

DEPARTMENT OF APPLIED GEOLOGY
ISM UNIVERSITY, DHANBAD



SYLLABUS

FOR

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

IN

APPLIED GEOLOGY

Effective from 2008-2009

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

(Course to be effective from 2008-2009)

I Semester

Course No.	Courses	L T P	Credit
Theory			
AMC 11101	Mathematics-I	3 – 1 – 0	07
ACC 11101	Chemistry *	3 – 1 – 0	07
EIC 11101	Electronics Engineering *	3 – 1 – 0	07
HSC 11101	English for Science & Technology *	3 – 1 – 0	07
MMC 11102	Manufacturing Processes *	1 – 3 – 0	05
CSC 11301	Computer Programming (S) *	3 – 0 – 0	06
FMD/ESD 11301	Global Energy Scenario & Energy Security (S) *	3 – 0 – 0	06
Practical			
ACC 11201	Chemistry Practical *	0 – 0 – 3/2	01.5
EIC 11201	Electronics Engineering Practical *	0 – 0 – 3/2	01.5
DSW	Counseling / Special Class	0 – 0 – 0	00
		Total	48

* Depending on the Section allotted to the students, these subjects may be interchanged with the subjects marked as # in the II Semester.

II Semester

Course No.	Courses	L T P	Credit
Theory			
AMC 12101	Mathematics-II	3 – 1 – 0	07
APC 12101	Physics #	3 – 1 – 0	07
EEC 12101	Electrical Technology #	3 – 1 – 0	07
MMC 12103	Engineering Mechanics #	3 – 1 – 0	07
MMC 12103	Engineering Graphics #	1 – 3 – 0	05
HSC 12301	Value Education, Human Rights and Legislative Procedure (S) #	3 – 0 – 0	06
GLD/ESD 12301	Earth System Science (S) #	3 – 0 – 0	06
Practical			
APC 12202	Physics Practical #	0 – 0 – 3/2	01.5
MMC 12202	Electrical Technology Practical #	0 – 0 – 3/2	01.5
SWC 12701	Counseling / Special Class / Co-Curricular Activities	0 – 0 – 0	(03)
		Total	51

Depending on the Section allotted to the students, these subjects may be interchanged with the subjects marked as * in the I Semester.

III Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 13101	Geology – I (Mineralogy, Petrology & Stratigraphy)	3 – 0 – 0	06
AMC 131xx	Methods of Applied Mathematics - I	4 – 1 – 0	09
APC 131xx	Mechanics	4 – 0 – 0	08
EIC 131xx	Communication Engineering	3 – 0 – 0	06
ACC 131xx	Inorganic Chemistry	3 – 1 – 0	07
Practical			
GLC 13201	Mineralogy and Petrology Practical	0 – 0 – 3	03
GLC 13202	Crystallography Practical	0 – 0 – 3	03
ACC 132xx	Inorganic Chemistry Practical	0 – 0 – 3	03
	Total	17 – 2 – 9	45

IV Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 14103	Geology – II (Physical and Structural Geology)	3 – 0 – 0	06
GLC 14104	Geology – III (Economic Geology)	3 – 0 – 0	06
GLC 14105	Geology – IV (Paleontology)	3 – 0 – 0	06
EEC 141xx	Applied Electrical Engineering	3 – 1 – 0	07
EIC 141xx	Microprocessors and their Applications	3 – 0 – 0	06
Practical/Project/Seminar/Dissertation/Viva-voce			
GLC 14203	Structural Geology Practical	0 – 0 – 3	03
GLC 14204	Economic Geology Practical	0 – 0 – 3	03
GLC 14205	Paleontology Practical	0 – 0 – 3	03
GLC 14906	Local Geological Field Excursion (S)*	0 – 0 – 0	04
SWC 14701	Co-Curricular Activity	0 – 0 – 0	03
	Total	15 - 1 - 9	47

* 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	Methods of Structural Geology	3 0 0	06
GLC 15113	Igneous Petrology	3 0 0	06
GLC 15114	Sedimentology	3 0 0	06
GLC 15115	Stratigraphy	4 0 0	08
Practical			
GLC 15211	Mineralogy Practical	0 0 3	03
GLC 15212	Methods of Structural Geology Practical	0 0 3	03
GLC 15213	Igneous Petrology Practical	0 0 3	03
GLC 15214	Sedimentology Practical	0 0 3	03
	Total	16 0 12	44

VI Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 16116	Geochemistry and Isotope Geology	3 – 0 – 0	06
GLC 16117	Metamorphic Petrology	3 – 0 – 0	06
GLC 16118	Geotectonics	3 – 0 – 0	06
MEC 161xx	Surveying	3 – 0 – 0	06
AMC 161xx	Numerical and Statistical Methods	4 – 0 – 0	08
Practical/Project/Seminar/Dissertation/Viva-voce			
GLC 16216	Geochemistry and Isotope Geology Practical	0 – 0 – 3	03
GLC 16217	Metamorphic Petrology Practical	0 – 0 – 3	03
MEC 162xx	Surveying Practical	0 – 0 – 2/2	01
AMC 162xx	Numerical and Statistical Methods Practical	0 – 0 – 3	03
GLC 16919	Sedimentary Terrain Mapping Training (S) *	0 – 0 – 0	03
GLC 16920	Economic Geology Field Training (S) *	0 – 0 – 0	03
GLC 16521	Viva-voce	0 – 0 – 0	02
SWC 16701	Extra Curricular Activities	0 – 0 – 0	03
	Total	16 – 0 – 10	53

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

Summer training during vacation after VI Semester with credit in VIIth Semester.

VII Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 17122	Kinematics of Rock Deformation	3 0 0	06
GLC 17123	Geostatistics	3 0 0	06
GLC 17124	Micropaleontology and Vertebrate Paleontology	3 0 0	06
MEC 171xx	Rock Mechanics	3 0 0	06
GPC 171xx	Geophysical Prospecting	3 0 0	06
Practical			
GLC 17222	Kinematics of Rock Deformation Practical	0 0 3	03
GLC 17223	Geostatistics Practical	0 0 3	03
GLC 17224	Micropaleontology and Vertebrate Paleontology Practical	0 0 3	
MEC 172xx	Rock Mechanics Practical	0 0 3	03
GPC 172xx	Geophysical Prospecting Practical	0 0 3	03
GLC 18825	Summer Training *	0 0 0	03
Total		15 0 15	48

* Summer training during vacation after VI Semester with credit in VIIth Semester.

VIII Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 18126	Remote Sensing and GIS	4 0 0	08
GLC 18127	Geomorphology	3 0 0	06
GLC 18128	Computer Applications in Geology	3 0 0	06
GLC 18129	Petroleum Geology	3 0 0	06
MEC 18105	Mining Methods and Unit Operations	3 0 0	06
Practical/Project/Seminar/Dissertation/Viva-voce			
GLC 18226	Remote Sensing and GIS Practical	0 0 3	03
GLC 18227	Geomorphology Practical	0 0 3	03
GLC 18228	Computer Applications in Geology Practical	0 0 3	03
GLC 18229	Petroleum Geology Practical	0 0 3	03
GLC 18930	Geological Mapping Training *	0 0 0	03
GLC 18531	Viva-Voce	0 0 0	02
SWC 18701	Co-curricular Activity	0 0 0	03
Total		16 0 12	52

*Geological Mapping Training camp of two weeks in deformed metamorphic/igneous terrain with credit in VIIIth Semester.

Summer training during vacation after VIII Semester with credit in IXth Semester.

IX Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 19132	Hydrogeology	3 0 0	06
GLC 19133	Exploration Geology and Mineral Economics	4 0 0	08
GLC 19134	Coal Geology	3 0 0	06
GLC 19135	Ore Geology	3 0 0	06
PEC 191xx	Petroleum Reservoir Engineering and Field Development	3 0 0	06
Practical/Project/Seminar/Dissertation/Viva-voce			
GLC 19232	Hydrogeology Practical	0 0 3	03
GLC 19233	Exploration Geology Practical	0 0 3	03
GLC 19234	Coal Geology Practical	0 0 3	03
GLC 19235	Ore Geology Practical	0 0 3	03
GLC 19536	Seminar	0 0 2	02
GLC 19837	Summer Training *	0 0 0	03
Total		16 0 14	51

* Summer training during vacation after VIII Semester with credit in IXth Semester.

X Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 10138	Engineering Geology	3 0 0	06
GLC 10139	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	Geotechnical Engineering		
FMC 10151	Mineral Beneficiation	3 0 0	06
MSC 10151	Industrial Management	3 0 0	06
Practical/Project/Seminar/Dissertation/Viva-voce			
GLC 10238	Engineering Geology Practical	0 0 3	03
FMC 10251	Mineral Beneficiation Practical	0 0 3	03
GLC 10845	Dissertation (Field work, Lab work and Seminar)*	0 0 6	06
GLC 10546	Composite Viva-voce	0 0 0	02
SWC 10701	Co-curricular Activity	0 0 0	03
Total		15 0 12	47

* Dissertation fieldwork during winter vacation with credit in Xth Semester.

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

(Course to be effective from 2008-2009)

I Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 21111	Mineralogy	3 0 0	06
GLC 21112	Methods of Structural Geology	3 0 0	06
GLC 21113	Igneous Petrology	3 0 0	06
GLC 21114	Sedimentology	3 0 0	06
GLC 21115	Stratigraphy	4 0 0	08
Practical			
GLC 21211	Mineralogy Practical	0 0 3	03
GLC 21212	Methods of Structural Geology Practical	0 0 3	03
GLC 21213	Igneous Petrology Practical	0 0 3	03
GLC 21214	Sedimentology Practical	0 0 3	03
	Total	16 0 12	44

II Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 22116	Geochemistry and Isotope Geology	3 – 0 – 0	06
GLC 22117	Metamorphic Petrology	3 – 0 – 0	06
GLC 22118	Geotectonics	3 – 0 – 0	06
MEC 221xx	Surveying	3 – 0 – 0	06
AMC 221xx	Numerical and Statistical Methods	4 – 0 – 0	08
Practical/Project/Seminar/Dissertation/Viva-voce			
GLC 22216	Geochemistry and Isotope Geology Practical	0 – 0 – 3	03
GLC 22217	Metamorphic Petrology Practical	0 – 0 – 3	03
MEC 222xx	Surveying Practical	0 – 0 – 2/2	01
AMC 222xx	Numerical and Statistical Methods Practical	0 – 0 – 3	03
GLC 22919	Sedimentary Terrain Mapping Training (S) *	0 – 0 – 0	03
GLC 22920	Economic Geology Field Training (S) *	0 – 0 – 0	03
GLC 22521	Viva-voce	0 – 0 – 0	02
SWC 22701	Extra Curricular Activities	0 – 0 – 0	03
	Total	16 – 0 – 10	53

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

Summer training during vacation after IInd Semester with credit in IIIrd Semester.

III Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 23122	Kinematics of Rock Deformation	3 0 0	06
GLC 23123	Geostatistics	3 0 0	06
GLC 23124	Micropaleontology and Vertebrate Paleontology	3 0 0	06
MEC 231xx	Rock Mechanics	3 0 0	06
GPC 231xx	Geophysical Prospecting	3 0 0	06
Practical			
GLC 23222	Kinematics of Rock Deformation Practical	0 0 3	03
GLC 23223	Geostatistics Practical	0 0 3	03
GLC 23224	Micropaleontology and Vertebrate Paleontology Practical	0 0 3	
MEC 232xx	Rock Mechanics Practical	0 0 3	03
GPC 232xx	Geophysical Prospecting Practical	0 0 3	03
GLC 23825	Summer Training *	0 0 0	03
Total		15 0 15	48

* Summer training during vacation after IInd Semester with credit in IIIrd Semester.

IV Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 24126	Remote Sensing and GIS	4 0 0	08
GLC 24127	Geomorphology	3 0 0	06
GLC 24128	Computer Applications in Geology	3 0 0	06
GLC 24129	Petroleum Geology	3 0 0	06
MEC 24105	Mining Methods and Unit Operations	3 0 0	06
Practical/Project/Seminar/Dissertation/Viva-voce			
GLC 24226	Remote Sensing and GIS Practical	0 0 3	03
GLC 24227	Geomorphology Practical	0 0 3	03
GLC 24228	Computer Applications in Geology Practical	0 0 3	03
GLC 24229	Petroleum Geology Practical	0 0 3	03
GLC 24930	Geological Mapping Training *	0 0 0	03
GLC 24531	Viva-Voce	0 0 0	02
SWC 24701	Co-curricular Activity	0 0 0	03
Total		16 0 12	52

*Geological Mapping Training camp of two weeks in deformed metamorphic/igneous terrain during winter vacation.

Summer training during vacation after IVth Semester with credit in Vth Semester.

V Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 25132	Hydrogeology	3 0 0	06
GLC 25133	Exploration Geology and Mineral Economics	4 0 0	08
GLC 25134	Coal Geology	3 0 0	06
GLC 25135	Ore Geology	3 0 0	06
PEC 251xx	Petroleum Reservoir Engineering and Field Development	3 0 0	06
Practical/Project/Seminar/Dissertation/Viva-voce			
GLC 25232	Hydrogeology Practical	0 0 3	03
GLC 25233	Exploration Geology Practical	0 0 3	03
GLC 25234	Coal Geology Practical	0 0 3	03
GLC 25235	Ore Geology Practical	0 0 3	03
GLC 25536	Seminar	0 0 2	02
GLC 25837	Summer Training *	0 0 0	03
Total		16 0 14	51

* Summer training during vacation after IVth Semester with credit in Vth Semester.

VI Semester

Course No.	Courses	L T P	Credit
Theory			
GLC 26138	Engineering Geology	3 0 0	06
GLC 26139	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	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 26238	Engineering Geology Practical	0 0 3	03
FMC 26251	Mineral Beneficiation Practical	0 0 3	03
GLC 26845	Dissertation (Field work, Lab work and Seminar)*	0 0 6	06
GLC 26546	Composite Viva-voce	0 0 0	02
SWC 26701	Co-curricular Activity	0 0 0	03
Total		15 0 12	47

* Dissertation fieldwork during winter vacation with credit in Vth Semester.

FIRST SEMESTER

AMC 11101	MATHEMATICS-I	3 1 0
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1. Calculus-I: Successive differentiation of one variable and Leibnitz theorem, Taylor's and Maclaurin's expansion of functions of single variable.
2. 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.
3. 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.
4. Evaluation of double integrals, Change of order of integration, 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.
5. Trigonometry of complex Number, 3D Geometry and Algebra: Function of complex arguments, Hyperbolic functions and summation of trigonometrical series.
6. 3-D Geometry: Cones, cylinders and conicoids; Central conicoids, normals and conjugate diameters.
7. Algebra: Convergence 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.

Reference Books:

Differential Calculus by B.C. and B.N. Mukherjee
Integral Calculus by B.C. Das and B.N. Mukherjee
Integral Calculus by R.K. Ghosh and K.C. Maity
Analytical Solid Geometry by Shanti Narayan
Text book of Engineering Mathematics by Debashish Dutta .

ACC 11101	CHEMISTRY	3 1 0
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1. Cement: Manufacturing, composition, setting and hardening of cement.
2. Glass: Types of Glasses, Manufacturing & properties of Glasses.
3. Polymers: Classification, structure - property relationship, conductive polymers.
4. Solid Fuels: Structure of coal, classification of coal, Effect of heat on coal, carbonization and pyrolysis. Recovery and purification of by-products obtained from coke ovens; Distillation of coal tar; coal chemicals.
5. Liquid Fuels: 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.
6. Gaseous Fuels: Characteristics of good fuel; calorific value, theoretical calculations of calorific value of a fuel, natural gas and hydrogen gas.
7. Phase rule and phase equilibrium diagram: Phase rule; degree of freedom, one and two component systems, temperature and composition diagrams, liquid-liquid and liquid-solid phase diagrams.
8. Lubricants: General characteristics of lubricants, chemistry of lube oil and greases. Reclamation of lubricants.
9. Equilibrium: Electrochemistry: Electric potentials at interfaces, electrodes, batteries, electrochemical cells and their applications.
10. Corrosion: Chemical and electrochemical corrosion, classification, factors affecting corrosion, Form of corrosion and general methods of corrosion prevention.

Reference books:

A Textbook of Engineering Chemistry-Sashi Chawla
Applied Chemistry: A Textbook for Engineers and Technologists - H.D.Gesser.
Engineering Chemistry - P.C. Jain & Monika Jain
Engineering Materials - K.G. Budinski & M K Budinski
Engineering Chemistry - B K Sharma

ACC 11201	CHEMISTRY PRACTICAL	0 0 3/2
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- Standards of HCl by Standard Sodium Carbonate solution
- Determination of Temporary Hardness of tap water.
- Estimation of Total Hardness of water.
- Determination of Iron in Ferrous Ammonium Sulphate solution (Redox titration).
- Determination of Copper in crystallized Copper Sulphate.
- Estimation of available Chlorine in Bleaching Powder.
- Determination of Molecular Weight of Organic Acid by Titration method.
- Estimation of Sodium Carbonate and bicarbonate in a mixture.
- To determine the saponification number of an oil.
- To determine the rate of hydrolysis of methyl/ethyl acetate. 1
- To prepare Chrome Alum.

EIC 11101	ELECTRONICS ENGINEERING	3 1 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, de 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, OPAMI Basics, Practical OPMAP Circuits.
- Introduction to Field Effect Transistors and their applications.
- Digital Electronics - Review of Basic Gates and Boolean Algebra, Introduction to Combinational Logic Design. Standard Representations of Logical Functions and their simplification Combinational Logic Design, Half Adder and Full Adders.
- Sequential Circuits - Flip flops S-R, J-K and D Application in Ripple Counters.

Reference Books:

Electronic Device and Circuit Theory - Boylestad & Nashlesky
 Digital Principles & Applications - Malvino & Leach

EIC 11201	ELECTRONICS ENGINEERING PRACTICAL	0 0 3/2
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- Study of Electronic Equipment & Components.
- Study of diode characteristics.
- Study of regulated power supply.
- Study of BJT characteristics.
- Study of op-amp characteristics.
- Implementation of Boolean algebra using logic gates.
- Adder Circuits.
- Flip Flops.

HSC 11101	ENGLISH FOR SCIENCE AND TECHNOLOGY	3 1 0
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- Language Resource Development: Using appropriate grammatical lexical forms to express meaning-accuracy, range and appropriacy to context; remedial exercises.
- Reading interpreting and using (a) written, and (b) graphic information: (a) Using (reading and writing) academic texts, articles in technical journals, instruction manuals/laboratory instruction sheets, safety manuals and regulations, and reports; and (b) 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, reporting; note making (from books/journals); writing assignments; summarizing, expanding, paraphrasing; answering exam questions; and 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 other (in class room, workshop, laboratory, seminar, conference, discussion, interview etc).

Reference Books:

Using English in Science and Technology - R K Singh
 Practicing English in Science and Technology - R K Singh
 Communication in English: Grammar and Composition - R K Singh
 Communication in English for Technical Studies - William, Ray; Ray Rabindranath; and Swales, John-Orient Longman

MMC 11102	MANUFACTURING PROCESSES	1 3 0
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- Carpentry:** Classification of timber, seasoning and preservation of wood, description and applications of the various tools used in carpentry, different joints and their practical uses.
- Forging:** Introduction to Forging, types of tools and their uses, colour representations of different temperature levels, recrystallisation, workability of metals at elevated temperature, safety rules.
- Casting:** Introduction to foundry, Pattern making, types of casting processes, purpose of runner & riser, applications of casting, defects in casting.
- Fitting:** Introduction to fitting jobs, fitting tools and their uses, safety rules.
- Welding:** Welding types, accessories, weldments, safety rules.
- Machine Tools:** Types of tools, types of Machine Tools and their specifications, safety rules.
- Measurement:** Use of vernier etc for product measurement.

Reference Books:

Workshop Technology Part I, II & III - W A J Chapman
 Workshop Technology Part I & II - Hazra Chowdhury
 Workshop Technology Part I & II - Raghubanshi

CSC 11301	COMPUTER PROGRAMMING (S)	3 0 0
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Introduction to Programming, Data Types, Variables, Operators and Expressions, Assignments, Input/Output, Control statements and iterations, Arrays and subscripted variables, String manipulation, Functions, Recursions, Structures and unions, Pointers, Dynamic memory allocation, Linked structure, File handling, Language preprocessor and Command line arguments.

Introduction to Object Oriented Programming in C++.

Reference Books :

- "The C Programming Language" - Brain W. Keringhan and Dennis M. Ritchi
- "Programming in ANSI C" - E. Balaguruswamy
- "Schaum's Outline of Programming with C" - Byron Gottfried
- "Fundamentals of Data Structures in C" - Ellis Horowitz, Satraj Sahni and Susan Anderson-Freed
- "Object Oriented Programming in C++" - E. Balaguruswamy
- "Object Oriented Programming in C++"- Robert Lafore

FMD/CMD 11301	GLOBAL ENERGY SCENARIO AND ENERGY SECURITY OF INDIA (S)	3 0 0
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- Definition of Energy; Primary and Secondary Energy; Difference between Energy, Power and Electricity;
- Renewable and Non-Renewable Sources of Energy; The concept and Significance of Renewability;
- Social, Economic, Political and Environmental Dimension of Energy; Major Types and Sources of Energy at the Global and at the National Level;
- Global and Indian Reserves and Resources of Natural Oil and Gas, Coal and Nuclear Minerals;
- Potential of Hydroelectric Power, Solar Energy, Wind, Wave and Biomass Based Power and Energy: Globally and in India;

6. Energy Sources and Power Generation: Thermal, Nuclear, Hydroelectric, Solar, Wind and Wave; General Principles; Relative Merits and Demerits including, Conversion Efficiency, Generation Cost and Environmental Impact: Concepts of Open and Combined Cycles, Cogeneration: Clean Coal Initiatives;
7. Power Transmission and Distribution: General Principles; Demand Side Management;
8. Social, Political, Economic and Legal Issues Involved in the Generation Transmission Distribution of Power in India;
9. Current Scenario and Future Prospects of Carbon Sequestration, Coal Gasification and CBM; Current Scenario and Future Prospects of Solar Power, Hydrogen Power and Fuel Cells; Energy cum Power Scenario of India vis-à-vis China, South Africa and the USA;
10. Global Energy Politics.

Reference Books:

Non-Conventional Energy Sources, G.D. Rai
A Textbook of Power Plant Engineering, R.K. Rajpur
World Coal Institute Website.
Uranium Information Center Website.
World Energy Council Website.
National Energy Policy, GOL

SECOND SEMESTER

AMC 12102	MATHEMATICS-II	3 1 0
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1. **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.
2. **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.
3. **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 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.
4. **Differential Equations:** Differential equations of first order and higher degree, Linear independence and dependence of functions. Higher order differential equations with constant coefficient, Rules for finding C.F. and P.I., Method of variation of parameter, and method of undetermined coefficients, Cauchy and Legendre's linear equations.
Linear differential equations of second order with variable coefficients; change of dependent variable, change of independent variable, linear equations of special types; dependent variable absent, independent variable absent. Simultaneous linear equations with constant coefficients. Various applications of higher order differential equations in solution of engineering problems.
5. **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.

Reference Books:

- Vector Analysis by Lalji Prasad
- Theory and Problems of Advanced Calculus by M.R. Spiegel (Schaum Series)
- Theory and Problems of Laplace form by M.R. Spiegel (Schaum Series)
- Higher Engineering Mathematics by B.V. Raman.
- Advanced Engineering Mathematics by R.K. Jain & S.R.K. Iyengar.

APC 12101	PHYSICS	3 1 0
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Thermal Physics:

1. 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.
2. 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:

1. Brief idea of molecular spectra; Rigid rotator, spectra of simple molecules, rotation and rotation-vibration spectra.
2. Brief idea of wave packet and wave function, Shrodinger equation, Particle in a Box.
3. Free electron theory; qualitative idea of band theory of solids and Hall effect Laser and laser systems (He-Ne and Ruby Lasers).
4. Electromagnetics and Electrical Phenomena in Rocks:
5. 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.
6. Rocks and minerals as dielectrics, electrical conductivity and electrical phenomena in rocks, Piezo-, ferro-, tribo-, and pyro-electricity.

Reference Books:

1. "A Treatise on Heat"- Saha and Srivastava
2. "Engineering Physics" - B.L. Theraja
3. "Physics of Rock and Minerals"- Rzhetsky & Novic

4. Lasers - Ghatak & Thyagrajan
5. "Solid State Physics" -C Kittel
6. "Elements of Electromagnetic theory" - M N O Sadiku

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 Brewster's angle & find refractive index.

EEC 12101	ELECTRICAL TECHNOLOGY	3 1 0
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1. Network theorems (KCL, KVL, Thevenin, Norton, Maximum power transfer) applied to steady state DC circuit. Single-phase AC circuits and phasor diagrams, series and parallel resonance. Three-phase AC circuits with balanced and unbalanced loads, phasor presentation, measurement of three-phase power by two-wattmeter method.
2. Single-phase transformer: Construction, types, EMF equation, equivalent circuit, phasor diagram, regulation, efficiency, OC and SC tests.
3. DC Machines: Construction, types, principle of operation, EMF and torque equation.
4. DC generator: OCC and external characteristic curves and efficiency.
5. DC motors: speed-torque characteristics, starting, 3-point starter, speed control and efficiency.
6. Three-phase induction motor: Construction, types, principle of operation, torque-slip characteristics, starting methods.
7. Introduction to three-phase synchronous motor.

Reference books:

1. Electrical Engineering Fundamentals - V Del Toro
2. Basic Electrical Engineering (Special Indian Edition) - J J Cathey, S A Nasar, P Kumar.
3. Hughes Electrical and Electronic Technology - E Hughes, I M Smith, J Hiley, K Brown.
4. Basic Electrical Engineering - D P Kothari and I J Nagrath.
5. Electric Machinery - A E Fitzgerald, C Kingsley, S D Umans.

EEC 12101	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 s-ingle phase transformer, Open -circuit characteristics of DC separately excited generator, External Characteristics of DC shunt generator, Three-point starter of DC shunt motor, Speed control of DC motor.

MMC 12103	ENGINEERING MECHANICS	3 1 0
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1. Fundamentals of Mechanics: Equivalent force system, Equation of equilibrium,
2. Introduction to Structural mechanics: Force analysis of Frames, Trusses, Shear force, bending moment analysis of Beams.
3. Friction force analysis: Laws, Sliding and rolling friction, Screw Jack, Wedge, Belt friction, Collar friction.
4. Properties of surfaces: First moment of area and the centroid, Second moment and product of areas, Transfer theorem, Polar moment of inertia.
5. Introduction of variational mechanics,
6. Kinematics of particles: Velocity and acceleration calculations, Relative motion.
7. Particle dynamics: Rectilinear translation, Rectangular and cylindrical coordinates. Energy methods: Conservation of mechanical energy, work-energy equations.
8. Linear momentum and moment of momentum: Impulse and momentum relations for a particle, Moment of momentum equations for a single particle and for a system of particles.
9. Introduction to kinematics and kinetics of rigid bodies.
10. Mechanical vibration of single degree of freedom system.

Reference Books:

- Vector Mechanics for Engineers - Statics & Dynamics: Beer, Johnston.
- Engineering Mechanics - Statics & Dynamics: Nelson, Best, McLean.
- Engineering Mechanics - Statics & Dynamics: Shames, Rao, Pearson.

Engineering Mechanics - K.L. Kumar.
 Engineering Mechanics - Statics & Dynamics: A.K. Tayal.

MMC 12102	ENGINEERING GRAPHICS	1 3 0
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1. Drawing instruments and their uses; Indian standards for drawing.
2. Lettering; Types of lines used in engineering graphics: full lines hidden lines, dimension lines centerlines, section lines construction lines etc.
3. Scales: representative fractions, reducing and enlarging scales, plain scales, diagonal scales and vernier scales.
4. Curves used in engineering practice: conic sections, ellipse, parabola, hyperbola, cycloid epicycloids, hypocyloid, involutes and spiral.
5. Orthographic projections: First angle and third angel projections, conventions used, orthographic projection of simple solids; Conversion of three-dimensional views to orthographic views.
6. Isometric projections: of simple solids, isometric views, conversion of orthographic views to isometric views; free hand sketching.

Reference Books :

Engineering Drawing - N D Bhatt
 Engineering Graphics - S C Sharma & Naveen Kumar
 Engineering Drawing - P S Gill
 Engineering Drawing with Auto-CAD - Parvez, Khan & Khaliq

HSC 12301	VALUE EDUCATION, HUMAN RIGHTS AND LEGISLATIVE PROCEDURE (S)	3 0 0
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1. Social Values and Individual Attitudes, Work Ethic, Indians Vision of Humanism, Moral and Nonmoral Valuation, Standards and Principles, Value Judgments.
2. Rural Development in India, Co-operative Movement and Rural Development.
3. Human Rights, UN declaration, Role of various agencies in protection and promotion of Rights.
4. Indian Constitution, Philosophy of Constitution, Fundamental Rights and Fundamental Duties, Legislature, Executive, and Judiciary: Their Composition, Scope and Activities.
5. The Legislature: Function of Parliament, Constitution of Parliament, Composition of the Council of the States, Composition of the House of the People, Speaker,
6. Legislative Procedure: Ordinary Bills, Money Bills, Private Members Bills; Drafting Bills; Moving the Bills, Debate, Voting, Approval of the President/Governor.
7. Vigilance: Lokpal and Functionaries.

Reference Books:

An Introduction to Ethics - Robert E. Dewey and Robert H. Hurlbutt III
 Introduction to the Constitution of India - Durga Das Basu
 Essay and Reflections - Sarvapalli Radhakrishnan, Mahatma Gandhi
 An Autobiography :The story of My Experiments with Truth - M.K. Gandhi,
 Human Rights : Questions and Answers - Leah Levin

GLD/CMD 12301	EARTH SYSTEM SCIENCE (S)	3 0 0
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Section 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.

Section 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.

Recommended Books:

1. Earth's Dynamic Systems – W. Kenneth and Eric H. Christiansen
2. Exploring Earth: An introduction to Physical Geology – John P. Davidson
3. Holmes Principles of Physical Geology – A. Holmes (Revised Ed. Doris L. Holmes)
4. A Textbook of Geology – P. K. Mukerjee
5. Earth System Science from biogeochemical cycles to global changes – M. Jacobson, R.J. Charlson, H. Rodhe and G.H. Orians (2002)
6. Fundamentals of Geophysics – W. Lowrie.

THIRD SEMESTER

GLC13101	GEOLOGY - I (MINERALOGY, PETROLOGY & STRATIGRAPHY)	3 0 0
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Mineralogy

Minerals: Physical and chemical properties; Crystal, crystal classes and systems; Classification of minerals and properties of common silicate minerals (Quartz, Feldspar, Pyroxene, Amphibole, Garnet, Olivine, Mica), sulphides (Pyrite, Chalcopyrite, Galena, Sphalerite) and oxides (Haematite, Magnetite, Chromite, Pyrolusite, Psilomelane).

Petrology

Igneous rocks: Magma and lava, extrusive and intrusive forms, textures; Classification and description of some common igneous rocks (Granite, Dolerite, gabbro, Basalt, Rhyolite, Pegmatite).

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

Metamorphic rocks: Processes of metamorphism, textures and structures of metamorphic rocks; Classification and description of some common metamorphic rocks (Slate, Phyllite, Schist, Gneiss, Quartzite, Marble).

Paleontology and Stratigraphy

Concepts of palaeontology; Fossils, their mode of preservation and significance as indices of age and climate; Concept of index fossils. Principles of stratigraphy; Broad stratigraphic subdivisions and associated rock types of important ore provinces, coal belts and oil fields of India.

Suggested Reading

- Krishnan, M. S., Geology of India
- Mukherjee, P. K., Introduction to Geology
- Read, H. H., Rutley's Elements of Mineralogy
- Turner, F. J. and Verhoogen, J., Igneous and Metamorphic Petrology

GLC13201	MINERALOGY AND PETROLOGY PRACTICAL	0 0 3
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Mineralogy

Study of physical properties of minerals

(A) Rock forming minerals: Talc, Gypsum, Calcite, Fluorite, Feldspar (Orthoclase, Microcline, Plagioclase), Muscovite, Biotite, Quartz, Beryl, Tourmaline, Corundum, Kyanite, Serpentine, Garnet and Sillimanite.

(B) Ore minerals: Haematite, Magnetite, Chalcopyrite, Malachite, Azurite, Chromite, Bauxite, Pyrolusite, Psilomelane, Sphalerite, Galena

Petrology

Study of common rocks with reference to their structures, mineral composition and uses.

(A) Igneous Rocks: Granite, Syenite, Gabbro, Basalt, Dolerite, Lamprophyre, Aplite, Pegmatite.

(B) Metamorphic Rocks: Slate, Schists, Gneisses, Quartzite, Marble, Amphibolite, Charnockite.

(C) Sedimentary Rocks: Conglomerate, Sandstone, Shale, Carbonaceous Shale, Coal, Limestone.

GLC13202	CRYSTALLOGRAPHY PRACTICAL	0 0 3
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Study of Symmetry elements of Crystal; Study of crystal models of different classes. Miller indices and zone axis calculations, Test for tautozonality. Stereographic projections of some important crystal classes, axial ratio calculations. Indexing of XRD peak profiles and calculation of lattice parameters.

AMC131xx	METHODS OF APPLIED MATHEMATICS - I	4 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 POE

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.

APC131xx	MECHANICS - I	4 0 0
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Law of motion, motion in a uniform field, components of velocity and acceleration in different coordinate systems, uniformly rotating frame, Centripetal acceleration, Coriolis force and its applications. Motion under central force, Kepler's law, Gravitational law and field, Potential due to a spherical body Gauss and Poisson equations for gravitational self-energy, Earthquakes, Seismic waves and Seismographs, Galitzin's Seismograph, Determination of the Epicentre and the focus, Modern application of seismology. System of particles, Centre of mass, equation of motion, conservation of linear and angular momenta, Conservation of energy, single stage and multistage rockets, elastic and inelastic collisions. Rigid body motion, Rotational motion, Moment of inertia and their products, principal moments and axes, Euler's equations, precessional motion, top, Gyroscope. Kinematics of moving fluids, equation of continuity, Bernoulli's theorem, viscous fluids, streamline and turbulent flow, Poiseulle's law, capillary tube flow, Reynold's number, Stoke's law. Surface tension and surface energy, molecular interpretation of surface tension, pressure on a curved liquid surface, wetting.

EIC131xx	COMMUNICATION ENGINEERING	3 0 0
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Elements of an Electrical Communication System; Analog Modulation Techniques (Block diagrams only) - AM, DSB, SSB, FM, PM; Random Processes; Effect of noise on analog modulation techniques; Pulse modulation - Sampling, PCM, DM, DPCM; Baseband Pulse transmission - Matched filter, Intersymbol interference; Passband Digital Transmission - ASK, FSK, PSK, QPSK; Introduction to Information theory and Coding; Selected topics - Spread Spectrum Systems, Multiuser Radio Communication.

ACC13125	INORGANIC CHEMISTRY	3 1 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), tetrasulphur tetranitride, 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.

ACC13225	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 14103	GEOLOGY - II (Physical and Structural Geology)	3 0 0
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Physical Geology (1-0-0)

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 (2-0-0)

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.

Suggested Reading

Homes, A., Physical Geology
Mukherjee, P. K., Introduction to Geology
Billings, M. P., Structural Geology

GLC 14203	STRUCTURAL GEOLOGY PRACTICAL	0 0 3
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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 14104	GEOLOGY - III (Economic Geology)	3 0 0
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1. Terminology: sedimentary/syn-sedimentary, syngenetic/epigenetic, stratiform/stratabound ores; ore and gangue minerals, grade and Tenor and project feasibility.
2. Classification of ore deposits: Magmatic, sedimentary, hydrothermal and metamorphic processes.
3. Processes of Ore mineralisation:
 - (a) Ores of igneous affiliations: Crystal fractionation (diamond, chromite, Fe-Ti-V oxide ores and pegmatites) and liquid fractionation (oxide and sulfide –liquid immiscibilities).
 - (b) Differentiation of magma and ore formation stages. Magmatic associations with special types like ultramafic rocks, carbonatites and felsic suites. Different categories of porphyry-type, Bushweld, Sudbury deposits. Massive sulphide deposits (VHMS-Type), Kuroko-Besshi-Mississippi valley type deposits.
 - (c) Sedimentary cycles and ore formation. Clastic, volcanoclastic and biogenic sources of sediments and sites of deposition. BIF, stratabound, stratiform types, polymetallic nodules, Laterites, nickel and bauxite deposits. Supergene ore forming processes. Mechanical and residual concentration processes.
 - (d) Metamorphic Ore processes. Metamorphism of ores and associated rocks. Skarn type mineralisation.
 - (e) Hydrothermal deposition of ores. Vein type deposits, Lode gold and hydrothermal base metal deposits.
4. Mode of occurrence and controls of ore deposition and ore depositional textures.
5. Temporal pattern and distribution of types of ores through geologic time.
6. Indian Mineral Deposits: Distribution, geology and genesis of important metallic and non-metallic deposits of India.

GLC 14104	ECONOMIC GEOLOGY PRACTICAL	0 0 3
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Study of ore suite samples from different localities and associations

GLC 14105	GEOLOGY - IV (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 14205	PALEONTOLOGY PRACTICAL	0 0 3
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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.

EEC 14152	APPLIED ELECTRICAL ENGINEERING	3 1 0
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Operation and characteristics of three-phase Induction motors; Methods of starting & speed control of three phase induction motor; Ward-Leonard method of speed control of DC motor; Basic principles of Thyristor controlled variable speed AC and DC motors; Principles of rate making of electricity and power factor improvement; Substation arrangement; Circuit breakers; Protective relays: - Induction pattern over current relay, thermal overload relay, earth fault relay, Lightning Arrester, Fuses: - types and selection. Industrial application & control of electrical motors: - Types of electric motors and their application in industry; Controllers for the speed control of DC & AC motors.

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

GLC 15211 / GLC 21211	MINERALOGY PRACTICAL	0 0 3
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Study of optical properties of minerals under petrological microscope.

GLC 15112 / GLC 21112	METHODS OF STRUCTURAL GEOLOGY	3 0 0
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1. Methods of constructing profiles of folds: Convolute and evolute methods, Concentric-arc method, Kink-style construction, Dip-isogon method, Down-plunge projection method
2. Tectonites: Different types and their significance. Petrofabric analysis. Relationship between deformation and metamorphism and criteria for recognition. Relative dating of orogenic belts.
3. 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.
4. Analysis of shear zones: Different types, Shear zone rocks, Shear sense indicators. Balanced cross-sections of thrust-belts. Applications of balanced cross-sections.
5. Analysis of fractures: Lineament-Array analysis and its significance for regional exploration programme, Joint-array Analysis and its significance, Fault-array Analysis.

GLC 15212 / GLC 21212	METHODS OF STRUCTURAL GEOLOGY PRACTICAL	0 0 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	IGNEOUS PETROLOGY	3 0 0
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1. Classification of igneous rocks. IUGS classification. Textures and structures of igneous rocks.
2. 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.
3. Nature and type of partial melting in the mantle. Magmatic differentiation and fractionation models.
4. Representation of chemical analysis of igneous rocks. Major and Trace element systematics in igneous rocks. Silica/alumina saturation, variation diagrams, their applications and limitations.
5. 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.

6. 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 15213 / GLC 21213	IGNEOUS PETROLOGY PRACTICAL	0 0 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 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 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	4 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	GEOCHEMISTRY AND ISOTOPE GEOLOGY	3 0 0
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Geochemistry

2 – 0 – 0

1. Origin and abundance of elements in the solar system and in the Earth and its constituents. Geochemistry of atmosphere, hydrosphere.
2. Atomic structures and properties of elements in the periodic table
3. Geochemical classification of elements. Special properties of LILE, HFSE and rear earth elements.
4. Laws of thermodynamics; 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.
5. Chemistry of natural waters. Mineral stability in Eh-pH diagram. Elemental mobility in surface environment. Concept of agrochemical-biogeochemical cycling and global climate.
6. 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.

Isotope Geology

1 – 0 – 0

7. Introduction: 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.
8. Basic principles of radiometric dating methods of Rocks: K – Ar and Ar – Ar methods, Rb – Sr and Sm – Nd methods, U – (Th –) Pb methods.
9. Stable isotope systematics: Carbon, Oxygen, Hydrogen and Sulphur and their implication

GLC 16216 / GLC 22216	GEOCHEMISTRY & ISOTOPE GEOLOGY PRACTICAL	0 0 3
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1. Sample preparation methods (Destructive and non-destructive), A- solution and B- Solution preparation.
2. Wet chemical analyses and titrimetric analyses of major and some trace elements.
3. Pellet sample preparation for XRF analyses.
4. Making applications and performing major and some trace elements using international standards with the help of XRF.
5. Sample preparation (carbon and gold sputtering) for Scanning Electron Microscopy.
6. Data presentation and associated problems.

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 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	GEOTECTONICS	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.

AMC 16101 / AMC 22101	NUMERICAL AND STATISTICAL METHODS	4	0	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.

AMC 16201 / AMC 22201	NUMERICAL AND STATISTICAL METHODS PRACTICAL	0	0	3
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A. Numerical Methods

Numerical solution of non-linear algebraic and transcendental equation by bisection, iteration, false position, secant and Newton Raphson methods. Numerical solution of a system of linear simultaneous equation by Gauss elimination and Gauss Seidel methods.

Interpolation by Lagrange's interpolation formula.

Numerical evaluation of definite integral by 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 Euler's, Modified Euler's, second and fourth order Runge-Kutta, Adams-Moulton and Milne's methods.

B. Scope of practice sessions

Computation of raw moments, central moments, coefficient of variation, coefficients of skewness and kurtosis; Fitting of straight line, second degree polynomial (parabola), power curve and exponential curve; Computation of product moment correlation, multiple and partial correlation coefficients; Regression coefficients and regression lines, plane of regression. Application of tests of significance based on numerical data.

MEC 16201 / MEC 22201	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.

Plane Table Surveying: General, Methods, Intersection, Traversing, Resection, two point problem and Three Points problem etc.

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

MEC 16201 / MEC 22201	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 17122 / GLC 23122	KINEMATICS OF ROCK DEFORMATION	3 0 0
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1. 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.
2. 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.
3. 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).
4. Experimental deformation and Rheology: Effects of confining pressure, pore fluid pressure, anisotropy, temperature and scale on rock deformation. Behaviour of rocks under experimental conditions.
5. Development of Structures: Mechanisms of folding, and strain variations around folds. Mechanism of rock fracturing. Development of secondary cleavage and lineations.

GLC 17222 / GLC 23222	KINEMATICS OF ROCK DEFORMATION PRACTICAL	0 0 3
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Analysis of stress using Mohr Circle construction., Strain analysis: Bilaterally symmetrical fossils, reduction spots, shear zone deformation, Flinn Diagram, Mohr Circle construction and flattening of folds.

GLC 17123 / GLC 23123	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 – properties, characteristics, population moments, confidence limits; Techniques of normal and lognormal probability distribution model fit to observational data – probability graph method, numerical approximations and chi-squared goodness of fit;
2. Concepts of Geostatistics: Concepts of Support, Autocorrelation, Random Function, Regionalised variable; Schools of Geostatistical thoughts; What, When and Why of Geostatistics; Stationarity and intrinsic hypotheses; Exploratory data analysis.
3. Semi-variogram: Definition, formulation, properties, mathematical relationship with covariogram, characteristics of an experimental semi-variogram; Calculation of experimental semi-variograms in 1-, 2-, and 3-dimensions with effect of change in support; Mathematical models of semi-variogram; Techniques of model fitting, viz. hand fit, non-linear least square, and point kriging cross validation techniques; Practical difficulties associated with semi-variography, viz. spatial anisotropy, non-stationarity and proportional effect, regularization, nugget effect, and presence of trend; Other types of semi-variograms, viz. accumulation semi-variogram and cross-semivariogram.
4. Extension and Estimation Variance: Definitions, 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; Shadow effect; Volume-variance relationship; Conditional bias in kriging.
6. Introductory Capsule on other types of kriging: Cokriging, collocated kriging, universal kriging, kriging with external drift, lognormal kriging, disjunctive kriging, multi-gaussian kriging, indicator kriging and probability kriging. A Brief Introduction to Multivariate Geostatistics.
7. 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, misclassified tonnages, and geostatistical grade control.
8. Introduction to Geostatistical (Stochastic) Conditional Simulation: definition and principles. Methods of Simulation, viz. Sequential Gaussian simulation, Sequential Indicator simulation and Simulated annealing simulation.

GLC 17223 / GLC 23223	GEOSTATISTICS PRACTICAL	0 0 3
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Drill hole compositing, Normal Distribution fitting, Lognormal distribution fitting, Chi-squared goodness of distribution fitting, Semi-variogram computations in 1-, 2-, and 3-dimensions, Semi-variogram modelling, Computation of estimation variance, dispersion variance, Point kriging, Block Kriging, Conditional simulation.

GLC 17124 / GLC 23124	MICROPALEONTOLOGY AND VERTEBRATE PALEONTOLOGY	3 0 0
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Micropalaeontology

1. Introduction to various groups of microfossils. Techniques of separation of microfossils from different types of sedimentary rocks.
2. Foraminifera and Ostracoda - their morphology, orientations, growth, reproduction, ecology and palaeoecology, classification, evolutionary trends and stratigraphic distribution.
3. Conodonts - Morphology, classification, biological affinity and stratigraphic distribution.
4. Application of micropalaeontology in fossil fuel exploration, and paleoclimate

Vertebrate Palaeontology

5. 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.
6. Evolution of mammalian dentition. Phylogeny of Equids, Proboscids and Hominids.
7. Origin, evolution and extinction of life; Dinosaurs and their extinction.

GLC 17224 / GLC 23224	MICROPALEONTOLOGY AND VERTEBRATE PALEONTOLOGY PRACTICAL	0 0 3
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Disintegration of sediments and separation of microfossils. Morphology of some important foraminifera, ostracoda and vertebrate fossils.

MEC 17101 / MEC 23101	ROCK MECHANICS	3 0 0
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1. Definition, importance and scope of the subject. Analysis of stress and strain at a point; Mohr's circle of stress and strain; stress field.
2. 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.
3. Theories of rock failure.
4. Stress concentration around an opening.
5. Rock slope engineering - factors influencing slope stability, factor of safety of a slope, analysis of slope failure, monitoring of slope stability, improving slope stability.
6. Rock bursts and bumps. Subsidence - causes, prediction, monitoring and prevention case histories in Indian scenario.
7. Determination of in-situ stresses.
8. Instrumentation and monitoring of stability of structure in rocks. Stabilization of weak and fractured ground - grouting and shotcreting.
9. Numerical modeling for Geotechnical applications.

MEC 17201 / MEC 23201	ROCK MECHANICS PRACTICAL	0 0 3
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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 17101 / GPC 23101	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, horizontal cylinder, semi-infinite horizontal sheet 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, vertical dipole. Horizontal dipole and dipping dipole.

Spontaneous Potential (SP) Method

Origin of SP, Field procedure to conduct SP survey, removal of bias from SP anomalies, common minerals showing SP anomalies, interpretation of SP anomalies.

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

True and apparent resistivity, resistivities of common rocks and minerals, Electrode configurations-Schlumberger and Wenner, 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.

Suggested Reading

- Dobrin, M. B. and Savit, C., Introduction to Geophysical Prospecting
- Parasnis, D. S., Applied Geophysics
- Rao, B. S. R and Murthy, I. V. R., Gravity and Magnetic Methods of Prospecting
- Nettleton, L. L., Gravity and Magnetics in Oil prospecting
- Telford, W. M., Geldart, L. P., Sheriff, N.D. and Keys, D. A., Applied Geophysics

GPC 17201 / GPC 23201	GEOPHYSICAL PROSPECTING PRACTICAL	0 0 3
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1. Reduction of gravity data to base station; To calculate Free air and Bouguer anomaly at given station; Interpretation of Bouguer anomaly map.
2. Elements of Earth Magnetic Field; Reduction magnetic data to base station; Interpretation of Magnetic anomaly map
3. Interpretation of VES curves for two layered earth and three layered earth
4. Calculation of water saturation from SP, Resistivity and porosity logs.
5. Lithology identification from gamma ray and Resistivity logs
6. To draw T-D curve for dipping refractor, and horizontal reflector
7. To calculate formation water resistivity from SP log
8. Interpretation of Dual Laterolog and Induction Log.
9. Calculation of NMO

EIGHTH SEMESTER

GLC 18126 / GLC 24126	REMOTE SENSING AND GIS	4 0 0
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A. Remote Sensing

(2 0 0)

1. 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.
2. 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.
3. Applications: Remote sensing in Geological mapping, Mineral Exploration, Ground water Exploration, Petroleum Exploration, Engineering Geology and Environmental studies.

B. GIS

(2 0 0)

1. Geographical Information System: Introduction and definitions; Technology and concepts; Components of GIS; Developments in GIS.
2. GIS data modelling, data analysis – Overlay, DEM and DTM; Topological modelling; Spatial operations, Map integration, Multi-criteria evaluation.
3. Steps in a GIS project: Identification of project objectives, Creation of project database, Analysis of data, and Data integration, and Presentation of map output.
4. Overview of GIS softwares, viz. ArcGIS, Geomatica and MapINFO.

GLC 18226 / GLC 24226	REMOTE SENSING AND GIS PRACTICAL	0 0 3
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1. Testing of Stereovision and examination of stereo aerial photograph under mirror stereoscope.
2. Spectral signature and analyses the given set of Spectral reflectance curves for Water, Soil and Vegetation within visible and near infrared wavelength.
3. Study and identification of major Geomorphologic features on stereo aerial photograph under Mirror stereoscope.
4. Study of given B&W imagery and noting down the details available on the Imagery along with scale and Latitude and Longitude.
5. Study of given False Color Composite (FCC) and interpreting various Geomorphologic terrain/features.
6. Digital Enhancement of Images in Geomatic S/W for betterment towards geological interpretation.
7. Handling of GIS softwares.

GLC 18127 / GLC 24127	GEOMORPHOLOGY	3 0 0
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1. Methods of geomorphologic investigations.
2. Structural and lithological controls of landforms and drainage patterns.
3. Physical, Chemical and Biological processes in weathering.
4. Depositional and Erosional landforms: Fluvial, Aeolian, glacial and marine.
5. Morphometric analysis of landforms.
6. Impact of climate on geomorphology.
7. Quaternary geology
8. Neotectonics
9. Geomorphology of India.
10. Applications of geomorphology in environmental and engineering geology problems.

GLC 18227 / GLC 24227	GEOMORPHOLOGY PRACTICAL	0 0 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 18128 / GLC 24128	COMPUTER APPLICATIONS IN GEOLOGY	3 0 0
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1. General Introduction to computers, Database with respect to Geology, Computer graphics (CAD).
2. Univariate and Multivariate Statistical models in geology. Introduction to orebody modeling, Geological modeling.
3. Computer applications in ore reserve estimation. Elementary concepts on Knowledge Based Expert System, Decision Support System, Neural Network, Genetic Algorithm, Fuzzy Logic.
4. Computer packages in Geology, viz. DATAMINE, SURPAC, MINEX, GEO-EAS, GSLIB, ISATIS, MICROMINE, GEMCON, ArcGIS, SPANS
5. Two dimensional contouring of geological data. Computer applications in petroleum exploration and ground water exploration.
6. Computer applications in petrological problems: Classification of igneous rocks with NEWPET software, plotting and interpretation of Spider diagram, REE patterns. Petrogenetic interpretation of igneous rocks.
7. Computer applications in structural geology: Stereographic projection, eigenvalue problems, Flinn plot, Ramsay plot and strain analysis. Fracture array analysis. Analysis of Paleomagnetic data.

GLC 18228 / GLC 24228	COMPUTER APPLICATIONS IN GEOLOGY PRACTICAL	0 0 3
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Introduction to GEXSYS/ISATIS Geostatistical Software, Statistical modeling, Semi-variogram modeling, Inverse distance modeling, Point kriging, Block kriging, Mineral Inventory and Grade-Tonnage Relation, Use of graphic packages for Analysis of Directional Data, for Palaeomagnetic Studies, Stereographic Projection of planes and lines. Strain Plots (Flinn / Ramsay / Hossack)
Softwares for Petrological problems, petroleum exploration, engineering geology and groundwater exploration..

GLC 18129 / GLC 24129	PETROLEUM GEOLOGY	3 0 0
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1. Petroleum: its different states of natural occurrence, chemical composition and physical properties of crudes in nature. Origin of petroleum, Maturation of kerogen; Biogenic and Thermal effect
2. Reservoir rocks: general attributes and petrophysical properties. Classification of reservoir rocks - fragmental reservoir rocks and chemical reservoir rocks.
3. 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.
4. Hydrocarbon traps: definition; anticlinal theory and trap theory, classification of hydrocarbon traps - structural, stratigraphic and combination; time of trap formation and time of hydrocarbon accumulation. Cap rocks - definition and general properties.
5. Formation water characteristics as oil exploration leads.
6. Plate tectonics and global distribution of hydrocarbon reserves. Classification of Indian basins and petroleum geology of Assam, Bengal, Cauvery, Krishna-Godavari, Cambay and Bombay offshore basins.
7. Application of Mass Spectrometry in Petroleum

GLC 18229 / GLC 24229	PETROLEUM GEOLOGY PRACTICAL	0 0 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.

MEC 18151 / MEC 24151	MINING METHODS AND UNIT OPERATIONS	3 0 0
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Surface Mining

Deposits amenable to surface mining; Box-cut - definition, objectives, types and their applicability, parameters, and methods; Production benches - objectives, formation and bench parameters; Unit operations and associated equipment; Classification of surface mine systems.

Underground Coal Mining

Deposits amenable to underground coal mining; Classification of underground coal mining methods; Bord and pillar method - general description, applicability, merits and demerits; selection of panel size, operations

involved and associated equipment; Longwall methods - Types and their general description, applicability, merits and demerits; selection of panel length and face length, operations involved and associated equipment; Methods for mining steeply inclined seams and thick seams; Hydraulic mining.

Underground Metal Mining

Deposits amenable to underground metal mining; Shape, size and position of drifts and cross-cuts; Raises and winzes; Classification of underground metal mining methods; Stopping methods - General description, applicability, operations involved and associated equipment for Room and pillar mining, Stope and pillar mining, Shrinkage stoping, Sublevel stoping, Cut and fill stoping, VCR method, Sublevel caving and Block caving.

NINTH SEMESTER

GLC 19132 / GLC 25132	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 canals, 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 19232 / GLC 25232	HYDROGEOLOGY PRACTICAL	0 0 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. Computation of simple problems on pumping test.

GLC 19133 / GLC 25133	EXPLORATION GEOLOGY AND MINERAL ECONOMICS	4 0 0
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1. Geological Prospecting and Exploration: Definitions and Principles; Planning aspects of prospecting programme; Methods of Prospecting; Field evidences - Criteria and Guides; Exploration strategies, procedures and design; Methods of Exploration – Surface and sub-surface; Stages of exploration with respect to objectives, work components and agencies involved. Search for buried and concealed mineral deposits.
2. Sampling: theory, objectives, number of samples, and methods of sampling – surface and sub-surface. Choice of sampling methods, preparation of samples, and errors in sampling. Computation of borehole data. Weighting of samples and calculation of average grade from drill hole sample values. Geological plans and sections for orebody evaluation; Concept of cut-off grade. Estimation of ore reserves; Geo-environmental aspects for mineral exploration; Development of mineral deposits.
3. Geochemical Exploration: Introduction, Geochemical cycle, geochemical mobility and association of elements. Pathfinder and target elements for geochemical exploration. Primary and secondary dispersions of elements; Orientation surveys; Mix media surveys. Determination of background, and geochemical anomalies;
4. Geochemical methods of mineral exploration: Stream sediment survey, Pedogeochemical survey, lithogeochemical survey, biogeochemical, geobotanical, hydrogeochemical, atmospheric and vapour surveys; radiometric, and isotopic; Heavy mineral surveys. Procedures for geochemical sampling. Interpretation of geochemical surveys; Geochemical exploration for nonmetallic minerals. Geochemical modelling for ore search.
5. Evaluation of different terrains for geochemical exploration with special reference to India. Instrumental analytical techniques. Selected Indian case studies.
6. Exploration risk management and parameters for success. Uncertainties of geological interpretation, drilling, core recovery, sampling, assaying and interpretation. Collection of data along Geological (G), Feasibility (F) and Economic (E) and axes during various stages of exploration following national norms.
7. Exploration drilling: objectives and techniques, viz. Diamond core, Rotary and Percussion. Stages of exploratory drilling techniques such as DTH, Air core drilling, Reverse circulation and diamond core drilling. Geological factors for planning of exploration drilling. Drill core logging and core sampling. Geological documentation for exploration planning.

Mineral Economics

1. World resources of minerals; Classifications of mineral resources – IMM, JORC, SAMERC, ISP and UNFC schemes. Mineral markets, Import-Export policies and International Trade. Demand analysis of minerals, Royalty and Taxes. India's status in mineral production.
2. Changing patterns of mineral consumption and substitution. International and national mineral policies. Mines and Minerals (Development and Regulation) act. Marine mineral resources and laws of sea.

GLC 19233 / GLC 25233	EXPLORATION GEOLOGY PRACTICAL	0 0 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 19134 / GLC 25134	COAL GEOLOGY	3 0 0
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1. Coal and its properties: Different varieties and ranks of coal. Origin of coal. Type of depositional processes. Coalification process and its causes.
2. Sediments closely associated with coal (coal balls, tonsteins, seat-earths, under-clays, fire-clays and soils).
3. 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.
4. Coal-bed methane: as energy resource. Maturation of methane in coals. Coal as a reservoir, Fundamentals of coal bed methane exploration and production
5. Methods of coal prospecting and estimation of coal reserves
6. Applications of coal petrography. Proximate and ultimate analyses. Industrial evaluation of coal characteristics with reference to coal classification.
7. Geology and coal petrography of different coalfields of India.
8. Uses of coal for various industries e.g. carbonization, liquefaction, power generation, gasification and coal-bed methane production.
9. Organic Petrology and organic geochemistry.

GLC 19234 / GLC 25234	COAL GEOLOGY PRACTICAL	0 0 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 19135 / GLC 25135	ORE GEOLOGY	3 - 0 - 0
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1. Introduction to Ore microscopy.
2. Qualitative and Quantitative methods in the identification of Ore minerals.
3. Ore textures and paragenesis. Industrial application of ore microscopy and process mineralogy.
4. Partitioning of trace elements and ore forming processes.
5. Nature of ore forming fluids. Different types of chemical reactions involved in hydrothermal alterations and supergene enrichment.
6. Phase diagrams of ore minerals.
7. Calculation of thermo-barometric parameters for oxide and sulphide phases.
8. Fluid inclusions and their application in the genesis of ores. Isotopes and their bearing on ore genesis and application.

GLC 19235 / GLC 25235	ORE GEOLOGY PRACTICAL	0 0 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.

PEC 19151 / PEC 25151	PETROLEUM RESERVOIR ENGINEERING AND FIELD DEVELOPMENT	3 0 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: Oil and gas field development: Principles of oil and gas field development; rational development plan; well spacing and patterns, Economics of field development

TENTH SEMESTER

GLC 10138 / GLC 25138	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.

Physicomechanical 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 10238 / GLC 26238	ENGINEERING GEOLOGY PRACTICAL	0 0 3
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Exercises on Engineering Geology maps, and section of Dam sites, Reservoir sites, Tunnels, Hill slopes, open pit slopes. Determination of physical properties of rocks and soils.

GLC 10139 / GLC 26139	ENVIRONMENTAL GEOLOGY	3 0 0
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Introduction to Environmental Geology

Scope of 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.

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

1. Historical developments, definitions and key concepts, base level changes, transgressions and regressions.
2. Stratigraphic surfaces: Stratal terminations, sequence stratigraphic surfaces. Unconformity and correlative conformity.
3. Systems Tracts: Lowstand, Transgressive, Highstand, Falling stage. Shelf-margin system tract (SMST)
4. Unconformities: Type I, Type II and Type III.
5. Sequence Models: Depositional sequence, Genetic stratigraphic sequence, Transgressive-Regressive sequence.
6. Hierarchy of sequences and bounding surfaces.

Basin Analysis

7. Definition and scope of basin analysis. Basin mapping methods: structure and isopach contouring, lithofacies maps, palaeocurrent analysis, Geohistory analysis. Thermal history.
8. Regional and global stratigraphic cycles. Tectonic classification of sedimentary basins.
9. 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

1. Coal bed methane generation and accumulation

2. Geological and petrographic influences on coal, Pore geometry, Micropore, Mesopore and macropore, cleat system
3. Sorption – principles, sorption isotherms – types and interpretation. CO₂, CH₄ and N₂ adsorption – desorption, hysteresis, langmuir isotherm, Swelling of coal matrix isotherm construction.
4. CH₄ content determination in coal seams.
5. 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.
6. Water production and disposal, injection wells, carbon dioxide sequestration.
7. Potential coal bed basins and production, hydraulic fracturing of coal seams, CBM exploration.
8. In-situ gasification.

Gas Hydrate

1. Gas hydrate, occurrence and origin; structure of gas hydrate, Types of gas hydrate;
2. Geological setting of Hydrate; Stability of gas hydrates; Gas hydrate reservoir;
3. Volume of gas in hydrate; inhibitors.
4. Geological exploration of gas hydrate
5. Prospect and potentialities of gas hydrate in India.

GLE 10142 / GLE 26142	CONTAMINANT HYDROGEOLOGY	3 0 0
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1. Introduction to contaminant hydrology
2. Low temperature aqueous geochemistry
3. Sources of contamination; chemical evolution of soil water and ground water
4. Solute transport in ground water; transformation, retardation and attenuation
5. Non-aqueous phase transport in ground water,
6. Monitoring contaminant migration
7. Site remediation technology and case studies

GLE 10143 / GLE 26143	NUCLEAR GEOLOGY	3 0 0
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1. Introduction (Discovery of radioactivity, isotopes etc.) Radioactivity and radioactive decay, Growth and decay mechanisms (α β γ decay) Decay units and dosage. Neutron activation.
2. Mass spectrometry. Geochronology: Dating methods: K-Ar and Ar-Ar methods, Rb-Sr and Sm-Nd methods, Fission track, ¹⁴C, U-Pb and Pb-Pb methods.
3. Application of Rb-Sr and Sm-Nd isotopes in petrogenetic studies. Stable isotopes: Fractionation mechanisms, Oxygen and hydrogen in hydrosphere and atmosphere, water, snow/ice, geothermal waters. Oxygen/hydrogen isotopes in igneous, metamorphic sedimentary rocks; their application for ore genesis.
4. Carbon and its stable isotopes in biosphere, fossil fuels, carbonates, carbonatites, diamonds, other igneous rocks, volcanic gases, marble/graphite, application in ore genesis.
5. Sulphur isotopes: fractionation mechanisms (biogenic versus equilibrium process), application in fossil fuels, evolution of marine sulphur, ore genesis.
6. Application of isotopes in mineral exploration.
7. Mineralogy of U and Th bearing economic minerals, geochemistry of U-Th and their distribution in ore bodies through geologic time and in different rock types, occurrence of U and Th in peninsular and extra-peninsular India.
8. Detectors of radioactivity: Geiger, proportional and scintillation counters and spectrometers.

GLE 10144 / GLE 26144	GEOTECHNICAL ENGINEERING	3 0 0
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1. 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);
2. Water-rock interaction, weathering indices, swelling indices, durability indices.,
3. Geotechnical investigations for new alignments, Underground Space Technology (UST) and ground control problems, subsidence, convergence and creep phenomenon, slope stability problems and control measures.
4. Anchoring of strata and geotechniques.

5. In-situ stress, methods and geotechnical investigation.
6. Geotechniques of cold region and ground control.
7. Geological hazards and geotechnical mitigation
8. Geotechnical aspects of mineral exploration and exploitation.
9. 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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Necessity, importance, scope, advantages and limitations of mineral beneficiation. Major unit operations involved, material balancing.

Liberation- importance and determination of liberation mesh 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. Movement of solids in liquids. Free, hindered and equal Settling. Rake, Spiral and Hydrocyclone classifiers.

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.

Typical flow sheets for beneficiation of Iron, Gold, Copper, Pb-Zn Sulphide ores. Coal and some industrial minerals. Bye-product recovery.

FMC 10251 / FMC 26251	MINERAL BENEFICIATION PRACTICAL	0 0 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 floatation.

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.