through geologic time. U and Th metallogenic Provinces of India.

Detectors of radioactivity: Geiger, proportional and scintillation counters and spectrometers.

GLE 10144 / GLE 26144	KINEMATICS OF ROCK DEFORMATION	3 0 0
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Stress: Definition, units and dimension; classes of stress; stress ellipsoid and principal axes of stress; stress at a point; stress on a plane; Mohr circle construction; stress trajectory.

Strain: Definition, strain parameters, strain ellipsoid and principal axes of strain, different types of strain, displacement and transformations (Lagrangian and Eulerian specifications), theory of deformation in two and three dimensions.

Strain Analysis: Graphical representations of strain (Flinn, Ramsay, Nadai-Hossack and Mohr circle diagrams), progressive deformation, significance of geological structures in relation to strain, measurement of deformation in nature (circular and ellipsoidal markers, bilaterally symmetrical objects and linear markers).

Experimental deformation and Rheology: Effects of confining pressure, pore fluid pressure, anisotropy, temperature and scale on rock deformation. Behaviour of rocks under experimental conditions.

Development of Structures: Mechanisms of folding, and strain variations around folds. Mechanism of rock fracturing. Development of secondary cleavage and lineations.

GLE 10145 / GLE 26145	GEOTECHNICAL ENGINEERING	3 0 0
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Introduction to geotechnical engineering, definition and phase relations, soil texture, type shape, Atterberg limits, soil classification, unified soil classification system, clay minerals and their structure; strength properties of soils, soil-foundation interaction and differential settlement, bearing capacity and California bearing ratio (CBR);

Water-rock interaction, weathering indices, swelling indices, durability indices.,

Geotechnical investigations for new alignments, Underground Space Technology (UST) and ground control problems, subsidence, convergence and creep phenomenon, slope stability problems and control measures.

Anchoring of strata and geotechniques.

In-situ stress, methods and geotechnical investigation.

Geotechniques of cold region and ground control.

Geological hazards and geotechnical mitigation

Geotechnical aspects of mineral exploration and exploitation.

Geotechnical and geomechanical aspects of Coal Bed Methane (CBM) exploration and exploitation.

FMC 10151 / FMC 26151	MINERAL BENEFICIATION	3 0 0
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Introduction to mineral beneficiation. Major unit operations involved, material balancing.

Liberation- importance and determination of liberation size, Crushing- fundamentals, construction and operational features of primary and secondary crushers. Jaw, Gyratory, cone and roll crushers. Grinding- theory and practice, Ball & Rod Mills- construction and operation.

Laboratory sizing and industrial screening including screen efficiency.

Movement of solids in liquids. Free, hindered and equal Settling. Rake and Spiral classifiers including hydrocyclone.

Gravity concentration- Theory and practice of Jigging. Heavy media separation and flowing film concentration.

Froth Flotation- Theory, Reagents, Machines and Practice. Magnetic and Electrical separations.

Flow sheets for beneficiation of ferrous and non-ferrous ores, coal and selected industrial minerals. By-product recovery.

FMC 10251 / FMC 26251	MINERAL BENEFICIATION PRACTICAL	0 0 2/3
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Sampling, Jaw crusher: efficiency, reduction ratio, size distribution of product; Roll Crusher: efficiency, reduction ratio and size distribution of product; Grinding: Effect of time and load on grinding; Dry and wet sieving: procedure and size distribution of product; Float and sink test; Dry magnetic separation; Wet magnetic separation Flowing film concentration; Jigging Coal Flotation; Mineral flotation.

MSC 10151 / MSC 26151	INDUSTRIAL MANAGEMENT	3 0 0
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Evolution of management theory and practice: Principles of scientific management; Functions of Management.

Concepts of organizational behaviour – Leadership and Motivation.

Concepts of Human Resource Management – Selection, Training and Development.

Finance Management – Capital Budgeting Techniques; Pay-back period, Accounting Rate Return, Net Present Value, Internal Rate of Return, Profitability Index; Sources of capital, Cost concepts and break-even analysis.

Project Management – Introduction, Network construction and identification of critical activities in Critical Path Method and Project Evaluation Review Technique.
Introduction to Marketing Management, Concept of product life cycle.
Introduction to Optimization Techniques, Linear programming - formulation and its graphical solution.