

# Course Structure & Syllabi

## Four Year B.E Mining Engineering



(Effective from 2014-2015 Academic Sessions)



**Department of Mining Engineering**

**Indian School of Mines**

**Dhanbad - 826004**

**I Semester  
PHYSICS (GROUP-I)**

Sl. No	Course Number	Course offering Department	Name of the course	L	T	P	Total Credit Hours
1	AMC 11101	AM	Mathematics-I	3	1	0	7
2	APC 11101	AP	Physics	3	0	0	6
3	MCC 11101	MEC	Engineering Graphics	1	4	0	6
4	EEC 11101	EE	Electrical Technology	3	1	0	7
5	MCC 11103	MEC	Engineering Mechanics	3	1	0	7
6	GLD/CMD 11301	AGL & ESE	Earth System Science (S) [ AGL 2-0-0 & ESE 1-0-0]	3	0	0	6
7	HSC 12305	HSS	Value Education, Human Rights and Legislative Procedure (S)	3	0	0	6
8	APC 12201	AP	Physics Practical	0	0	3/2	1.5
9	EEC 12201	EE	Electrical Technology Practical	0	0	3/2	1.5
			Total	<b>19</b>	<b>7</b>	<b>3</b>	<b>48</b>

**CHEMISTRY (GROUP-II)**

Sl. No	Course Number	Course offering Department	Name of the course	L	T	P	Total Credit Hours
1	AMC 11101	AM	Mathematics-I	3	1	0	7
2	ACC 11101	AC	Chemistry	3	0	0	7
3	MCC 11102	MEC	Manufacturing Process	1	4	0	6
4	ECE 11101	ECE	Electronics Technology	3	0	0	6
5	CSE 11301	CSE	Computer Programming (S)	3	0	0	6
6	DMS/AP 11301	DMS & AP	Disaster Management [ DMS 2-0-0] & Energy Resources [ AP 1-0-0] (S)	3	0	0	6
7	HSC 11103	HSS	English for Science & Technology	3	0	0	6
8	ACC 12201	AP	Chemistry Practical	0	0	3/2	1.5
9	ECE	ECE 12201	Electronics Engineering Practical	0	0	3/2	1.5
10	CSE 12301	CSE	Computer Programming Practical (S)	0	0	2	2
			Total	<b>19</b>	<b>5</b>	<b>5</b>	<b>48</b>

**II Semester**  
**CHEMISTRY (GROUP-I)**

Sl. No	Course Number	Course offering Department	Name of the course	L	T	P	Total Credit Hours
1	AMC 12101	AM	Mathematics-II	3	1	0	7
2	APC 11101	AP	Physics	3	0	0	6
3	MCC 11101	MEC	Engineering Graphics	1	4	0	6
4	EEC 11101	EE	Electrical Technology	3	1	0	7
5	MCC 11103	MEC	Engineering Mechanics	3	1	0	7
6	GLD/CMD 11301	AGL & ESE	Earth System Science (S) [ AGL 2-0-0 & ESE 1-0-0]	3	0	0	6
7	HSC 12305	HSS	Value Education, Human Rights and Legislative Procedure (S)	3	0	0	6
8		DSW	Co-Curricular Activities (Only for Second Semester)	0	0	0	(3)
8	APC 12201	AP	Physics Practical	0	0	3/2	1.5
9	EEC 12201	EE 12201	Electrical Technology Practical	0	0	3/2	1.5
			<b>Total</b>	<b>19</b>	<b>7</b>	<b>3</b>	<b>48 + (3)</b>

**PHYSICS (GROUP-II)**

Sl. No	Course Number	Course offering Department	Name of the course	L	T	P	Total Credit Hours
1	AMC 12101	AM	Mathematics-II	3	1	0	7
2	ACC 11101	AC	Chemistry	3	0	0	7
3	MCC 11102	MEC	Manufacturing Process	1	4	0	6
4	ECE 11101	ECE	Electronics Technology	3	0	0	6
5	CSE 11301	CSE	Computer Programming (S)	3	0	0	6
6	DMS/AP 11301	DMS & AP	Disaster Management [ DMS 2-0-0] & Energy Resources [ AP 1-0-0] (S)	3	0	0	6
7	HSC 11103	HSS	English for Science & Technology	3	0	0	6
8		DSW	Co-Curricular Activities (Only for Second Semester)	0	0	0	(3)
8	APC 12201	AP	Chemistry Practical	0	0	3/2	1.5
9	ECE 12201	ECE	Electronics Engineering Practical	0	0	3/2	1.5
10	CSE 12301	CSE	Computer Programming Practical (S)	0	0	2	2
			<b>Total</b>	<b>19</b>	<b>5</b>	<b>5</b>	<b>48 + (3)</b>

### III Semester

Sl. No	Course No.	Course Name	Contact Hours*			Credit Hours
			L	T	P	
1	MEC 13101	Drilling and Blasting	3	0	0	6
2	MEC 13102	Mine Surveying – I	3	0	0	6
3	MEC 13202	Mine Surveying – I Practical	0	0	2	2
4	MEC 13103	Introduction to Mining (S)**	2	0	0	4
5	GLR 13151	Mineralogy, Petrology and Stratigraphy	3	0	0	6
6	GLR 13251	Mineralogy and Petrology Practical	0	0	2	2
7	MCR 13101	Mechanical Engineering – I	3	1	0	7
8	MCR 13201	Mechanical Engineering – I Practical	0	0	3/2	1.5
9	AMR 13101	Methods of Applied Mathematics – I	3	1	0	7
10	HSS Optional (S)*** (Any One) HSE 13302 (i) Philosophy of Science HSE 13303 (ii) Gandhian Studies HSE 13304 (iii) Oral Communication Skills HSE 13305 (iv) Oral Presentation Skills HSE 13307 (v) Present History of India		3	0	0	6
11	MEC 13601	Mining Excursions	0	0	0	(4)
12	MEC 13801	Mining Project	0	0	0	(2)
Total			<b>20</b>	<b>2</b>	<b>7.5</b>	<b>49.5 + (6)</b>

\* L: Lecture, T: Tutorial, P: Practical | \*\*S: Sessional | \*\*\* HSS (S): Humanities and Social Sciences, Sessional

### IV Semester

Sl. No	Course No.	Course Name	Contact Hours*			Credit Hours
			L	T	P	
1	MEC 14101	Mine Development	3	0	0	6
2	MEC 14102	Mine Surveying – II	3	1	0	7
3	MEC 14202	Mine Surveying – II Practical	0	0	2	2
4	GLC 14158	Geology for Mining Engineers	3	1	0	7
5	GLC 14258	Geology for Mining Engineers Practical	0	0	2	2
6	MCR 14101	Mechanical Engineering –II	3	1	0	7
7	MCR 14201	Mechanical Engineering –II Practical	0	0	3/2	1.5
8	AMR 14101	Numerical and Statistical Methods	3	1	0	7
9	HSC 14306	English for professional communication (S)**	3	0	0	6
10	MEC 14601	Mining Excursions	0	0	0	(4)
11	MEC 14001	Comprehensive Viva-Voce	0	0	0	(4)
12	MEC 14801	Mining Project	0	0	0	(2)
13	SWS 14701	Co-curricular Activities	0	0	0	(3)
Total			<b>18</b>	<b>4</b>	<b>5.5</b>	<b>47.5 +(13)</b>

\* **L:** Lecture, **T:** Tutorial, **P:** Practical      \*\* **S:** Sessional

### V Semester

Sl. No	Course No.	Course Name	Contact Hours*			Credit Hours
			L	T	P	
1	MEC15101	Rock Mechanics	3	0	0	6
2	MEC15201	Rock Mechanics Practical	0	0	2	2
3	MEC15102	Surface Mining	3	1	0	7
4	MEC15103	Underground Coal Mining	3	0	0	6
5	MEC15104	Underground Metal Mining	3	0	0	6
6	MMR15101	Mine Electrical Engineering (S)	3	1	0	7
7	MEC15601	Mining Excursions	0	0	0	(4)
8	MEC15801	Mining Projects	0	0	0	(4)
			<b>15</b>	<b>2</b>	<b>2</b>	<b>34+(8)</b>

\* **L:** Lecture, **T:** Tutorial, **P:** Practical, **S:** Sessional

## VI Semester

Sl. No	Course No.	Course Name	Contact Hours*			Credit Hours
			L	T	P	
1	MEC 16101	Mine Ventilation	3	1	0	7
2	MEC 16201	Mine Ventilation Practical	0	0	2	2
3	MEC 16103	Surface Mine Planning & Design	3	1	0	7
4	MEC 16104	Applied Rock Mechanics & Numerical Modelling	3	1	0	7
5	MEC 16204	Applied Rock Mechanics & Numerical Modelling Practical	0	0	2	2
6	MMR 16101	Mining Machinery – I	3	0	0	6
7	MEC 16601	Mining Excursions	0	0	0	(4)
8	MEC 16001	Comprehensive Viva-Voce	0	0	0	(4)
9	MEC 16901	Survey Camp**	0	0	0	(6)
10	MEC 16801	Mining Project	0	0	0	(4)
			<b>12</b>	<b>3</b>	<b>4</b>	<b>31+(18)</b>

\* L: Lecture, T: Tutorial, P: Practical, S: Sessional

\*\* Survey camp at the end of V Semester is credited in VI Semester

**VII Semester**

Sl. No	Course No.	Course Name	Contact Hours*			Credit Hours
			L	T	P	
1	MEC 17101	Mine Environmental Engineering	3	1	0	7
2	MEC 17201	Mine Environmental Engineering Practical	0	0	2	2
3	MEC 17102	Mine Legislation and Safety – I	3	1	0	7
4	MMR 17101	Mining Machinery – II	3	0	0	6
5	MEC 17103	Computer Aided Mine Planning (S)	0	3	0	3
		Elective (Any one)	3	0	0	6
	MEE 17101	(i) Rock Excavation Engineering				
	MEE 17102	(ii) Advanced Mine Ventilation				
	MEE 17103	(iii) Open Pit Slope Analysis and Design				
	MEE 17104	(iv) Marine Mining				
	MEE 17105	(v) Dimensional Stone Mining				
	MEE 17106	(vi) Numerical Modelling in Ground Control				
6	MEC 17801	Project and Seminar	0	0	0	(6)
7	MEC 17601	Mining Excursions	0	0	0	(4)
			<b>12</b>	<b>5</b>	<b>2</b>	<b>31+(10)</b>

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**VIII Semester**

Sl. No	Course No.	Course Name	Contact Hours*			Credit Hours
			L	T	P	
1	MEC18101	Mine System Engineering	3	0	0	6
2	MEC18102	Advanced Underground Mining	3	1	0	7
3	MEC18103	Mine Legislation & Safety - II	3	0	0	6
4	MSC18151	Industrial Management (S)	3	0	0	6
5		Elective (Any One)	3	0	0	6
	MEE18101	(i) Innovative Mining systems				
	MEE18102	(ii) Map Projections & GIS				
	MEE18103	(iii) Mine Safety Engineering				
	MEE18104	(iv) Coal Bed Methane				
	MEE18105	(v) Underground Space Technology				
	MEE18106	(vi) Mineral Economics				
6	MEC18801	Project and Seminar	0	0	0	(6)
7	MEC18601	Mining Excursions	0	0	0	(4)
8	MEC18001	Comprehensive Viva-Voce	0	0	0	(4)
9	MEC18002	Vacational Training**	0	0	0	(5)
			15	1	0	31+(19)

\* L: Lecture, T: Tutorial, P: Practical, S: Sessional

\*\* A total of 30 days Vacation Training in a mine to be taken at the end of IV & VI Semester of which at least 15 days training should be taken at the end of VI semester. The Vacation training will be credited in VIII Semester.



## SYLLABUS

### I & II SEMESTERS

#### AMC 11101 MATHEMATICS- I

(3-1-0)

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

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

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

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

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

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

#### AMC 12101 MATHEMATICS- II

(3-1-0)

#### Vector Calculus and Fourier Series:

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

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

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

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

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

#### **Recommended books for Mathematics I & II:**

1. Higher Engineering Mathematics by B.V. Ramana, Tata McGraw-Hill.
2. Advanced Engineering Mathematics by R.K. Jain and S.R.K. Iyengar, Narosa Publishing House.
3. Calculus and Analytic Geometry by G.B. Thomas and R.L. Finney, Narosa Publishing House.
4. Advanced Engineering Mathematics by M.D. Greenberg, Pearson.
5. Higher Engineering Mathematics by B.S. Grewal, Khanna Publishers.

**APC11101/APC12101 PHYSICS**

**(3-0-0)**

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

**Modern Physics:** Brief idea of molecular spectra; Rigid rotator, spectra of simple

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

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

**Recommended Books:**

1. Heat And Thermodynamics; Brij Lal & Subrahmanyam; S Chand & Co Ltd; 2001
2. Thermal And Statistical Physics; R B Singh; New Age Publications; 2009
3. An Introduction To Thermal Physics; Schroeder; Dorling Kindersley India; 2007
4. Thermal Physics And Statistical Mechanics; Roy & Gupta; New Age Publications; 2001
5. Concepts Of Modern Physics; Beiser; McGraw-Hill Science; 2010
6. Modern Physics; Sivaprasath & Murugesan; S. Chand Publisher; 2009
- 7.

**APC11201/APC12201      PHYSICS PRACTICAL      (0-0-3/2)**

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

**ACC11101 / ACC11102      CHEMISTRY      (3- 0- 0)**

**Cement:** Manufacturing, composition, setting and hardening of cement.

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

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

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

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

**Gaseous fuel:** Characteristics of good fuel; calorific value, theoretical calculations of

calorific value of a fuel, natural gas and hydrogen gas.

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

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

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

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

**ACC12101 / ACC12102      CHEMISTRY PRACTICAL      (0- 0- 3/2)**

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

**Recommended Books:**

1. A Textbook of Engineering Chemistry-Sashi Chawla
2. Applied Chemistry: A Textbook for Engineers and Technologists - H.D. Gesser.
3. Engineering Chemistry - P.C. Jain & Monika Jain
4. Engineering Materials - K.G. Budinski

**MCC 11101/ MCC 12101      ENGINEERING GRAPHICS      (1 – 4 – 0)**

**Introduction:** Drawing instruments and their uses; Indian standards for drawing. Lettering and Types of lines used in engineering graphics.

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

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

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

**Projection of Solids and Development of surfaces**

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

**Recommended Books:**

1. Engineering Drawing - N D Bhatt
2. Engineering Graphics - S C Sharma & Naveen Kumar
3. Engineering Drawing - P S Gill
4. Engineering Drawing with Auto-CAD - Parvez, Khan & Khalique

**MCC 111021/ MCC 12102      MANUFACTURING PROCESSES      (1-4-0)**

**Carpentry:-** Classification of timber, seasoning & preservation to wood, description and application of the various tools used in carpentry, different joints and their practical uses.

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

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

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

**Welding:** Welding types, accessories. weldments.

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

**Measurement:** Use of measuring instruments etc for product measurement.

**Recommended Books:**

1. Workshop Technology part I, II & I IJ----- W A J Chapman
2. Workshop lechnology part I & II ----- Hazra Chowdhary
3. Workshop Technology part I & II ----- Raghuvanshi
4. Workshop Technology ----- S.K. Garg
5. Manufacturing Technology ----- P. N. Rao
6. A Text book of Workshop Technology ----- R S Khurmi & J K Gupta

**EEC 11102/12102      ELECTRICALTECHNOLOGY      (3 - 0 - 0 )**

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

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

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

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

DC motor – operation, torque equation, starting, losses and efficiency, applications.

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

**Recommended 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.

**EEC11201/12201      ELECTRICAL TECHNOLOGY PRACTICAL      (0 - 0- 3)**

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

**ECC 11101/12101      ELECTRONICS ENGINEERING      (3-0-0)**

Semiconductor Diodes and Applications – Introduction Characteristics, dc and ac resistances of a diode. Half wave and Full wave rectification. Zener Diodes and then use as regulators, Clippers and Clampers.

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

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

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

Introduction to Field Effect Transistors and their applications.

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

**Recommended Books:**

1. Electronic Device and Circuit Theory - Boylestad & Nashelsky
2. Digital Principles & Applications - Malvino & Leach

**ECC 11201/12201**

**ELECTRONICS ENGINEERING (LAB)**

**(3-0-0)**

1. Study of Electronic Equipment & Components.
2. Study of diode characteristics.
3. Study of regulated power supply.
4. Study of BJT characteristics.
5. Study of op-amp characteristics.
6. Implementation of Boolean algebra using logic gates.
7. Adder Circuits.

**MCC 11103/MCC12103**

**ENGINEERING MECHANICS**

**(3-1-0)**

**Fundamentals of Mechanics:** Equivalent force systems, Equilibrium of rigid bodies.

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

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

**Properties of surfaces:** Centroid of composite bodies, Pappus-Guldinus theorem, moment of

inertia of composite bodies, parallel axis theorem, product of inertia, principal axes, Mohr's

circles for moments and products of inertia.

**Virtual work:** Principle and applications, Stability of equilibrium.

**Kinematics and kinetics of particles:** Curvilinear motion, Dynamic equilibrium, Angular

momentum, Revision of Conservation of Energy, Energy and Momentum methods for Single

Particle and for a System of Particles, Impulsive motion.

**Kinematics of rigid bodies:** General plane motion, Instantaneous center of rotation, Planer

motion relative to a rotating frame, Coriolis acceleration, Frame of reference in general motion.

**Kinetics of rigid bodies:** Application of the principle of impulse and momentum to the 3D

motion of a rigid body, Kinetic energy in 3D, Euler's equations of motion, Motion of a Gyroscope, Eulerian angles.

**Recommended Books:**

1. Vector Mechanics for Engineers - Statics & Dynamic: Beer, Johnston.
2. Vector Mechanics - Statics & Dynamics: Nelson, Best, McLean.
3. Vector Mechanics - Statics & Dynamics: Shames. Rao, Pearson.
4. Engineering Mechanics: Timoshenko & Young.

**Programming in C**

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

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

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

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

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

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

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

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

**Programming in JAVA**

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

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

**Recommended Book:**

- 1) "Programming with C by Byron Gottfried" , *Second edition, Schaum's Outline Series* ,1998
- 2) "C programming by Kernighan and Ritchie", *Second edition, Prentice Hall*, April 1, 1988
- 3) "Java: The complete reference – Herbert Schildt", *Eight edition, McGraw – Hill*, 2011.
- 4) "The C Programming Language by Bjarne Stroustrup", *Pearson Education*, 2000.
- 5) "C: The complete reference – Herbert Schildt", *Fourth edition, McGraw-Hill*, 2000.
- 6) "Programming With Java by E Balaguruswamy", *4th Edition, Tata McGraw-Hill*, 2008
- 7) "Let us C – by Yashwant Kanitkar", *BPB publications*, 2008.



Laboratory experiments will be based on the materials covered in the theory of this paper emphasizing the following topics.

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

**(GLD/CMD)(11301/12301)      EARTH SYSTEM SCIENCE (S)      (3 0 0)**

**Part A :      AGL (2-0-0)**

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

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

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

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

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

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

**Part B :      ESE (1-0-0)**

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

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

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

**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 Mukherjee
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.

## **DISASTER MANAGEMENT & ENERGY RESOURCES**

### **DMS11301/DMS12301 DISASTER MANAGEMENT (S) (2-0-0)**

Concepts of Disaster, Types of Disaster and Dimensions of Natural and Anthropogenic Disasters (cyclone, flood, landslide, subsidence, fire and earthquake); Principles and Components of Disaster Management, Organizational Structure for Disaster Management, Disaster Management Schemes; Introduction to Natural Disasters and Mitigation Efforts: Flood Control, Drought Management, Cyclones, Terror Threats; Pre-disaster risk and vulnerability reduction; Post disaster recovery and rehabilitation; Disaster related Infrastructure Development; Role of Financial Institutions in Mitigation Effort; Psychological and Social Dimensions in Disasters; Disaster Management Support Requirements – Training, Public Awareness.

### **APD11301/APD12301 ENERGY RESOURCES (1-0-0)**

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

#### **Books Recommended:**

1. Non-Conventional Energy Sources by G.D.Rai, Khanna Publishers.
2. Fundamentals of Renewable Energy Resources by G.N. Tiwari & M.K. Ghosal, Alpha Science International.
3. Solar Energy: Fundamentals and Applications by H P Garg & J Prakash, Tata McGraw-Hill Publishing Company Ltd.
4. Solar Energy: Principles of Thermal Collection and Storage by S P Sukhatme, Tata McGraw-Hill Publishing Company Ltd.

### **HSS11305/HSS 12305 VALUE EDUCATION, HUMAN RIGHTS AND LEGISLATIVE PROCEDURE (3-0-0)**

Social Values and Individual Attitudes, Work Ethics, Indian Vision of Humanism, Moral and Non-moral Valuation, Standards and Principles, Value Judgements. Rural Development in India, Co-operative Movement and Rural Development. Human Rights, UN declaration, Role of various agencies in protection and promotion of rights. Indian Constitution, Philosophy of Constitution, Fundamental Rights and Fundamental Duties, Legislature, Executive and Judiciary: Their Composition, Scope and Activities.

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

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

Vigilance: Lokpal and Functionaries.

### **HSS 11101/HSS12101 ENGLISH FOR SCIENCE AND TECHNOLOGY (3-0-0)**

Language Resource Development: Using appropriate grammatical lexical forms to express meaning-accuracy, range and appropriacy in grammatical lexical exercises.

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

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

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

#### **Recommended Books:**

1. Robert, E. Dewey and Robert, H, Hurlbutt III. An Introduction to Ethics, Macmillan Publishing co. int., New York, 1977.
2. Radakrishnan, S. Mahatma Gandhi: Essays and Reflections. Jaico Publishing House, Mumbai, 1957.
3. Gandhi, M K. An Autobiography; The Story of My Experiment with Truth. Navjeevan Trust, Ahmadabad, 1927.
4. Leah Levin. Human Rights: Questions and Answers, National Book Trust, New Delhi, 1998.
5. Basu, Durga Das, Introduction to Constitution of India, Prentice Hall of India Pvt. Ltd., New Delhi, 1994.

### **III Semester**

#### **DRILLING AND BLASTING (MEC 13101)**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>0</b>	<b>0</b>

#### **Exploration Drilling**

Boring for exploration; Various types of exploratory drills and their applicability – Auger, Cable-tool, Odex, Core Drills; Core recovery: single and double tube core barrels, wire line core barrel; Storage of cores; Interpretation of borehole data.

#### **Explosives and Initiating Systems**

Types of explosives, their composition and properties, classification; Selection of explosives; Manufacture, transport, storage and handling of explosives; Testing of explosives; Types of initiating systems – Electrical Detonators, Detonating Fuse, Detonating Relays, NONEL, Electronic Detonators, Blasting accessories, exploders.

#### **Drilling & Blasting in Surface Mines**

Drilling: Blasthole drills – types, classification, applicability and limitations; Mechanics of drilling, performance parameters, drilling cost, compressed air requirement for hole cleaning; Selection of drilling systems, drilling errors, organization of drilling.

Blasting: Mechanics of rock fragmentation; Livingstone theory of crater formation; Factors affecting blasting, Blast design - estimation of burden and spacing, estimation of charge requirement; Initiation patterns; Secondary blasting – pop and plaster shooting; Problems associated with blasting, Ground vibration and air over pressure, Blast instrumentation

#### **Drilling & Blasting in Underground Mines**

Coal mines: Drilling systems and their applicability, blasting-off-solid, different blasting cuts, ring hole blasting, calculation of specific charge, specific drilling and detonator factor, initiation patterns.

Metal mines: Drilling systems and their applicability, blast design for horizontal drivages, different blasting cuts, long hole blasting, vertical crater retreat blasting.

#### **MINE SURVEYING – I (MEC 13102)**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>0</b>	<b>0</b>

**Surveying:** Definition, objective, classification and principles of surveying.

**Linear Measurement:** Instruments for measuring distances; Ranging and taping survey lines; Chain surveying – principle, field work, off-sets, booking and plotting, obstacles in taping.

**Angular Measurement:** Bearing of lines; Rectangular coordinate system; Essentials of the micro-optic theodolite; Measurement of horizontal and vertical angles; Temporary and permanent adjustments; Theodolite traversing; Computation of co-ordinates; Adjustment of traverse; Temporary and permanent adjustments.

**Levelling:** Definition & terminology; Levelling instruments types - tilting, auto set and digital levels; Levelling staves; Different types of levelling - differential, profile,

cross-sectional and reciprocal levelling; Booking and reduction methods; Underground levelling; Temporary and permanent adjustments of levels.

**Total Station:** Principle of electronic measurement of distance and angles; construction and working with Total Station; Errors; Application and recent developments in Total Station.

**Plane Table Surveying:** Methods

**Contours:** Concepts; Characteristics of contour; Contour Interval; Methods of contouring and uses of contours.

**Computation of areas and volumes**

#### **MINE SURVEYING – I PRACTICAL (MEC 13202)**

L	T	P
0	0	2

Study and sketch the **linear measuring instruments** & carrying out Chain Surveying; **Prismatic Compass** and carrying out Compass Traversing; **Vernier theodolite** & angle measurement by Repetition Method; Angle measurement by Reiteration Method using **Micro-optic theodolite**; Study and sketch of a **Tilting level** & carrying out Fly Levelling; Study and sketch of **Auto level** & carrying out Profile Levelling; Study and sketch of **1" Theodolite** and angle measurement; **Plane Table Surveying** by Radiation Method and Contouring; Study and sketch of **Total Station** and measurement of angles, distance and determination of coordinates and RL using Total Station; Preparation of grid and plotting the field data.

#### **INTRODUCTION TO MINING (S) (MEC 13103)**

L	T	P
2	0	0

Mining – definition and economic importance; Mine – definition, different types and classification; Mine life cycle; Mineral deposit – different types and their classification; Mineral resources of India; Modes of entry to a mine – shaft, incline, decline, adit and box-cut. Overview of surface mining: Types of surface mines, unit operations, basic bench geometry, applicability & limitations and advantages & disadvantages. Overview of underground mining: Different coal mining methods and their applicability & limitations; Different metal mining methods and their applicability & limitations; Basic concepts of transportation, ventilation, illumination and support in underground mines.

#### **MINERALOGY, PETROLOGY AND STRATIGRAPHY (GLR 13151)**

L	T	P
3	0	0

##### **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.

### **MINERALOGY AND PETROLOGY PRACTICAL (GLR 13251)**

L	T	P
0	0	2

## **Mineralogy**

Study of physical properties of:

(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.

### **MECHANICAL ENGINEERING – I (MCR 13101)**

L	T	P
3	1	0

Introduction to Strength of Materials; Stress-strain diagram; Elastic constants and their relations, Thermal stresses and strains, Stresses in oblique planes - Principal stresses and principal planes.

Theory of simple bending; Deflection of beams-integration method and moment area

method. Analysis of stresses in pressure vessels- thin and thick cylinders. Torsion of solid and hollow circular Shafts.

Introduction to theory of Machines; Basic concepts: degrees of freedom, kinematic constrains, linkages, mechanisms. Different types of gears, gear trains, reduction ratio and torque assessment, application of gearboxes. Basic principles and constructions of governors, flywheels, brakes, clutches and dynamometers.

Case study based on laboratory setups on the above broad areas.

References:

1. Mechanics of Materials – Beer, Johnston et-al
2. Strength of Materials – S.S.Rattan
3. Strength of Materials – V.S.Prasad
4. Theory of Machines – Sadhu Singh
5. Theory of Machines – S.S.Rattan
6. Theory of Machines and Mechanisms – Uicker, Pennock and Sigley

**MECHANICAL ENGINEERING – I PRACTICAL (MCR 13201)**

L	T	P
0	0	3/2

1. Tensile test of a mild steel specimen on Universal Testing Machine (UTM)
2. Young's modulus by flexure of beam method
3. Stiffness test of closed coiled helical spring
4. Determination of M. I. of a connecting rod
5. Coefficient of friction between belt / rope and pulley
6. Efficiency of a screw jack

**METHODS OF APPLIED MATHEMATICS – I (AMR 13101)**

L	T	P
3	1	0

**Part-I**

**Complex Variables:**

Limit, continuity and differentiability of function of complex variables. Analytic functions. Cauchy-Riemann's equations, Cauchy's integral theorem, Morena's theorem, Cauchy's integral formula, Taylor's and Laurent's series, singularities, Residue theorem; Contour integration.

**Special Functions:**

Solution of Bessel equations, recurrence relations and generating function for  $J_n(x)$ , orthogonal property and integral representation of  $J_n(x)$ . Solution for Legendre equation, Legendre polynomial, Rodrigue's formula, orthogonality property and generating function for  $P_n(x)$ .

**Part-II**

**Laplace Transforms:**

Laplace transforms of simple functions, properties of Laplace transform, t-multiplication and t-division theorems, Laplace transforms of derivatives, integrals and periodic functions. Inverse Laplace transform and its properties, convolution

theorem. 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, solution of one dimensional wave equation, one dimensional unsteady heat flow equation and two dimensional steady heat flow equation by variable separable method with reference to Fourier trigonometric series.

**HSS OPTIONAL (S) (ANY ONE)**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>0</b>	<b>0</b>

**PHILOSOPHY OF SCIENCE (HSE 13302)**

Introduction: Rationale for study of philosophy of science prevalence of imbalances; General approach, nature, scope and relation of the subject with historical development; Science and philosophy vis-à-vis need for intellectual and moral balance. Scientific and philosophical approaches to knowledge development and knowledge application (emphasis on earth and mineral sciences).

Foundations of philosophy: Nature, concept, scope, methodology, divisions and implications.

Concept and Nature of Science: Origin/aim, methodology, scope and development; Nature of scientific methods; Movements, scientific thought; Divisions of science; Scientific laws and scientific explanations.

Convergence of Science and Philosophy: Unified theory; Space-time relationship, patterns of change; Deeper issues and broad involvements of science; Status of scientific proposition and concepts of entities, epistemic and ontological aspects.

Philosophical Analysis and Scientific Practice: Philosophic base of Eastern Thought and their parallel in science; The essentials of unity between Eastern Thought pattern and Western science; Need for harmony between intuitive thought and rational knowledge; Philosophy of science with reference to Western Thought; Philosophers of science– Western and Eastern.

Inter-relationship of Science and Culture: Science and aesthetics, science and human values, science in the full tradition, science vis-à-vis human conduct and social affairs; Social significance of science; Implications of philosophy of science for a new peaceful social order, synthesis of eastern “Work View” and Western “Materialism”.

**GANDHIAN STUDIES (HSE 13303)**

Introduction to Gandhi’s life and philosophy; Fundamentals of Gandhian economics; Gandhi’s concept of human nature, perfectibility of man; Ethical ideas of Gandhi – Truth, Ahimsa, Brahmacharya, Non-stealing, Non-possession and Voluntary poverty.

Gandhi’s interpretation of history and society.

Public welfare and Sarvodaya Philosophy – Antyodaya; Sarvodaya socialism and capitalism; Nature of Sarvodaya economy from Gandhi to Vinoba; Concept of production and distribution in Sarvodaya economy and its utility in our socio-economic and scientific/technical development; Non-violent economy vis-à-vis



centralized industrial economy and rural economy.

Study of the current industrial problems and priorities as against the Gandhian ideology.

Gandhian approach to manpower management, prospects, cooperative production and consumption, rural entrepreneurship, finance, planned changes for helping the disadvantaged sections of the society.

Man and machine – problems of automation and Gandhi's views.

Gandhi's political views: The state as an organ of violence, political sovereignty of the people, decentralization of political power, concept of freedom, the ideal political condition – Ram Rajya.

Satyagrah, the importance of truth force, self suffering, winning over the opponent by love.

### **ORAL COMMUNICATION SKILLS (HSE 13304)**

The nature, purpose and characteristics of good conversation; Phonological forms to use in speech; Developing conversation skills with a sense of stress, intonation and meaning; Use of question tags; Starting, maintaining and finishing conversations; Standard conversational exchanges; Spoken language idioms; Effective listening and attention to others; Gestures and body language; Do's and don'ts in conversation; Telephone conversations; Functions of English in conversation: introductions, greetings, clarifications, explanations, interactions, opinions, agreements and disagreements, complaints, apologies.

Participating in informal discussions and situations.

Using information to make some decision, i.e., making social arrangements with friends.

Reproducing information in some form (question/answer, summarizing, orally reporting etc.).

### **ORAL PRESENTATION SKILLS (HSE 13305)**

Characteristics of a good presentation; Assessing the audience and its needs; Planning a presentation; Different presentation styles; Using the presentation Matrix; The Informative Presentation; The Demonstration Presentation; The Persuasive Presentation; Presentation structure and design; Materials and logistics; Visual aids and their development and use; Rehearsing and delivering; Using performance techniques; Overcoming anxiety and stress; Openings and closings; Getting and maintaining audience attention; Using language to optimal effect; Body language and gestures; Linguistic aspects: introducing, sequencing, signaling, quoting, clarifying and summarizing; Handling questions.

## **PRESENT HISTORY OF INDIA (HSE 13307)**

Idea of a Nation: defining nation, citizenship duties, profession, society, the modern nation, state as it emerged after 1789, the socio – economic context of the new 'nation'.

The Modern Individual: transition from pre-modern definition & social location of individuals to the growth of idea of free individual, the social contact, the duties of an individual, atomization of individual and a critique to it.

Colonial rule in India: colonial redefinition of nation, individual, society in India; A critique of pre-colonial mode of life by the colonial theorists, the 'progressive' colonial alternatives, the ambiguity in colonial 'images' of India.

Nation and the nationalists: The ideological contestation of colonial images by the nationalists, the critiques of colonialism by Gandhi, Nehru, Tagore, S. C. Bose, Aurobindo Ghosh, M. N. Roy, J. P. Narayan; Problematizing colonial ideas – impact of colonialism in India; Problems with the nationalist critique of colonialism, colonialists and nationalists on the idea of 'science', 'modernity', 'development'.

Re-inscribing Indian femininity: Changing views of Indian femininity vis-à-vis female sexuality.

Threats of neo-colonialism: The challenges to the nation, post-colonial critique of colonialism and nationalism; Individual and society in a changing world order.

## IV Semester

### **MINE DEVELOPMENT (MEC 14101)**

L	T	P
3	0	0

**Opening-up of Deposits:** Choice of mode of entry – adit, shaft, decline and combined mode, their applicability, number and disposition.

**Vertical and Inclined Shafts:** Location, shape, size, and organisation of shaft sinking, construction of shaft collar, shaft fittings.

**Shaft Sinking Operations:** Ground breaking and muck disposal – tools and equipment, lining; ventilation, lighting and dewatering; sinking in difficult and water-bearing ground.

**Insets:** Design, excavation and lining.

**Mechanised Sinking:** Simultaneous sinking and lining; slip - form method of lining; high speed sinking.

**Shaft Boring:** Methods and equipment.

**Special Attributes:** Widening and deepening of inclined and vertical shafts; staple shafts, raised shafts.

**Main Haulage Drifts and Tunnels:** Purpose, shape, size and location; excavation – ground breaking, muck disposal, ventilation and supporting.

**High Speed Drifting/Tunnelling:** Application of mechanised methods; roadheaders and tunnel boring machines.

**Recent Developments** in shaft sinking and drifting/tunnelling.

**Layouts** of pit-top and pit-bottom, Coal Handling Plant, Bunkers and Railway Sidings.

### **MINE SURVEYING – II (MEC 14102)**

L	T	P
3	1	0

**Mine Plans and Sections:** Statuary requirements of Mine Plans and Sections, accuracies, scale.

**Control Surveys:** Triangulation – classification; Reconnaissance; Procedures for angles and base-line measurement; Comparison with precise EDM traversing.

**Gyro-North Determination:** Principle of Gyro-theodolite/Gyromat; Determination of Gyro-north.

**Correlation:** Methods of correlation – direct traversing in inclined shaft, correlation in vertical shaft – single and two shafts, Gyro-Laser combination; Shaft depth measurement.

**Development Surveys:** Control of direction and gradient in drifts, tunnels, raises, winzes.

**Stope Surveying:** Purpose; Methods of survey in moderately and steeply inclined ore bodies, flat and vertical ore bodies/seams.

**Slope Monitoring in Opencast Mines:** Geodetic and Remote Sensing Methods, Slope Stability Radars.

**Subsidence Monitoring:** Subsidence Monitoring of subsidence due to underground mining activities.

**GPS:** Principle of GPS; Instrument; Errors and working with GPS; Application of GPS in mine surveying; Developments in satellite based Navigation system.

**Application of Automation & IT in surveying:** Data acquisitions; Preparation of plans and sections; Calculation of earth works

**Introduction to Surveying softwares**

**Application of GIS and Remote Sensing in Surveying**

**MINE SURVEYING – II PRACTICAL (MEC 14202)**

L	T	P
0	0	2

**Precise Levelling** and distribution of closing error; Study and sketch of **Digital Level**; Detailed surveying and contouring with **Total Station**; Working with **SURPAC** and preparation of Mine Plan; Earthwork calculation using SURPAC and plotting; Plotting of sections using **LISCAD**; Study and practice of **Gyro-theodolite/Gyromat**; Study of **GPS** and data collection; GPS data downloading and post-processing; Study of **Nadir Plummet** and LASER for Correlation survey; Subsidence monitoring using 1" – Micro-optic Theodolite & Precise Level.

**GEOLOGY FOR MINING ENGINEERS (GLC 14158)**

L	T	P
3	1	0

**Structural Geology**

Study 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 mining operations. Principles of stereographic projections of linear and planar features of rocks.

**Economic Geology and Exploration Geology**

Introduction and scope of economic geology; Ore and gangue; Processes of ore formation; Major Indian mineral deposits (Iron, Manganese, Copper, Lead, Zinc) - distribution and mode of occurrence.

Mineral Exploration – concepts and methods viz. surface and subsurface; Exploration strategy and design; Stages of exploration; Resources and reserves.

**Coal and Petroleum Geology**

Rank, characteristics and important constituents of coal; Classification and origin of coal; Chief characteristics of Indian coals; Geology of the principal coalfields of India.

Concept of organic constituents of petroleum origin, migration, accumulation, concept of traps and important petroliferous basins of India.

**GEOLOGY FOR MINING ENGINEERS PRACTICAL (GLC 14258)**

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>2</b>

Study of topographic maps; Completion of outcrops : 1 – and 3 – point problems; Map illustrating ‘V’ rules; Calculation of attitude, thickness and depth of orebodies; Fracture patterns in rose diagram; Maps illustrating fold, fault and unconformity; Stereographic projection.

**MECHANICAL ENGINEERING –II (MCR 14101)**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>1</b>	<b>0</b>

Introduction to thermodynamics; Analysis of various thermodynamic processes, P-V and T-S diagrams. Analysis of air standard cycles – Otto, Diesel and Dual cycles. Classifications, applications and performance estimation of internal combustion engines; Fundamentals of simple open cycle and closed cycle gas turbines and reciprocating air compressors – single and multi-stage.

Performance study and power estimation on laboratory experimental data.

Introduction to Fluid Mechanics; Properties of fluid, classifications, ideal fluid, Newtonian fluid and non-Newtonian fluids, Newton’s law of viscosity. Fluid pressure and its measurement – Piezometers, Manometers, Mechanical gauges. Continuity equation, types of flow. One dimensional equation of motion, Bernoulli’s equation, applications of Bernoulli’s equation, venturimeter. Flow through pipes – Darcy-Weisbach’s equation.

Classification, basic construction and applications of different types of pumps and water turbines.

Performance study and power estimation based on laboratory experimental data.

References:

1. Fluid Mech. and Fluid Power Engg – D.S.Kumar
2. Fluid Mech. and Hyd. Machines – R.K.Bansal
3. Hydraulics, Fluid Mech. and Fluid Machines – S Ramamurtham
4. Engg. Thermodynamics – P.K.Nag
5. Thermodynamics – Cengel and Boles
6. Thermal Engg. - Rathore

**MECHANICAL ENGINEERING –II PRACTICAL (MMR 14201)**

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>3/2</b>

1. Study of construction and operation of 4-stroke SI engine model.
2. Study of construction and operation of 4-stroke CI engine model.
3. Performance testing of a 4-stroke Diesel engine.
4. Determination of coefficient of discharge of venturimeter.
5. Verification of Bernoulli’s Theorem.
6. Determination of friction factor for pipes.

## NUMERICAL AND STATISTICAL METHODS (AMR 14101)

L	T	P
3	1	0

### **Part A: Numerical Methods**

Solution of algebraic and transcendental equations by bisection, iteration, false position and Newton Raphson methods.

Solution of a system of linear simultaneous equations by Gauss elimination, Gauss-Jordan, Crout's triangularisation, Jacobi and Gauss Seidel methods.

Finite difference, Symbolic relations, Interpolation and extrapolation, Newton-Gregory forward and backward, Gauss forward and backward, Stirling, Bessel and Lagrange formulae, Inverse interpolation by Lagrange and iterative methods, Numerical differentiation and integration, Trapezoidal, Simpson's 1/3<sup>rd</sup>, Simpson's 3/8<sup>th</sup> and Weddle quadrature formulae.

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

### **Part B: Statistical Methods**

Moments, skewness and kurtosis.

Probability: Various approaches of probability, two theorems (without proof), conditional probability, Bayes Theorem.

Random variable: Definition, probability mass & density functions, distribution function, mathematical expectation and moment generating function.

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

Theory of least squares and curve fitting.

Correlation and Regression: Simple, multiple & partial correlation coefficients, regression lines, regression coefficients and their properties.

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

## ENGLISH FOR PROFESSIONAL COMMUNICATION (S) (HSC 14306)

L	T	P
3	0	0

### **Part 1: Professional Oral Communication**

#### **Meetings and Discussions:**

1. The nature of group discussion: Forms, functions, structural dimensions and interaction dimensions.
2. The conduct of group discussion: Leadership functions, meeting management, providing the beginning, providing optimal participation, responding to problems, maintaining communication, coordinating, consensus testing, seeking clarification, providing clarification, co-operation, initiating topic shift,

guiding for progress, ensuring objectivity, creating the atmosphere, effecting closure and follow-up; Participant responsibilities, preparing for participation, communicating effectively, contributing systematically, maintaining friendly attitudes; Process evaluation.

3. Starting meetings and discussions: Opening the discussion, problem analysis, stating objectives, suggesting good group procedure (time management, speaking procedure, etc.).
4. Presenting and supporting opinions: Asking for opinions, supporting opinions, giving opinions, making suggestions, asking for suggestions.
5. Balancing points of views: Expressing advantages, disadvantages and consequences; Resenting alternatives; Accepting and rejecting ideas and proposals; Building up arguments.
6. Professional listening: Decoding and comprehending, taking notes, listening cues, micro-markers and macro-markers.

#### **Job Interviews:**

1. Job interview (JI): The interviewing process, types of interviews and interview formats
2. Re-interview preparation techniques, self analysis, skills assessment, company analysis, job analysis, practice, developing the interview file.
3. Projecting success: The beginning, the middle and the end of the interview.
4. Interviewing strategies.
5. Upholding the personality and overcoming interviewing hazards.

#### **Part 2: Professional Writing**

##### **Report Writing:**

1. Mechanics of professional writing: Stages of writing, research and preparation, some basics.
2. Report writing (RW): Characteristics of business and project reports, reports and other forms of communication, features of good reports.
3. Types of reports (Formal/Informal).
4. Structure of Formal Reports: Front matter, main body and back matter.
5. Elements of formal reports: Organization, format and graphics.
6. Style of Reports: Readability of reports, choice of words and phrases, construction and length of sentences and paragraphs.

##### **Business Correspondence:**

1. Nature and Principles of Business Correspondence.
2. Structure of business letters.
3. Business letter formats.
4. Letters giving instructions, inquiry letters, letters of complaints, letters urging action.
5. Employment letters and applications; Job query letters, job application letters, recommendation letters, follow-up letters, letters of acceptance, letters of refusal.
6. C. V. & Resume writing.

7. Business memos: Form and structure.
8. Writing an effective memo.

**Methods :**

1. Theoretical input.
2. Practical exercises, handouts and worksheets.
3. Interactive classroom discussions.
4. Group communication tasks, simulation and role play.
5. Guided discussions and practice discussions.
6. Mock interview sessions.
7. Self and peer evaluation.
8. Audio-video input.
9. Written assignments.
10. Student portfolio.
11. Quizzes

**Tutorial & Practice Sessions:**

Guided group discussions, open group discussions, case study discussions, mock interviews, students' seminars, paper presentations, writing practice, and group writing projects.

**(Note:** For tutorial and practice sessions, students will be divided into small groups, and the time-table for these sessions will be communicated to the students).



## V Semester

### **ROCK MECHANICS (MEC 15101)**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>0</b>	<b>0</b>

**Rock mechanics:** Definition, history, inherent complexities, source of information and field of application of rock mechanics.

**Concept of stress and strain in rock:** Analysis of stress, strain and constitutive relations in isotropic and anisotropic rocks.

**Physico-mechanical properties of rock:** Determination of physical properties, strengths, strength indices and static elastic constants; Parameters influencing strength; Abrasivity of rock and its determination.

**Dynamic properties of rock and rockmass:** Propagation of elastic wave in rock media; Determination of dynamic strength and elastic constants of rock.

**Time dependent properties of rock:** Creep deformation and strength behaviour; Creep test and rheological models.

**Strength and Deformability of Rock Mass:** In situ shear tests; Evaluation of shear strength; In situ bearing strength test; In situ deformability tests- Plate Loading Test, Plate Jacking Test and Borehole Jack Tests

**Failure criteria for rock and rockmass:** Theories of rock failure; Coulomb, Mohr and Griffith criteria; Empirical criteria.

**Pre-mining state of stress:** Sources, methods of determination including over coring, hydro-fracturing methods and other methods.

**Physico-mechanical properties of soil:** Origin of soils; Basic relationships; Index properties including consistency and gradation; Clay mineralogy; Classification of engineering soils; Engineering properties of soils – compressibility, consolidation, compaction and strength.

**Ground water:** Free and confined groundwater; Exploration and engineering importance of groundwater; Influence of water on rock and soil behaviour; Permeability of rocks; Measurement of permeability; Ground water flow in rockmass; Groundwater pressure in rockmass and its measurement.

**Engineering classification of rocks and rock masses:** Classification systems in rock engineering; Classification of intact rocks; Classification of rockmasses-Terzaghi's rock load, RQD, Rock Structure Rating, Bieniawski's RMR, Barton's Q-System, Laubscher's-MRMR, Hoek's-GSI, Palmstrom's RMi, CMRI-ISM Rock mass classification and Recent developments; correlations between different classification systems; Applications of Rockmass Classification in rock engineering.

## **ROCK MECHANICS PRACTICAL (MEC 15201)**

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>2</b>

Preparation of rock sample for testing in laboratory; Methods for determination of compressive strength, tensile strength, shear strength and triaxial strength of rock; Porosity of rock; Abrasivity of rock; Strength indices of rock; Modulus of elasticity and Poisson's ratio; Slake durability of rock; Shear strength, consistency, consolidation and compaction of soil; Determination of in situ stresses in rock.

## **SURFACE MINING (MEC 15102)**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>1</b>	<b>0</b>

### **Introduction**

Surface mining - basic concepts, applicability, advantages and disadvantages; Role of surface mining in total mineral production; Deposits amenable to surface mining vis-à-vis excavation characteristics; Surface mining unit operations; Surface mining systems vis-à-vis equipment systems – classification, applicability, advantages and disadvantages.

### **Opening up of deposits**

Box cut – objective, types, parameters, methods; Factors affecting selection of box cut site; Production benches – formation, parameters and factors affecting their selection.

### **Preparation for excavation**

Ripper: Types, classification, applicability and limitations; Method and cycle of operation; Estimation of output; Concept of rippability.

Estimation of number of drills required for a given mine production.

### **Discontinuous/cyclic methods of excavation and transport**

Shovel-dumper operation: Applicability and limitations of electric shovel, hydraulic excavators and dumpers; Cycle time and productivity calculation for shovel and dumper; Estimation for equipment (shovel, dumper and other heavy earth moving machines) required for a given mine production; Method of work for sub-surface bedded and massive deposits and for hilly massive deposits by shovel – dumper combination.

Dragline operation: Applicability and limitations, different modes of operation; Side cast diagram and calculation of reach; Cycle time and productivity calculation; Calculation of required bucket capacity for a given handling requirement; Maximum usefulness factor and its significance in selection of dragline for a given situation; Method of work by simple side casting.

Scrapers: Applicability and limitations, various types; Method and cycle of operation; Pusher dozer and push-pull operation.

Dozers: Applicability and limitations; Types and classification; Types of blade and corresponding merits and demerits; Method and cycle of operation.

Front-end-loaders: Applicability and limitations; Method and cycle of operation; Minimum tipping- load – concept, estimation and significance; Calculation of maximum working load and selection of bucket capacity of a front-end-loader for a given job condition.

### **Continuous methods of excavation and transport**

Bucket wheel excavators: Applicability and limitations; Types and principle of operation; Operational methods – lateral block / half block method, full block methods and their corresponding merits and demerits; Calculation of productivity.

Continuous surface miners: Types, classification, applicability and limitations; Principles of operation; Operational methods – classification; Wide / full bench method, block mining method and stepped cut method; Empty travel back method, turn back method and continuous mining method; Conveyor / truck loading method, side casting method and windrowing method, Respective merits & demerits and applicability & limitations of these methods.

**Conveyors:** Shiftable and high angle conveyors; Mode of operation, applicability and limitations; Merits and demerits of conveyor as a system of transportation.

### **Semi-continuous methods of excavation and transport**

Continuous excavation and partly/fully cyclic transport system: Different methods and applicability & limitations.

Cyclic excavation and partly/fully continuous transport system: Different in-pit crushing and conveying methods and their respective applicability & limitations.

### **Mining of developed coal seams and dimensional stones**

Mining of developed coal seams: Problems associated; Methods of working.

Dimensional stones: Types, occurrences and uses; Methods vis-à-vis equipment for extraction of primary blocks in granite and marble quarries.

### **Slopes in surface mines**

Types of mine slope – highwall and waste dumps; Common modes of slope failure; Factors influencing stability of slopes; Slope stability assessment techniques; Waste dumps - types and formation methods; Slope protection, stabilization and monitoring.

## **UNDERGROUND COAL MINING (MEC 15103)**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>0</b>	<b>0</b>

**Introduction:** History of coal mining; coal resource and their geographical distributions; Coalification and factors affecting coalification process, modes of accumulation of coal, evidences in support of in-situ and drift theories; Geological time scale vis-à-vis formation of coal, occurrence and distribution of coal in various stratigraphic horizons; Coal seam structure and abnormalities, geological and other features of Indian coalfields.

**Bord and Pillar Mining:** Choice of methods of mining coal seams; factors affecting choice of mining methods. General principles of Bord and Pillar (B&P) development, different schemes of development and associated merits/demerits; Design of B&P

workings, statutory provisions related to B&P workings, Semi-mechanised and mechanized schemes of B&P development; Mechanised face loading. Conditions suitable for mechanical loaders and continuous miners.

**Pillar Extraction:** Preparatory arrangement for depillaring operation, statutory provisions on depillaring; principles of designing pillar extraction, factors affecting choice of pillar extraction; partial and full extraction; depillaring with caving and stowing; mechanization in depillaring operation.

Local and main fall, indications of roof weighting, measures to bring down roof at regular interval; air blast and measures to minimize its effects; precautions during depillaring operation against fire and inundation; multi-section and contiguous workings. Extraction of pillars in seams prone to bumps.

**Longwall Mining:** Factors affecting longwall mining, longwall face layouts, advancing and retreating faces, single versus double unit longwall faces, orientation of longwall faces; single versus multiple heading gate roads, factors affecting length and width of longwall panel.

Extraction of Longwall panel, working with shearer and plough, support system of longwall face and gate roads, monolithic packing in longwall advancing gate roads; case studies of longwall faces in India.

**Roof Supports:** Timber props and cogs; friction/hydraulic props and chocks; other steel supports; types of roof bolts; function, applicability and advantage of roof bolting and cable bolting; powered supports; systematic support rules; supporting scheme of development gallery, B&P and L/W faces, depillaring district; withdrawal of support.

Conditions requiring stowing in mines; types of stowing; suitable materials for hydraulic stowing; stowing plant and stowing range; hydraulic gradient and hydraulic profile.

## UNDERGROUND METAL MINING (MEC 15104)

L	T	P
3	0	0

### Introduction:

Present status of Indian metal mining industry; Scope and limitations of underground mining.

### Development:

Choice of level interval and back/block length; Shape, size, position, excavation and equipping of shaft station/plat, grizzly, ore/waste bin, main ore pass system, underground crushing and loading stations, underground chambers, sump and other subsidiary excavations; Arrangements for dumping into main ore pass; Underground crushing, loading and hoisting.

Cross-cuts and drifts – their shape, size and position; Review of excavation process – ground breaking, mucking, ventilation and support; Track extension and car switching; Use of modern drilling and loading equipment in drifting; Raises and winzes – their shape, size and position; Excavation process – ground breaking, mucking, ventilation and support; Modern methods of raising - Alimak and Jora-lift

raising, longhole method including vertical crater retreat method of raising; Raise boring – systems and their details; Modern methods of winzing; Secondary breaking at grizzly – conventional and mechanised methods.

Waste handling systems in underground workings

**Stoping:**

Selection of stoping methods; Classification of stoping methods; Stoping of narrow ore bodies by underhand, overhand, breast, longhole and raise mining methods; Resuing; Mining of parallel veins; Room & pillar, sublevel, large diameter blast hole/DTH, cascade, shrinkage and vertical crater retreat methods – their applicability, stope layouts, stope preparation, ground breaking, mucking, ventilation and supporting; Haulage and dumping; Supported methods – horizontal overhand and underhand cut-and-fill methods, square-set method and its variations, details of stope layouts, ground breaking, supporting, mucking, ventilation, haulage and dumping.

**Mine supports:**

Timber support: Post, drift-set of various types, square-set, crib-set, cog, stull and chock/chockmat supports; forepoling/piling; load bearing capacity of timber supports; bulkheads.

Steel support: Steel set – rigid and yielding types; tubbing, wire mesh, steel lining, screw jacks and ratchet jacks; improvised steel props, friction props, hydraulic props; link bars and chocks, powered supports; .

Cement support: Poured monolithic and reinforced concrete lining; monolithic pump packing, concrete blocks, concrete slabs, guniting and shotcreting.

Rock support: Pillars of ore and waste, pack walls, masonry walls and arches – building materials and construction.

Fill support: Materials of backfill and their procurement; theoretical aspects of slurry transportation; preparation, transport and placement of hydraulic backfill with and without cement; Paste fills; rock and concrete fills; surface arrangement for storage and mixing; pneumatic and mechanical methods of backfilling.)

Reinforcement systems: Materials and techniques; rock bolts and dowels - different types and uses; mechanics of bolting; point anchored rockbolts - Slot and wedge type, expansion shell type, grouted point anchor type; full column anchors - Wooden and fibreglass dowels, mechanical full column anchors, split sets/friction rock stabilizers, swellex, full column grouted rockbolts; installation and testing of rock bolts; cable bolting – its installation and applications.

Innovations in support and reinforcement systems for hard rock mines.

**MINE ELECTRICAL ENGINEERING (S) (MMR 15101)**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>1</b>	<b>0</b>

Concept of earth fault current limitation in underground (UG) mine power systems, Type of electrical power supply systems for UG coal mines, solidly-earthed, restricted-neutral and insulated-neutral systems of power supply-their comparison.

Earth fault protection techniques for various types of mine power supply systems, sensitive and fail-safe earth fault relays.

Mining type circuit breaker-air circuit breaker, vacuum and SF<sub>6</sub> breaker, Tran switch unit, Gate-end box, drill panel, Remote control and inter- lock circuits for mining type circuit breakers.

Electrical power planning for mechanized longwall coalfaces, General electrical distribution scheme, voltage drop problems and remedial measures, Inbye substation capacity selection

Haulage signaling and longwall face signaling systems, Illumination planning for UG coal mines roadway lighting systems, intrinsically safe lighting systems for longwall faces. Shaft signaling system.

Earthing practice in mines: earth pits, earthing of mobile electrical equipment in mines, mining cable-types and construction, Selection of cable size.

Principle of flame-proof enclosure, intrinsically safe circuit, Methods of attaining intrinsic safety, Zener safety barriers and their applications.

Indian electricity rules as applied to mines/CEA

Mine Winder – AC & DC Drives for winders, Static Ward-Leonard drive for D.C. Winder, AC winder with liquid controller. Electrical braking of winders – Plugging & Dynamic braking. Winder depth and speed indicator. Automatic contrivances – overspeed, overwind, slack rope and rope slip detector system.

Design of power supply system in mines: load assessment, electrical layout diagram, selection of transformers and technique of power factor improvement.

## VI Semester

### **MINE VENTILATION (MEC 16101)**

L	T	P
3	1	0

**Composition of mine atmosphere:** Mine gases – production, properties and effects; Sampling and analysis of mine air; Methane content; Methane drainage; Flame safety lamp and its uses; Methanometers; Methane layering; Radon gas and its daughter products; Monitoring of gases.

**Heat and humidity:** Sources of heat in mines; Effects of heat and humidity; Psychrometry, Kata thermometer; Air-conditioning.

**Air flow through mine openings:** Laws of flow, resistance of airways, equivalent orifice, losses in airways, distribution of air, economic design of airways; Flow control devices; Permissible air velocities in different types of workings/openings; Standards of ventilation.

**Natural ventilation:** Causes, effect of seasonal variations, calculation of NVP from air densities, thermodynamic principles and other methods.

**Mechanical ventilation:** Types of mine fans; Theory, characteristics and suitability of fans; Selection, testing and output control; Fans in series and parallel; Forcing and exhaust configurations; Reversal of flow; Fan drifts, diffusers, evasees; Booster and auxiliary ventilation; Venturi blowers; Ventilation of deep mines – underground and open pit.

**Ventilation planning:** Planning of ventilation systems and economic considerations; Ventilation layouts for underground coal and metal mines; Calculation of air quantity required for ventilating a mine; Calculation of total mine head; Ventilation network analysis principles and computer applications; Ventilation surveys.

### **MINE VENTILATION PRACTICAL (MEC 16202)**

L	T	P
0	0	2

Study and use of MSA-D6 methanometer; Flame safety lamp – construction and gas testing; Detection of mine gases using advanced equipment; Analysis of mine gases using Gas Chromatograph; Measurement of air flow using velometer, vane anemometer and pitot tube; Plotting of fan characteristic curves; Determination of psychrometric properties of air; Estimation of air cooling power using Kata thermometer.

### **SURFACE MINE PLANNING & DESIGN (MEC 16103)**

L	T	P
3	1	0

#### **Introduction**

Stages/Phases of mine life; Preliminary evaluation of surface mining prospects; Mine planning and its importance; Mining revenues and costs - calculation of FW, PV, NPV, IRR, payback period, depreciation by different methods, cash flow and ACFC; Mine planning components, planning steps and planning inputs.

### **Ore reserve estimation**

Ore zone and bench/level compositing; Objectives and principles of ore reserve estimation; Estimation of grade at unknown point; Methods of ore reserve estimation - vertical cross section method, horizontal cross section method and 3-D geological block method; Classification of ore reserves.

### **Stripping ratio**

Concept of stripping ratio; Types of stripping ratios and their significance; Choice between surface and underground mining.

### **Geometrical considerations**

Basic bench geometry; Pit layouts.

### **Pit Planning**

Development of economic block model; Pit Cut-off grade and its estimation; Ultimate pit configuration and its determination – hand method, floating cone technique, Lerchs-Grossmann algorithm, and computer assisted hand method.

### **Production planning**

Determination of optimum mine size and Taylor's mine life rule; Sequencing by nested pits; Cash flow calculations; Mine and mill plant sizing, Lanes algorithm for estimation of optimum mill cut-off grade; Introduction to production scheduling.

### **Analysis and design of highwall slopes and waste dumps**

Pit slope geometry; Influence of pit slope on mine economics; Highwall slope stability analysis and design methodology; Stability analysis and design methodology for waste dumps.

### **Design of haul roads**

Addition of haul road on pit plan; Design of road cross section; Design of road width, curves and gradient; Haul road safety features and their design.

### **Design of drainage system in surface mines.**

### **Selection of mining system vis-à-vis equipment system.**

### **Closure of surface mines.**

**Feasibility Report** - Contents and preparation.

## **APPLIED ROCK MECHANICS & NUMERICAL MODELLING (MEC 16104)**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>1</b>	<b>0</b>

### **Applied Rock Mechanics (Section – A)**

**Design and stability of structures in rock:** Methods for design and stability analysis of underground excavations; Energy released by making an underground excavation; Design of single and multiple openings in massive, stratified and jointed rock mass.

**Design of mine pillars:** Mine pillars and their classification; pillar mechanics; Design of mine pillars and shaft pillar: stresses acting on pillars; stress distribution in pillars;



mechanics of pillar failure; interaction of pillar, floor and roof; design of rooms and pillars; design of barrier and yield pillars.

**Subsidence:** Causes and impacts of subsidence; Mechanics of surface subsidence, discontinuous and continuous subsidence; Monitoring, prediction, control and management of subsidence.

**Caving of rockmass:** Rock caving in mining; Mechanics of rock caving; Assessment of cavability; caving prediction and control.

**Rockburst and coal bump:** Phenomenology of rockbursts and coal bump; causes, prediction, monitoring and control of rockbursts; gas outbursts.

**Monitoring rockmass performance:** Purpose and nature; geotechnical instrumentation; role and design of geotechnical measurement and seismic and micro-seismic monitoring systems; underground data collection; interpretation of monitoring data; practical aspects of monitoring.

**Mechanics of fragmentation:** Principles of coal and rock cutting and drilling mechanics; the performance of rock cutting by picks, disc and roller-cutters; cutting tool interaction;

### **Numerical modelling (Section – B)**

**Introduction:** Need for numerical modelling in design of excavations in mines; Domain and boundary conditions; Discretisation of domain and boundary; Methods of numerical simulation for excavations in mining.

**Finite element method:** Basic principle; Assembling elements to form a structural stiffness matrix; Imposing boundary conditions and solving structural equations using plane truss; Elements on assumed displacements, constant strain triangle, isoparametric formulation, advantages and their limitations.

**Finite difference method:** Explicit finite difference method; Finite difference equation; Mechanical damping, mechanical time-step determination, solution stability, advantages and their limitations.

**Boundary Element Method:** Introduction, formulation, advantages and their limitations.

### **Non-linear solution methods**

**Introduction to Numerical Modelling Packages:** Strand – 7 and FLAC.

### **APPLIED ROCK MECHANICS & NUMERICAL MODELLING PRACTICAL (MEC 16204)**

L	T	P
0	0	2

Load-yield characteristics of friction prop and hydraulic prop/leg; Drillability of rock; Anchorage strength of rock bolt; Rock fracture toughness; Dynamic modulus of elasticity; Shear properties of discontinuity; Blast induced ground vibration; Use of high speed video camera; Use of rockmass monitoring system in assessing blasting performance; Load cell, extensometer, vibrating wire stress meter and convergence meter.

**Numerical modelling using software:** Simulation of mine pillar and underground opening in mines,

**MINING MACHINERY - I (MMR 16101)**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>0</b>	<b>0</b>

Classification, application, constructional features of drilling machines used in underground coal and metal mining, coal cutters, shearer, plough, continuous miner, road header and dirt header, loading and transport equipment, man riding systems, free steered vehicles, shuttle car, ram car.

Classification and constructional difference of different types of winders, mechanics of winding, power calculation, rope selection, inspection and maintenance. Safety features and automatic contrivances.

Classification, construction, and selection of mine pumps and compressors.

## VII Semester

### **MINE ENVIRONMENTAL ENGINEERING (MEC 17101)**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>1</b>	<b>0</b>

**Mine fires:** Causes and classification of mine fires; Spontaneous combustion – mechanism, stages of spontaneous combustion, susceptibility indices, factors affecting spontaneous combustion; Detection and prevention of spontaneous heating and accidental fires; Dealing with mine fires – direct and indirect methods, fire stoppings; Re-opening of sealed-off areas; Fires in quarries, Coal stacks and waste dumps.

**Mine explosions:** Firedamp and coal dust explosions – causes and prevention, explosive limits; Stone-dust and water barriers; Explosion in quarries over developed pillars; Investigation after an explosion.

**Inundation:** Causes and prevention; Precautions and techniques of approaching old workings; Dewatering of waterlogged working, safety boring apparatus, pattern of holes; Design and construction of water dams.

**Rescue and recovery:** Rescue equipment and their uses, classification of rescue apparatus; Resuscitation; Rescue stations and rescue rooms; Organisation of rescue work; Emergency preparedness and response system.

**Airborne respirable dust:** Generation, dispersion, measurement and control; Physiological effects of dust, dust-related diseases.

**Illumination:** Cap lamps; Layout and organisation of lamp rooms; Standards of illumination; Photometry and illumination survey.

### **MINE ENVIRONMENTAL ENGINEERING PRACTICAL (MEC 17201)**

<b>L</b>	<b>T</b>	<b>P</b>
<b>0</b>	<b>0</b>	<b>2</b>

Determination of airborne respirable dust concentration using gravimetric dust sampler, real-time aerosol monitor and personal dust sampler; Determination of inflammability index of coal by Godbert's apparatus; Determination of susceptibility of coal to spontaneous combustion by crossing point temperature method; Study and sketch of rescue apparatus; Evaluation of performance of rescue equipment by Artificial Lung Machine.

### **MINE LEGISLATION AND SAFETY - I (MEC 17102)**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>1</b>	<b>0</b>

#### **Mine Legislation**

The Mines Act, 1952; The Coal Mines Regulations, 1957; The Metalliferous Mines Regulations, 1961;

#### **Mine Safety**

Occupational hazards of mining; Accidents and their classification; Frequency and severity rates of accidents; Basic causes of accident occurrence; Place-wise and Cause-wise analysis; Measures for improving safety in mines; Cost of accidents.

Introduction to risk based safety and health management system; Methods of Risk assessment.

## MINING MACHINERY – II (MMR 17101)

L	T	P
3	0	0

Design, construction and operation of blast hole drills, rippers, shovels, hydraulic excavators, scraper, dragline, dumpers, wheel loaders, dozers, graders, surface miners, BWE, spreader, stacker & reclaimer.

High capacity belt conveyors – constructional detail and selection procedures.

Aerial rope ways – classification, layout and constructional features.

Classification, application and constructional features of crushers, breakers and feeders.

## COMPUTER AIDED MINE PLANNING (S) (MEC17103)

L	T	P
0	3	0

Introduction to strategic open pit planning and design; concepts of optimization in open pit design; Introduction to Mine Planning & Surveying software (SURPAC and others) – data acquisition, data representation and processing, database creation and management, computations of various parameters, digital terrain model (DTM), interpolation of data on triangular or rectangular grid points, reduction of data into presentable form, sectioning, compositing, solid modelling, autoplotting, 3D modelling, block modelling and determination of ultimate pit configuration (UPC).

## ELECTIVE (ANY ONE)

L	T	P
3	0	0

### (i) ROCK EXCAVATION ENGINEERING (MEE 17101)

**Introduction:** Scope and importance of rock excavation engineering in mining and construction industries; physico-mechanical and geotechnical properties of rocks vis-à-vis excavation method; selection of excavation method. Rock breaking processes: Primary, Secondary and Tertiary, Energy consumption computations

**Drilling:** Advances in drilling equipment, pneumatic versus hydraulic, design and operating parameters of surface and underground drilling; evaluation of drill performance; mechanism of bit wear; bit selection; economics of drilling.

**Blasting:** Explosives and their selection criteria for rock excavation; blast design for surface excavations and optimisation; advanced blast initiation systems; blast performance evaluation; cast blasting; techno-economic and safety aspects of surface and underground blasting; advances in blast design for underground excavations; contour blasting; computer aided blast designs. Under water drilling and blasting

**Rock Cutting:** Theories of rock tool interaction for surface excavation machinery – rippers, dozers, scrapers, BWE, continuous surface miners, auger drills; theories of rock tool interaction for underground excavation machinery – ploughs, shearers, roadheaders, continuous miners and tunnel boring machines; selection criteria for

cutting tools; advanced rock cutting techniques – high pressure water jet assisted cutting.

**Recent Developments** in rock excavation machinery.

### **(ii) ADVANCED MINE VENTILATION (MEE 17102)**

**Mine thermodynamics:** Computation of thermodynamic properties of mine air; Basics of modes of heat transfer in mine roadways; Evaporation and consequent changes in mine air properties; Thermal properties of rocks; Fourier and Biot numbers; Calculation of heat flow and temperature rise in mine airways; Sources of heat and moisture transfer in Bord and Pillar/Longwall and other workings.

**Network analysis:** Hardy Cross method of iterative analysis; Thermodynamic analysis of mine airflow in ventilation network without and with change in moisture content; Change in Darcy-Weisbach equation and square law due to variation of air density; Pseudo-pressure equation; Leakage and recirculation; Application of thermodynamic network analysis for complete mine ventilation circuit; Application of software for solving real life ventilation problems in coal and metal mines.

Recent developments in mine ventilation; Air conditioning & ventilation in deep mines; Gas monitoring systems.

### **(iii) OPEN PIT SLOPE ANALYSIS AND DESIGN (MEE 17103)**

#### **Introduction**

Types and formation of slopes in surface mines, pit slope vis-à-vis mine economics, mechanism of common modes of slope failure, factors influencing stability of slopes, and planning of slope stability investigations.

#### **Geotechnical Information**

Geotechnical data required for highwall slope stability studies. Collection of Geological Data and their interpretation for stability studies of highwall slopes.

#### **Shear Strength**

Shear strength of intact rock, discontinuity surfaces, filled discontinuities and rock-mass - estimation and determination; Surface roughness, joint roughness coefficient – estimation and determination.

#### **Water Flow**

Concepts of water flow through a material and its permeability; water flow through rock-mass, water flow through soil type material and broken spoil material; Estimation and measurement of permeability and water pressure; Graphical solution of seepage problems (flow nets), seepage forces and seepage patterns under different conditions.

#### **Analysis and Design of Pit Slopes and Waste Dumps**

Slope stability assessment methods and techniques; Analysis and design criteria and methodology for highwall slopes and backfill and waste dumps; Probabilistic approaches of slope analysis and design.

#### **(iv) MARINE MINING (MEE 17104)**

**Introduction:** Overview of terrestrial mining operations; Marine environment; Origin of nodules.

**Exploration and characterisation:** Inland water, outer continental shelf and deep ocean.

Exploitation systems for dissolved, sea-bed and concealed mineral deposits.

**Economic and legal considerations in underwater mining.**

**Environmental impacts of ocean mining.**

#### **(v) DIMENSIONAL STONE MINING (MEE 17105)**

**Introduction:** Definition, historical use of natural stones.

**Geology and occurrences:** Classification of dimensional stones, composition, chemical and geo-chemical properties, various standards for normalization of dimensional stones.

**Mining of dimensional stones:** Various techniques of dimensional stone mining – block mining and slab mining; Manual mining; Mechanized mining – line drilling, in-situ sawing by wire saw, chain saw, portable circular saw, flame cutting.

**Cutting / Sawing tools:** Tool carrier – circular steel blade, steel wire rope, chain jib saw, physical and mechanical properties, elastic properties, tension etc.; Cutting tools – diamond segments, diamond pearls / bits, tungsten bits etc.; Process of manufacture, ingredients, brazing / fitting, wearing pattern and control; Cost of cutting.

**Handling of blocks and slabs:** Equipment used □ derrick crane, front loaders, fork-lifts, mobile cranes, trucks and trailers.

**Quarrying machines for dimensional stones:** Portable circular saw, wire saw, chain saw, line drills – special design features of the machines, techniques of use and maintenance.

**Production monitoring:** Recovery, waste generation, productivity, inherent defects, measurement and corrective actions, cost evaluation.

**Environmental issues:** Management of solid waste, slurry waste, soil land and water; Protection and rehabilitation.

**Health, safety and welfare:** Protective care from abrasive dust, personal safety and welfare.

**Application, processing and architecture in dimensional stone:** Application – flooring, roofing, cladding, stairs, paving, facets; Processing and polishing – various techniques for sawing of blocks, shaping of edges, polishing and calibration; Fixing and installation – techniques of fixing of dimensional stones in various applications like flooring, cladding, faceds, stairs, roofing and paving; Care and maintenance of dimensional stones – techniques for post fixing care and maintenance of dimensional stones in various applications.

## **(vi) NUMERICAL MODELLING IN GROUND CONTROL (MEE 17106)**

**Introduction:** Numerical Modelling techniques for rock mechanics and ground control, Excavation in rock and related rock mechanics problems, Need of numerical modeling in solving the ground control problem in mine design and underground space technology

**Review** of theory of Elasticity and failure criteria, Estimation of rock mass property for numerical modeling of excavations

**Finite element Method:** Potential Energy and Rayleigh-Ritz method, Finite element form of Rayleigh-Ritz method, Isoperimetric formulation of FE, Introduction to Non-linear solution method

**Finite Difference method:** Derivation of Finite difference Equations. Introduction to FDM implementation in FLAC

**Constitutive modeling** and their uses: Mohr's Coulomb Plasticity model for simulation of rock failure, Interfaces to simulate the bedding planes, Simulation of support in rock: bolts, props and lining.

**Boundary Element method**

## **VIII Semester**

### **MINE SYSTEM ENGINEERING (MEC 18101)**

<b>L</b>	<b>T</b>	<b>P</b>
<b>3</b>	<b>0</b>	<b>0</b>

#### **Introduction to systems engineering:**

Concept of system, sub-system and system environment; Classification of systems; Systems analysis; Creative aspects of planning and design; Factors influencing creativity, techniques and alternative ideas/solutions.

#### **Linear Programming: \_**

Linear Programming models; Assumption of linear programming, Graphical and Simple method of solving Linear Programming Problems; Basic and Basic feasible solution, optimal solution, interpretation of SIMPLEX table. Primal and Dual Problem. Application of Linear Programming for solution of mining related problems of production planning, scheduling and blending.

#### **Transportation and Assignment Problem:**

Transportation models, Variations on Classical Transportation models, Solution. Algorithm for Transportation problem. Assignment model, Variations on Classical Assignment model; solution algorithm for Assignment problems. Application to mining problems.

#### **Project Management with PERT & CPM:**

Assumption of PERT and CPM; Methods of drawing network; Redundancy and identification of redundant jobs; Critical path calculation, Criticality index; Statistics related to PERT; Probability of completing a project by a due date, Lowest cost schedule: Case studies.

#### **Network Models:**

Introduction and concept; shortest route and minimal spannial tree problems, application to mining problems.

#### **Simulation:**

Introduction and concept; Scope and limitation; System type versus simulation technique; Generating input data; Monte-Carlo simulation; Simulation of equipment maintenance and inventory systems in mines.

#### **Inventory management:**

Introduction, components and nature of inventory problems,; Classical E.O.Q model; EOQ model with quantity discount; Static and dynamic inventory problems.



L	T	P
3	1	0

**Underground Coal Mining (Section – A) (2 -0 -0)**

**Mining of thick seams:** Concept of a thick seam; Problems of mining thick seams; Past experience of working thick seams by Bord & Pillar method in multi-sections; Longwall based multi-slice methods:- Inclined slicing, horizontal slicing and cross-slicing in ascending and descending sequence; Under winning methods:- sub-level caving, integral caving, blasting gallery method, descending shield method.

**Hydraulic Mining of Coal:** Conditions suitable for hydraulic Mining of Coal, Hydraulic Mining Operation, Hydraulic breaking of coal, hydraulic transport and hydro hoisting; Layout of workings for hydraulic mining of moderately thick seams.

**Mining of thin seams:** Problems in Mining thin seams; Equipment and methods for thin seam extraction.

**Underground Coal Gasification:** Conditions suitable for Underground Coal Gasification; Basic principle and technology of underground coal gasification, Advantage and disadvantage of UCG: Scope of application of UCG in Indian conditions.

**Highwall Mining:** Introduction, Applicability and Method

**Underground Metal Mining (Section – B) (1 -1 -0)**

**Introduction:** Current status of recent developments in underground metal mining methods in India and abroad.

**Mine Sampling:** Definition, purpose and scope, Preparation of samples, methods and computations; Application of statistical methods in sampling

**Caving methods:** Top slicing, sub-level caving and block caving methods; Stope layouts, stope preparation and production operations; Design and construction of draw points; Mechanics of draw and draw control procedure; Recovery and dilution.

**Combined systems:** Combined open-room, shrinkage, and cut-and-fill systems; Combined systems with subsequent filling of rooms.

**Deep mining:** Problems of deep mining and the remedial measures; Design and layout of stopes in rockburst prone mines.

**Special methods:** Hydraulic, thermal, hydrochemical and biochemical methods; Nuclear device mining system – scope of application for mining of deep seated low grade mineral deposits; Underwater/sea-bed mining – current status; Different methods of winning manganese nodules from the ocean-floor.

Recent developments in underground metal mining.

## MINE LEGISLATION AND SAFETY - II (MEC 18103)

L	T	P
3	0	-

### Mine Legislation

The Mine Rules, 1955; The Mines Rescue Rules, 1985; Provisions of Electricity Rules, 1961 relevant to Mining.

Salient provisions of the Mines and Minerals (Development & Regulation) Act, 1957, Mineral Concession Rules, 1960, and Mineral conservation and Development Rules.

### Mine Safety

Investigations into mine accidents and accident reports;

Mine Emergency Management System;

## INDUSTRIAL MANAGEMENT (S) (MSC 18151)

L	T	P
3	0	0

Introduction to management evolution of management theory and practice; Designing operations – basic concepts of goods and services; competitive advantage concepts; basic concepts of operations strategy; forecasting - basic forecasting concepts and its importance , moving average; exponential smoothing, regression concepts; quality – basic concepts of quality management, different quality standards, different tools of TQM; plant location – methods of evaluating location alternative; inventory management – importance the inventory in the system, ABC analysis, EOQ models supply chain management – supply chain strategies, managing supply chain; JIT Lean concepts.

## ELECTIVE (ANY ONE)

L	T	P
3	0	-

### (i) INNOVATIVE MINING SYSTEMS (MEE18101)

**Technological innovations:** Technology, invention, innovation, research and development – basic types, technology life cycle.

**System concepts:** System concepts for innovative mining, methods for stimulating creativity in an organisation and current technological needs; Basics of system dynamics, value engineering and just in time (JIT) – possible applications.

**Innovations in mining operations:** Innovations in unit operations in surface and underground mining including high speed shaft sinking method; Developments in hard rock mining; New developments in longwall mining and Developments in mine ventilation systems.

**New frontiers of mining:** Mining in deep sea, outer space and Antarctica; Oil mining; Extraction of coal bed methane.

Remote monitoring of longwall support performance using telemonitoring device.

**Automation and robotic:** Development of robotic systems, different types and possible contributions.

### **(ii) MAP PROJECTIONS & GIS (MEE18102)**

*Map Projections:* Concept of map projections; classification of map projections; conical, polyconic, conformal, Cassini, mercator and universal traverse mercator projections (UTM), scale factors, calculations on projections, state plane coordinates (national grid), coal grid for mining areas, transformation of coordinates.

*GIS:* Concepts and terminology, essential components, data acquisition, raster and vector data, topology and spatial relationships, data storage verification and editing, database construction, database structure, hierarchical data, network systems, relational database, data manipulation and analysis. Spatial and mathematical operations in GIS, overlay, query based, buffers, spatial analysis, various GIS packages and their salient features.

### **(iii) MINE SAFETY ENGINEERING (MEE17103)**

**Introduction:** Safety management systems in Indian mining industry; Need for Mine safety; Mine safety statistics.

**Risk Management:** Risk Management related terms and definitions; Basic concept of risk; Difference between hazards and risks; Risk components and types, Risk management objectives, Risk management process; Risk analysis objectives in hazardous system life cycle; Functions of a risk manager; Hazards Identification and Risk Assessment (HIRA).

**Risk Analysis Methods:** Hazard and Operative (HAZOP) Analysis; Failure Mode and Effect Analysis (FMEA); Failure Mode Effect and Critical Analysis (FMECA); Job Safety Analysis (JSA); Preliminary Hazard Analysis (PHA); Appraisal of advanced techniques – fault tree analysis.

**Mine Accident Analysis:** In-depth study of accidents due to various causes; and Human Behavioral Approach in mine safety.

**Safety audits and control:** Safety audit methods; Training of Miners.

Recent trends of development of safety engineering approaches.

### **(iv) COAL BED METHANE (MEE18104)**

Coalification process and coal grades.

Methane generation and storage in coal; Geological control in Coal Bed Methane (CBM) exploration; Methane adsorption, desorption in coal.

Coal as CBM reservoir: In-place methane estimation; Transport of methane in coal-bed.

Drilling & Completion of a CBM hole/well.

Identification and characterization of coal beds by hole/well logs.

Hydraulic fracturing in coal beds.

Production performance of a CBM hole/well; Water drainage & gas-water separation.

Gas volume measurement.

Compression & transport; Liquefaction and utilization.

Enhanced recovery by CO<sub>2</sub> and N<sub>2</sub> adsorption methods.

#### **(v) UNDERGROUND SPACE TECHNOLOGY (MEE18105)**

**Introduction:** Natural caves, archeological caves and their construction; Tunnels for various purposes like road, rail, and hydropower tunnels.

**Need for underground space:** Congestion in cities and its impact on development of social infrastructure for transport, water and power supply, separation of pedestrian and motorized vehicles and its movements, storage of materials, defence facilities including civil shelters.

**Engineering utilities:** Hydropower tunnels and caverns; Underground storage for LPG and crude oil.

**Geo-engineering investigations:** Topographic and geological survey, auguring, drilling, soil and rock sampling, and testing; Preparing sub-surface geological cross section; Geo-radar use and data analysis for shallow tunnels; Geophysical investigations to prove deeper sub-surface features; Physico-mechanical properties and collection of rock mechanical data.

**Planning and design:** Assessment of behaviour of tunnelling media, deformation modulus and rock pressure assessment; determination of appropriate size and shape; Design of openings in rocks with the help of field data; Instrumentation and monitoring; Numerical modelling to assess the stability.

**Support design and stabilization techniques for underground tunnels and caverns:** Steel supports, rock bolts, shotcrete, wire mesh, chainlink fabric and fibre reinforced shotcrete and other ground consolidation/grouting techniques.

**Other storage:** Grain storage, their advantages, disadvantages, underground cold storage and cellar for foods and beverages.

**Nuclear waste disposal:** Conditions for waste disposal, effect of radioactivity and heat on surrounding rocks; Conceptual design of a nuclear waste disposal facility.

**Modern developments:** Underground ring roads/bypasses in mega cities, metro, parking lots, shopping centres; Submerged and floating tunnels, underground libraries, museums, dwelling units, and resorts.

## (vi) MINERAL ECONOMICS (MEE18106)

**General:** Economic importance of the mineral industry; Risky nature of the mining industry; Demand and Supply analysis, National mineral policy;

**Mineral price and pricing:** International monetary system, Factors affecting mineral price, kinds of price quotation, Mineral price index, Mineral prices

**Mineral Resource/Reserve:** Concept, classification and estimation of reserves. Applications of Geostatistics.

**Mineral inventory:** concept, characteristic features, composition and economic significance; Estimation of life index.

**Demand analysis and Market survey:** Meaning and law of demand; methodology of demand analysis, Market survey

**Conservation of mineral resources** – Means of conservation and limitations in the scope of Conservation

**Mine Sampling:** Definition, purpose and scope, Preparation of samples, methods and computations; Application of statistical methods in sampling

**Loss of mineral in mining** - Classification and incorporation of losses, co-efficient of completeness of mineral extraction, Dilution and recovery

**Examination of mineral properties:** Definition, purpose, type and scope of examination

**Mine valuation:** Basic concept, Earlier approaches to mine valuation, recent approaches to evaluation

**Investment Appraisal:** Elements of investment appraisal, Static methods of investment appraisal, Dynamic methods of appraisal, discounted cash flow analysis

**Mining costs:** Capital and operating costs; Factors affecting operating cost; Methods of estimating future costs; Standard cost and forecast; Budget and budgetary control.

**Mine finance:** Capital – its importance, various forms and formation; mine accountancy and book keeping

**Mineral Taxation System:** Theory of taxation on minerals, Mineral tax designing, Types of mineral taxes, Taxes affecting mineral sector

**Internal and External Trade:** Taxes and duties; Imports and exports; International investment and trade in mineral materials & products.

**Mineral information system:** Data-information-informatics-data base, Mineral information system in India and problems, Mineral information system in outside India