MN 3.1 ENGINEERING MATHEMATICS III

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 3.1	Engineering Mathematics - III	3	1	--	3	100	25	--	--	--	**125**

Course Objective:

1. To get the mathematical knowledge and skills necessary to support the concurrent and subsequent engineering studies.
2. Formulating problems.
3. Solving problems analytically.

Course Outcomes:

The student after undergoing this course will be able to:

1. Handle linear systems using matrices.
2. Express a periodic function as a Fourier series in terms of sine and cosine functions.
3. Use tools like Laplace transforms and Fourier transforms in formulating and solving Engineering problems.
4. Model and solve partial differential equations corresponding to vibration and Radiation phenomena.

UNIT - 1 (13 Hours)

Matrices: types, determinant, inverse, elementary transformations, rank, reduction to normal, canonical forms, linear independence of vectors, system of the form A.X=O and A.X=B and their solutions, Eigen values and vectors, Cayley-Hamilton theorem with applications, minimal polynomial and diagonalization.

UNIT - 2 (13 Hours)

Fourier Series: periodic function, trigonometric series, Euler‟s formulae, Drichlet‟s condition,Even and odd functions, half range series, Parseval‟s identity.

Fourier Transformations: Fourier transform, inverse Fourier transforms, applications, convolution theorem.

UNIT - 3 (12 Hours)

Laplace Transforms: definition, existence conditions, properties, inverse Laplace transforms, transform of periodic functions and Dirac-Delta function, convolution theorem, applications insolving linear differential equations with initial conditions and system of linear simultaneousequations.

UNIT - 4 (10 Hours)

Partial Differential Equations: classification, solution by method of separation of variables.

Wave Equation: derivation and solution of one-dimensional wave equation using separation variables method.

Heat Equation: derivation and solution of one-and two dimensional using separation variablesmethod.

Recommended Readings:

1. B. S. Grewal; Higher Engineering Mathematics; Khanna Publications, New Delhi.
2. Veerarajan; Engineering Mathematics; Tata-McGraw Hill publications, New Delhi.
3. Erwin Kreyzig; Advanced Engineering Mathematics; New International Pub Ltd
4. P. Kandasamy; Engineering Mathematics; Chand & Co. New Delhi.
5. R. M. Baphana; Applied mathematics III; Technova Publication.

MN 3.2 ELECTRICAL DRIVES AND DIGITAL ELECTRONICS

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 3.2	Electrical Drives and Digital Electronics	3	1	2	3	100	25	--	25	--	**150**

Course Objective:

1. Understand the Electrical drives which are the prime movers for mining machinery
2. Study of digital electronic circuit.
3. Concepts of electrical drives with associated controls.

Course Outcomes:

The student after undergoing this course will be able to:

1. Equip with basic knowledge on electrical motors.
2. Use instruments for electrical measurements.
3. Understand an electronic circuit in Mining Machinery.

UNIT - 1 (14 Hours)

D.C. Motors: Principles of electromechanical energy conversion. DC machine: construction, EMFequation. D. C motors: principles, torque equations, motor characteristics, speed control, starting. Three phase induction motor- principle, construction, slip, torque-slip characteristics, starting, speed control.

UNIT - 2 (10 Hours)

Single Phase Induction Motor: Principle operation of split phase type, capacity start motors, stepper motors-types, principle; Synchros -construction, principle and applications; servo-motorsDC, 2-phase AC; drives concept, classification, characteristics and braking of DC motors.

UNIT - 3 (10 Hours)

Instruments: Working principle, construction, torque equations of the following analog instruments: (a) PMMC (b) Moving iron (c) Electrodynamometer types, Shunts and

multipliers for PMMC type instruments and extension of range. Electrodynamometer, Wattmeter - construction, torque equation. Induction type Energy meter - construction, torque equation. Measurement of power and energy.

UNIT - 4 (14 Hours)

Study of Logic Circuits: NOT, AND, OR, NAND, NOR, XOR and XNOR gates with schematic symbol and truth table.

Study of Boolean Algebra: Laws, rules, and theorems, of Boolean algebra, sum of products (SOP)form, product of sum form (POS), of Boolean functions, study of K-maps restricted 4 variables only.

Combinational Logic: analysis of half adder, full adder, encoders and decoders.

Recommended Reading:

1. Malvino & Leach; Introduction to micro processors; Tata McGraw Hill Pub., New Delhi
2. Morris Mano; Digital Logic & Computer design; Prentice Hall of India, New Delhi
3. B. L. Theraja; A text Book of Electrical Technology; S. Chand Pub.
4. Millman & Halkias; Integrated electronics; Tata McGraw Hill Pub, New Delhi
5. A. K. Sawhney; A course in electrical and electronic measurement and instrumentation; Dhanpat Rai & Sons, New Delhi.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. Speed control of DC shunt / compound motor.
2. Ward Leonard method of speed control of DC motors
3. Study of 3-point starter
4. To find out various parameters of induction motors by direct load test
5. Study of DOL and star delta starter.
6. Measurement of power by two wattmeter methods
7. Measurement of energy by 1-Ø energy meter
8. Performance of Logic Gates
9. Boolean Equation
10. Reduction using Boolean Algebra

MN 3.3 MECHANICS OF SOLIDS

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
					Th. Duration (Hrs)	Marks					
		L	T	P		TH	S	TW	P	O	Total
MN 3.3	Mechanics of Solids	3	--	2	3	100	25	--	--	25	**150**

Course Objective:

1. To know variety of stresses, strain and deformation due to external loads.
2. To perform Two Dimensional Stress and Strain Analysis.
3. To study the behavioral pattern of beams, struts, columns, cylinders etc.
4. To study various failure theories and energy methods.

Course Outcomes:

The student after undergoing this course will be able to:

1. Learn fundamental concepts of Stress, Strain and deformation of solids and understand the applications of the strength of Materials approach to analyze simple structural elements, subjected to direct tension/compression/ shear loading, bending and torsion.
2. Understand the stress analyses for systems subjected to combined loading using different theories of failure.
3. Utilize the principles of deflection in beams.
4. Understand and use the principles of Energy Methods and its applications in structural solutions.
5. Understand and practice the concepts involved in structural stability.

UNIT - 1 (12 Hours)

Stress, Strain and Deformation of Bodies: Rigid bodies and deformable solids-tension, compression, and shear stresses, deformation of simple and compound bars, thermal stresses, elastic constants, volumetric strains, thin cylinders and shells, deformation of thin cylinders and shells, stresses on inclined planes, principal stresses and principal planes, Mohr circle of stress

UNIT - 2 (12 Hours)

Loading and Stresses on Beams: Types of loading, shear force and bending moment, cantilevers, simply supported beams and over-hanging beams. Theory of simple bending,

bending stress distribution, load carrying capacity, proportioning of sections, leaf springs, fletched beams, shear stress distribution

UNIT - 3 (12 Hours)

Torsion: Torsion of circular shafts, close and open springs Struts and Columns: Struts and core of section, stability of columns, Euler‟s critical load fordifferent end conditions of column, empirical formulae for buckling loadMembers subjected to combined load: Shafts subjected to bending moment and twisting moment,members subjected to bending and directed tension/compression.

UNIT - 4 (12 Hours)

Energy Principles: Strain energy under different loading conditions, Maxwell‟s theorem,Catigliono‟s theorems, deflection of structures using virtual load method Theories of failures: Various theories of failures and their limitations, comparisons and applications

Recommended Reading:

1. S. Ramamrutham; Strength of Materials; Dhanpat Rai Publishing Co. (P) Ltd.
2. S. Sreenath; Strength of Materials; Tata McGraw-Hill Education.
3. Beer Ferdinand, Johnson E. Russel; Mechanics of Materials, Mc Graw Hill Books.
4. S. P. Timoshenko, D. H. Young; Elements of Strength of Materials, East West
5. S. S. Bhavikatti; Strength of Materials; Vikas Publishing House Pvt Ltd,
6. R. C. Hibeller; Mechanics of materials; Pearson Press, India

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. Tension Test on Steel bars.
2. Compression Test on Concrete Cubes /Bricks/Stone etc.
3. Shear Test on Steel bar.
4. Flexure Test on Timber/ Tile.
5. Charpy Impact Test.
6. Hardness Tests.
7. Spring Test.
8. Verification of Maxwell's Theorem,
9. Verification of Principle of Superposition.
10. Torsion Test.

MN 3.4 ELEMENTS OF MINING ENGINEERING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 3.4	Elements of Mining Engineering	3	1	--	3	100	25	--	--	--	**125**

Course Objective:

1. Introduction to mining industry and mineral potential.
2. Understand the Mining Terminologies.
3. Basic principles of extraction and mining methods.
4. Operations including Drilling and blasting in rock excavation and protection from collapse.

Course Outcomes:

The student after undergoing this course will be able to:

1. Enable students to demonstrate the importance of mining in national economy.
2. Understand the terminology associated with the discipline.
3. Be familiar with the available regulatory mechanism to enable safe and sustainable mining operations.
4. Equips the students with detail knowledge on various engineering techniques used for drilling, blasting, roof support and allied activities in mine construction for exploitation of minerals.

UNIT - 1 (12 Hours)

The Mining Industry: Mining as basic industry for raw material for other industries. Different stages in mining. Unit operations. Classification of mines. Indian mineral industry – status, organisations, activities. Introduction to National Mineral Policy.

Mineral Wealth: Availability of minerals in India and worldwide. Mineral Trade. World bodies/cartels in mineral trade. Concepts of exploration and prospecting. Mineral reserves as a function of technological growth. Foreign collaboration and Foreign Direct Investment in Mining. Indian efforts for exploration abroad. Status with respect to sea bed mining.

Mining Terminology: Mining, Mine, Mineral, Rock, Ore, Ore body, Mineral deposit, Countryrock, Hangwall, Footwall, Overburden, Seam, Vein, Lode, Dip, Strike, Outcrop, Grade of ore, Tenure, Development, Adit, Shaft, Incline, Tunnel, Drift, Crosscut, Level, Raise, Winze, Sump, Stoping/Depillaring, Stope, Goaf, Caving, Subsidence, Stowing.

UNIT - 2 (12 Hours)

Drilling for Blasting: Types and principles of drilling. Principles of operation of Coal drill, Jack hammer, Wagon drill, Down the hole drill, Drill rigs. Drilling pattern in opencast mines. Drilling pattern for underground drives. Types of drill bits.

Explosives and Accessories: Basic composition of explosives. General classification and classification as per Indian Explosive Act. Properties of Common explosives. Permitted Explosives. Bulk explosives. Composition and construction of initiators such as Safety fuse, Plain Detonator, Electric Detonators, Detonating Fuse, Delay Detonators and Detonating Relay. Blastingtools. Regulations on storage and use of explosives. Explosive Magazines. Disposal of explosives.

UNIT - 3 (12 Hours)

Blasting: Theory of blasting. Charging of blast holes, stemming, decking. Direct and Inverse initiation. Delay Blasting. Firing sequence in opencast benches. Pulsed infusion shotfiring. Solid blasting in coal mines. Ring hole blasting. Various controlled blasting techniques. Calculation of explosive requirement and powder factor. Concept of spherical charge. Crater blasting. Need of ubgrade drilling. Secondary blasting. Safety aspects in blasting with respect to flying fragments, danger zone, misfires, blown out and blown through shots. Concept of under-water blasting. Latest developments in blasting. Mine regulations on blasting.

UNIT - 4 (12 Hours)

Roof Supports: Concept of Pressure Arch Theory. Yielding and non-yielding supports. Description of different types of supports. Fore poling in loose rocks. Roof testing. Prop setting. Support of roadway junctions. Support of roadways with excess height. Side lagging. Hydraulic and FrictionProps. Prop withdrawal. Mining legislation on supports.

Recommended Reading:

1. D. J. Deshmukh, Elements of Mining Technology-Vol I, Central Techno Publications, Nagpur, 7th Ed, 2001.
2. H. L. Hartman, Introductory Mining Engineering, John Wiley, New York, 1987.

3. G. K. Pradhan, Explosive and Blasting Technology, Mintech Publications, Bhubaneshwar.
4. Shevyakov, Mining of Mineral Deposits, Foreign Language Publishing House, Moscow.
5. S. Krishnaswamy, India‟s Mineral Resources, Oxford & IBH Pub. Co., New Delhi.

MN 3.5 MACHINE DRAWING AND CAD

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
					Th. Duration (Hrs)	Marks					
		L	T	P		TH	S	TW	P	O	Total
MN 3.5	Machine Drawing and CAD	1	1	3	4	100	25	25	--	--	**150**

Course Objective:

1. To visualize mechanical component and convert it into a drawing.
2. To gain knowledge in two dimensional drafting.
3. To understand conventional symbols used in machining and mechanical details as per IS.
4. To assemble and disassemble the mechanical parts.

Course Outcomes:

The student after undergoing this course will be able to:

1. Visualize and draw intersections of various solids.
2. Understand and draw various types of joints and power transmitting joints.
3. Explain concepts and applications of limits, fits and tolerances.
4. Draw assembly and part drawings of various mechanical components.

UNIT - 1 (8 Hours)

Assembly Drawing: Assembly of machine parts. Preparation of assembly drawing of simple machine parts such as couplings; joints, engine parts, etc., Drawing of parts and subassembly from assembly drawing. Limits, fits and tolerances for design and drawing of components and assemblies. Introduction to computer graphics, Graphic display devices.

UNIT - 2 (8 Hours)

Computer-Aided Drawing: Familiarising with the menu. Absolute, relative and polar co-ordinate system. Drawing basic objects: point, line, circle, arc, ellipse, polygon, rectangle, multi line, doughnut.Drawing with precision: drawing construction lines and rays, calculating areas, calculating distance and angle, use of measure, divide, inquiry command.

UNIT - 3 (8 Hours)

Section Drawings: Convention for sectioning of machine components in computer graphics, Section of simple machine components. Use of interactive menu-driven software for preparation of line drawing; graphic coordinate system; interactive computer graphic draw erase, move, rotate, mirror and hatch; introduction to mathematical concept for line, circle and curve drawing; Scan conversion, real time scan conversion, Run length encoding, Character display, Window clipping, Geometric transformations, Visible line and visible surfaces.

UNIT - 4 (8 Hours)

Disassemble Drawings with Bill of Materials: Drill jig, Connecting rod, Crane hook, Tailstock of milling machine, Hydraulic control valves etc.

Recommended Reading:

1. N. Siddheshwar, P. Kannaiah and V V S Sastry, Machine Drawing, Tata-McGraw Hill.
2. K.C. John, A text book of Machine Drawing, PHI Learning Pvt. Ltd., New Delhi
3. N. D. Bhat, Machine Drawing, Charotar Publishing Company
4. IS Code SP 46 -1988
5. P. S. Gill, Machine Drawing, SK Kataria & Sons, New Delhi
6. K. L. Narayana, P. Kannaiah and K. Venkata Reddy, Machine Drawing, New Age International Publishers
7. K. R. Gopalkrishna, Machine Drawing, Subhash Publications

List of Experiments:

(The term work marks to be awarded based on the assessment of assignments conducted)

1. At least, TWO sheets on assembly and TWO sheets on disassembly should be done on drawing sheets during the practical sessions.
2. At least THREE sheets on assembly and THREE sheets on disassembly should be done using the standard drafting software (Auto CAD).
3. Sketch book should comprise of free hand sketches of Joints and Power Transmission Units.

MN 3.6 MINING GEOLOGY - I

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 3.6	Mining Geology - I	3	1	2	3	100	25	--	25	--	**150**

Course Objective:

1. To get Basic Knowledge and skills in various aspects of geology.
2. Study of rocks and minerals and geological structures.
3. Mapping the geological features in an area

Course Outcomes:

The student after undergoing this course will be able to:

1. Understad various terminologies in geology.
2. Identify rocks and minerals by verifying the physical properties.
3. Understand the structure of earth and ore formations.

UNIT - 1 (12 Hours)

Physical Geology: Role of Geology in Mining Engineering- scope and applications. Internal structure and composition of the earth. Introduction to plate tectonics and types of plates. Earth process- weathering, grades, drainage patterns and geomorphic features. Role of running water, wind, glaciers. Ground water- origin, occurrence. Earthquakes and volcanoes (Engineering importance only). Mountains, planes and plateaus in shaping the earth.

UNIT - 2 (12 Hours)

Mineralogy: Mineralogy of industrially important metallic and non-metallic minerals. Theories of ore formation including secondary enrichment processes. An outline of ore microscopy. Physical properties of minerals- study of Quartz, Feldspar, Mica, Pyroxenes, Amphiboles, olivine and garnet groups. Preliminary treatment on strategic, critical and essential minerals. Elements of crystallography and mineralogy.

Petrology: Petrology of igneous, sedimentary and metamorphic rocks including formation, texture, structure, composition, description and classification. Deformation of rocks and

resulting structures, Physical properties of rocks including porosity, permeability and capillarity. An introductions to modern theories of tectonism.

UNIT - 3 (12 Hours)

Structural Geology: Structural features of rocks- true dip, apparent dip and strike. Study of Geological structures- definition and classification of faults, folds, identification procedure. Joint systems- types. Non-conformities and their types- recognition and engineering importance. Stereographic projections, and fracture analysis applied to mining operations. Geology of fuels. Importance of structures in oil accumulation. An outline of structural settings for ore deposits.

UNIT - 4 (12 Hours)

Stratigraphy: Principles of stratigraphy, geological time scale, fossils and their uses: major geological formations of peninsular India-geographical distribution, classification, Lithology and economic importance of Dharwar system, Cuddapah system, Vindhayan system, Gondwana system and Deccan trips. Stratigraphy of Goa, Study of regional geology: interpreting geological maps and plans, practical site investigation procedures, collection of structural (geological) data.

Recommended Reading:

1. Parbin Singh; Engineering and General Geology; S. K. Kataria & Sons Publ.; 2008
2. P. K. Mukherjee; A Text Book of Geology; World Press.
3. Chenhakesavulu; Text book of Engineering Geology; 2nd edition; Mcmillan Publishers, India; 2011.
4. Gokhale N.W: Manual of Geological maps, CBS Pub, New Delhi, 2000
5. K. M. Bangar; Principles of Engineering Geology; Standard Publ. Dist., 2013

List of Experiments:

At least 8 experiments should be conducted from the list of experiments.

1. Megascopic Identification and Description of Silicate Group of Minerals.
2. Megascopic Identification and Description of Non-Silicate Group of Minerals.
3. Megascopic Identification and Description of Ore Minerals.
4. Megascopic Identification and Description including the petrogenesis of Igneous Rocks
5. Megascopic Identification and Description including the petrogenesis of

Sedimentary Rocks

6. Megascopic Identification and Description including the petrogenesis of Metamorphic Rocks
7. Exercises on topographical maps for calculating the bearings, trends and understanding the scale.
8. Exercises on geological maps and drawing sections for horizontal and dipping series of beds intruded by vertical dykes.
9. Exercises on geological maps and drawing sections for dipping series traversed by vertical strike and dip faults.
10. Exercises on geological maps and drawing sections for folded series of beds.
11. Exercises on geological maps and drawing sections for two series of beds seperated by an unconformity.
12. Graphical solution of structural problems on strike, dip, thickness and width of outcrop of rock strata

MN 4.1 MINE DEVELOPMENT

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 4.1	Mine Development	3	1	--	3	100	25	--	--	--	**125**

Course Objective:

1. To study of the ore body and calculation of reserves.
2. To studey various methods to access to ore body.
3. To study various techniques for Mine development.

Course Outcomes:

The student after undergoing this course will be able to:

1. Use various exploration practices.
2. Plan for suitable type of mine openings for a given geological, topographical and mining conditions.

UNIT - 1 (12 Hours)

Exploration and Boring: Stages in exploration such as locating mineralised area, initial exploration, development exploration, exploitation exploration. Surface and Underground methods of exploration. Boring. Types of drill bits. Hole sizes. Diamond drilling: surface arrangements, feeding mechanism, core barrel, core box. Core sampling. Core recovery. Calyx drilling. Auger drilling. Wireline drilling. X-ray drilling. Continuous core rigs. Underground boring. Water loss in drilling.

Sampling and Reserve Estimation: Methods of sampling: stratified sampling and pattern sampling. Sample preparation for analysis. Coning and quartering. Methods of reserve estimation: area of influence, triangular, cross sectional, longitudinal section, block method and graphical methods. Cut-off grade. Average width. Computation of reserve. Mineable and workable reserves. Basic principles of reserve classification. United Nation Framework Classification.

UNIT - 2 (12 Hours)

Opening Up a Mineral Deposits: Selecting location of opencast entry. Box cut, trenches and bench formation. Sequence of development. Stripping ratio. Elements of opencast bench. Determining height and width of benches. Haul roads. Development of a seam deposit in opencast mining. Opening and development for massive ore body in opencast mining. Underground entry.

Applicability and Comparison of Entries. Selection of site. Shape and size of underground entries. Examples of opening up gently dipping ore body, inclined deposits, steeply inclined deposits and scattered deposits. Comparison of coal mining and metal mining. Development into panels/blocks. Factors determining panel/block size. Basic principles of coal mine/ metal mine development. Mine regulations on mine entries.

UNIT - 3 (12 Hours)

Shaft Sinking: Marking centre of shaft. Drilling and blasting in shaft sinking. Shaft centering arrangement. Dealing with water. Ventilation and lighting during shaft sinking. Special methods of shaft sinking: Caisson method, Piling method, Freezing method and Cementation method. Deepening and widening of shaft. Mine regulation on shaft.

UNIT - 4 (12 Hours)

Tunnelling: Selection of size and shape of drift, level and crosscut. Basic cyclic operations. Types of drilling, loading and hauling machines used in tunnelling. Drainage and ventilation. Temporary and permanent supports. Maintaining gradient and direction. Tunnel borers. Calculation of cycle time and rate of progress. Mine regulations on development headings.

Raising and Winzing: The unit operations. Methods of raising: two compartment method, Longhole method, Drop raising. Difficulties in raise drivage. Alimac Raise Climber. Raise borers. Supporting and ventilation of raises. Comparison of drilling, charging and blasting operations between raises and winzes. Specific problems in winzing. Safety regulations on inclined road ways.

Recommended Reading:

1. D. J. Deshmukh; Elements of Mining Technology; Vol. 1 & 2; Denett & Co.; 2010
2. R. N. P. Arogyaswamy; Courses in Mining Geology; Oxford & IBH Pub. Co., New Delhi.
3. R. T. Deshmukh; Mineral and Mine Economics;, Myra Publications, Nagpur, 1986
4. Howard L. Hartman, Jan M. Mutmansky; Introductory Mining Engineering; Wiley, 2002.

5. Indian Bureau of Mines; Comprehensive Guidelines on Prospecting Requirements, www.ibm.nic.in

MN 4.2 FLUID MECHANICS AND MACHINERY

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 4.2	Fluid Mechanics and Machinery	3	--	2	3	100	25	--	25	--	**150**

Course Objective:

1. To understand fluids, its properties and fluid statics.
2. To analyze Kinematics and Dynamics of fluid flow.
3. To understand the concept of buoyancy and viscous flow.
4. To study boundary layer concept.

Course Outcomes:

The student after undergoing this course will be able to:

1. Understand the basic concept of fluid flow and properties of fluids.
2. Understand the principles of fluid statics, kinematics and dynamics.
3. Analyze fluid flow problems with the application of the momentum and energy equations.
4. Understand concept of buoyancy, viscosity and importance of viscosity in real flows.
5. Perform dimensional analysis for problems in fluid mechanics.
6. Understand the concept of boundary layer formation.

UNIT - 1 (12 Hours)

Fluid: Definition. Types of fluids. Fluids as a continuum. Fluid properties such as Density, Specific gravity, Surface tension and capillarity. Vapour pressure. Viscosity and compressibility.Classification of fluids. Fluid statics. Absolute and gauge pressure of fluids. Measurement ofpressure. Fluid static force on immersed surfaces. Buoyant forces. Stability of floating andsubmerged bodies. Hydraulic press, cranes and lifts. Fluid kinetics. Methods of describing fluid motion. Lagrangian and Eulerian approaches. Types of motion. Rotational and irrotational flows. Vorticity and circulation. Velocity and acceleration. Local and convective acceleration. Potential flows. Velocity potential and stream function. Laplace equation. Uses and limitations of flownets. Methods of analysis of flownet.

UNIT - 2 (12 Hours)

Fluid Dynamics: Forces influencing fluid motion. Types of forces. Body and surface forces. Energy and Head. Equations of fluid dynamics. Euler equation and application. Integration of Euler equation to get Bernoullis‟ equation. Momentum equation. Fluids subjected to uniform horizontal and vertical acceleration. Vortex motion. Free and forced vortex. Application of Bernoullis‟ equation in measurement of flows. Stagnation pressure. Pitot tube, Prandtl tube, venturi meter, and orifice plate. Flow nozzles, orifices, mouthpieces, notches and weirs.

UNIT - 3 (12 Hours)

Pipe Flow: Transition from laminar flow to turbulent flow. Problems in pipe flow. Losses in pipe flow. Major and minor losses. Losses in transition. Losses in fittings and valves. Friction loss in pipe. Coefficient of friction. Commercial pipes in use. Different arrangements of pipes. Pipes open to atmosphere. Pipe connecting reservoirs. Branching pipes. Pipes in parallel and series. Equivalent lengths. Syphons. Pipe net work. Laminar flow in pipes.

UNIT - 4 (12 Hours)

Reciprocating Pump: Construction and Principle of working, indicator diagram, Effect of acceleration and friction of liquids in suction and delivery pipes. Application of air vessels and their advantages. Coefficient of Discharge and slip of reciprocating pump.

Centrifugal Pump: Priming of pumps. Minimum starting speed. Multistage pumps. Pumps in series and parallel. Performance characteristic. Losses and efficiency of Centrifugal Pump. Operational Difficulties in Centrifugal Pump. NPSH: Mechanism of Cavitations. Working of Hydraulic Crane, Air Lift Pump, Hydraulic Ram, Hydraulic Lift and Jet pump.

Recommended Readings:

1. R. K. Bansal; A textbook of Fluid Mechanics & Hydraulic machines; Laxmi Publications (p) Ltd; 2012.
2. R. W. Fox, P. J. Pritchard, A. T. McDonald; Introduction to Fluid Mechanics; Wiley India; 7/e.
3. P. N. Modi, S. M. Seth; Hydraulics & Fluid Mechanics including Hydraulic Machines; Standard Book House, New Delhi; 2009.
4. Y. A. Cengel, J. M. Cimbala; Fluid Mechanics: Fundamentals & Applications; TMH, New Delhi; 2/e.
5. D. S. Kumar; Fluid Mechanics & Fluid Power Engineering; S. K. Kataria & sons, New Delhi; 2008.

List of Experiments:

At least 8 experiments should be conducted from the list of experiments.

1. Verification of Bernoulli‟s theorem.
2. Calibration of a Venturimeter.
3. Calibration of a orificemeter
4. Calibration V-notch
5. Calibration of rectangular notch
6. Friction in pipes-Determination of coefficient of friction for a G.I. pipe
7. Frictional loss in pipe due to bend and nozzle
8. Reynold‟s Experiment: Demonstration of Laminar and turbulent flow.
9. Visit to industry to study various hydraulic machinery used.

MN 4.3 MINING GEOLOGY - II

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 4.3	Mining Geology–II	3	2	--	3	100	25	25	--	--	**150**

Course Objective:

1. To study prospecting and exploration techniques ans classification and estimation of ore reserves.
2. Study of geological, geophysical and geochemical exploration techniques.
3. Study drilling methods, accessories for drilling and core logging.
4. To study Geological conditions favourable for formation of ores and occurrence and localisation of economic mineral deposits.

Course Outcomes:

The student after undergoing this course will be able to:

1. Understand and apply prospecting and exploration techniques and to estimate the ore reserves.
2. Understand and apply a combination of exploration techniques suitable for probable ore deposit
3. Understand the selection of drilling method for a deposit.
4. Have a broad overview of various mineral deposits located in different parts of India.

UNIT - 1 (12 Hours)

Introduction: Different methods, scope and limitation of prospecting. Reconnaisance Survey. Alluvial sampling, Pit sampling, Procedures for obtaining Prospecting Licence. Main features of Mineral Concession Rules.

Ore Reserve Classification: Classification of reserves. Understanding the terms Resourse Potential, Resource Base, Resources, Reserves, Grade, Tenor and Specification. Geological consideration and Techno-economic considerations for classification. Prospective (hypothetical) and Prognostic (speculative) Resources as per IS-12595. The three dimensional approach of United Nations Framework Classification. The codes and

extended codes in UNFC. Advantages of UNFC. Impact of UNFC on Indian iron ore inventory. The main provisions of Mineral Conservation and Development Rules.

Ore Reserve Estimation: Basic principles of ore reserve calculation, Triangular and polygon methods, Average factor and area method, Mining block method, Cross section method, Average grade and arithmetic average, Cut off grade calculation, Accuracy of sampling.

UNIT - 2 (12 Hours)

Mineral Exploration Procedures: Theories of ore formation, Stages in mineral exploration, Various exploration methods. Guides to Ore, Regional Guides, Geochemical Guides, Groundwater as a Guide, Geo-botanical and Biochemical Guides, Physiographic Guides, Mineralogical Guides, Rock Alteration, Stratigraphic and Lithologic Guides, Fracture Patterns as Guides, Contacts and Folds as Guides, Dislocated Ore Bodies, Ore Bodies Displaced by Intrusives, Coal and Oil Shale. Remote sensing. Satellite imaging. Sterioscope. Geological mapping.

Exploration Geophysics: Methods and application, Airborne versus Ground Surveys, magnetometer survey, Gravity Methods, Electrical, seismic and radiometric methods, Limitations in Mining Geophysics.

Geochemical Exploration: Geochemical cycle. Distribution of elements during magmatic, sedimentary and metamorphic process. Principles, methods and and equipments for trace element analysis. Interpretation of geochemical data.

UNIT - 3 (12 Hours)

Exploratory Drilling: Types of drilling, Diamond drilling. Hole diameters. Wireline drilling. Reamer shells and TC bits. Core barrel and casing. Fishing tools. Types of drilling fluids. Sludge collection methods. Deep drilling practice. Drill hole pattern, Drill hole spacing, Bore hole deviation and its correction. Drill hole data logging. Sludge sampling,

Oil Well Drilling: Types of wells. Modern drilling techniques. Off shore drilling. Use of blowout prevention. Casing programme and design.

UNIT - 4 (12 Hours)

Economic Geology: Ore, gangue, tenor, assay and grade of ore, classification of mineral deposits; ore forming processes-magmatic, hydrothermal, oxidization and supergene enrichment, residual concentration, mechanical concentration and sedimentation Principles of hydrology including transmission of ground water in rock and soils, applied to surface and underground mining operations.

Economic Indian Mineral Deposits: Origin, mode of occurrence and distribution of following metallic minerals- iron ores, manganese, copper, Chromite, bauxite, lead and zinc; non metallic deposits-asbestos, mica, Gemstones, kyanite, barite, Magnesite, graphite, kaolin, garnet and feldspars. Petroleum deposits: origin and occurrences. Resources in India and worldwide.

Recommended Reading:

1. R. N. P. Arogyaswamy; Courses in mining geology; Oxford & IBH Co., New Delhi; 1994.
2. Umeshwar Prasad, Economic geology, 2nd edition CBS pub New Delhi; 2000.
3. K.V.G.K Gokhale and T.C Rao; Economic Mineral Ore Deposits of India, Thompson Press.
4. H. L. Hartman, Jan M. Mutmansky; Introductory Mining Engineering; John Wiley & Sons; 2002.
5. Charles J. Moon, Michael K.G. Whateley & Anthony M. Evans (Ed); Introduction to Mineral Exploration. Blackwell Publ; 2006.

Term Work

(The term work marks to be awarded based on the assessment of assignment conducted)

1. Detailed study report on three field visits conducted to study mineralogy, petrology, structural geology and weathering effects.

MN 4.4 SURVEYING - I

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 4.4	Surveying – I	3	1	2	3	100	25	--	25	--	**150**

Course Objective:

1. Understand the importance of surveing in Mining Industry.
2. Understand basic surveying teminologies and Methods.
3. Getting familiar with surveying eqiupment and taking measurements.
4. Learn to prepare the survey plans.
5. Understand the progress in excavation from the survey plans.

Course Outcomes:

The student after undergoing this course will be able to:

1. Use surveying eqiupment and taking measurements.
2. Interpretation and data extaraction from survey plans.
3. Prepare the survey plans.

UNIT - 1 (12 Hours)

Introduction: Basic definitions, objectives, divisions and Importance of Surveying to Engineers; Classification and Principles of Surveying, Overview of Land Surveying; Surveying measurements and errors.

Basic Surveying Instruments: Tape and Compass, Principle of reversal, EDM and accessoriesBasic Principle, Errors, Precautions and Problems.

Level: Different types and various parts, Working Principle, Temporary and Permanent adjustments, Sensitivity of level Tube, Errors and mistakes, Levelling Staff.

Theodolite: Different types and various parts -Basic terms, Fundamental lines, Temporary and Permanent adjustments, Errors and mistakes in Theodolite.

Measurement of Distance: Basic definitions, Methods, Ranging; Errors-types, Corrections and Precautions; Field problems and their solutions.

UNIT - 2 (12 Hours)

Measurement of Angles and Direction: Basic Definitions- meridians, declination-variations, local attraction, Prismatic and Surveyors Compass: Whole circle and reduced bearings. Traversing withchain and compass. Methods; Methods of repetition and reiteration; Errors and mistakes, Corrections and Accuracy.

Plane Table Surveying: Instruments, Plane table and its accessories Telescopic alidade Basic definitions, Advantages and disadvantages; Setting of instruments, Orientation, methods, Two and Three- point problem, Accuracy in plane table survey, Errors, Precautions, Plotting of details including contours

UNIT - 3 (12 Hours)

Determination of Elevation: Basic Definitions, Dumpy level and tilting level, Curvature and Refraction, Methods; Reductions of levels. Differential levelling and field book note, Reciprocal Levelling; Profile levelling, Longitudinal and cross sectioning Trigonometric Levelling: Introduction, Errors and Mistakes in levelling, Error Propagation; heights and distance with base of the object accessible, base of object inaccessible, with instrument stations in the same vertical plane as the elevated object and instrument station not in the same vertical plane as the elevated object.

UNIT - 4 (12 Hours)

Contouring: Contouring: Introduction, Contour interval, methods of contouring, interpolation of contours, Uses of contour maps.

Minor Instruments and Measurement of Areas and Volumes: Use of planimeter, Clinometers, box sextant, line ranger, optical prism, and Abney level. Measurement of area and volume by Trapezoidal and Simpson's rule.

Transit Theodolite : Parts and optics of transits. Temporary and permanent adjustments. Repetition and reiteration method of measuring horizontal angles.

Measurements of Vertical Angles: Traverse survey. Methods of balancing traverse. Gales Traverse table. Omitted measurements.

Recommended Reading:

1. B. C. Punmia, Ashok Kumar and Arun Kumar; Surveying Vol. I; Firewall Media; 2005.
2. Kanetkar, Kulkarni; Surveying and Levelling Vol. I; A.V.G Publications, Pune
3. N. N. Basak; Surveying and Levelling; Tata McGraw Hill Pub.

4. S. K. Duggal; Surveying; Tata McGraw Hill pub.
5. S. K. Husain, M.S. Nagaraj; Surveying and Levelling, Vol I & II; S.Chand and Co.

List of Experiments:

(Eight sheets covering chain and compass survey, plane table survey, longitudinal and Cross Sections)

1. Chain and Compass Surveying – 1 Sheet
2. Plane Table Surveying – 1 Sheet
3. Profile Levelling: Cross and Longitudinal Section of Road - 2 Sheets.
4. Contouring Sectioning of a road and contouring - 2 Sheets

MN 4.5 ROCK MECHANICS AND GROUND CONTROL - I

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 4.5	Rock Mechanics and Ground Control - I	3	1	2	3	100	25	--	--	25	**150**

Course Objective:

1. Learning basic rock mechanics and its application in Mining Industry.
2. Getting knowledge of rock behaviour and properties.
3. Understand basic concepts of stress - strain analysis and slope stability.
4. Solving problems associated with rock pressure and rock movement.

Course Outcomes:

The student after undergoing this course will be able to:

1. Carry out various physico-mechanical tests.
2. Understand the rock behaviour.
3. Analyze of available data for Rock Engineering.
4. Solve rock mechanics problem in mining and excavation projects.

UNIT - 1 (12 Hours)

Introduction: Definition of some important terms used in rock mechanics. Application of rock mechanics in mining. Constraints in rock mechanics application. Introduction to stress analysis.Principal stresses and strains. Differential equations of static equilibrium. Mohr‟s circle of stressand circle of strain.

UNIT - 2 (12 Hours)

Physico-Mechanical Properties of Rock: Physical properties of rock: density, porosity, moisturecontent, permeability, swell index, Slake durability index, thermal conductivity, hardness, durability, Protodyaknov index, impact strength index, point load index. Application of technicalindices of rocks in mining practice. Effect of geological parameters on engineering properties of rock mass. Introduction to general classification of rock mass.

UNIT - 3 (12 Hours)

Mechanical and Rheological Properties of Rocks: Preparation of test specimens. Laboratory determination of mechanical properties of rocks: compressive strength, tensile strength, shear strength, Units of elasticity Poisson‟s ratio, tri-axial strength of rocks. Mohr‟s envelope. Effect of various parameters on the strength of rocks. In – situ strength. Effect of joints and fracture on mechanical properties of rocks. Dynamic wave velocities. Dynamic elastic constants: their determination in the laboratory and application in mining. Time dependent properties of rocks. Creep behaviour of rock: different stages. Rheological models. Acoustic properties of rocks. Determination of elastic properties of rocks and rock mass based on acoustic properties. Theories of rock failure. Hoek and Brown failure theory.

UNIT - 4 (12 Hours)

Slope Stability: Types of slope failure: plane, wedge and circular. Slip circle. Effect of clay intrusions and fault planes on slope failure. Factor of safety. Stability analysis. Determining slope stability of working benches and berms. Strengthening the slopes. Dump stability. Design criteria and monitoring system for dumps. Overburden dump stabilization.

Recommended Reading:

1. R. E. Goodman; Introduction to Rock Mechanics; John Wiley & Sons; 1989.
2. B. P. Verma; Rock Mechanics for Engineers; Khanna PUbl.; 2013
3. John A Hudson and John P Harrison, Engineering Rock Mechanics- An introduction to the principles, Pergamon Press, 1997.
4. B. H. G. Brady, S. T. Brown; Rock Mechanics for Underground Mining; Chapman and Hall; 1993
5. Obert, L and Duvall, W.I. Rock Mechanics and design of Structure in Rock John Wiley and Sons Inc., New York 1967.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. Preparation of rock specimens for laboratory tests.
2. Determination of porosity and density
3. Determination of uni-axial compressive strength of rocks.
4. Determination of point load strength index.
5. Determination of tensile strength of rock by Brazillian test.
6. Determination of Protodyakanov index of the given rock specimen.
7. Determination of slake durability index of rocks.
8. Determination of shear strength and punch shear strength.
9. Schmidt hammer test

MN 4.6 NUMERICAL TECHNIQUES AND STATISTICS

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 4.6	Numerical Techniques and Statistics	3	1	--	3	100	25	--	--	--	**125**

Course Objective:

1. To provide Engineering students with a basic knowledge of various Numerical Methods used to solve algebraic, transcendental, differential and partial differential equations, and to calculate derivatives and integrals.

Course Outcomes:

The student after undergoing this course will be able to:

1. Solve an algebraic or transcendental equation using an appropriate numerical method.
2. Approximate a function using an appropriate numerical method.
3. Solve differential and partial differential equation using an appropriate numerical method.
4. Calculate a definite integral using an appropriate numerical method.
5. Solve a linear system of equations using an appropriate numerical method.
6. Implement a numerical method using a modern computer language.
7. Understand the basic concepts of probability, random variables and probability distributions.

UNIT - 1 (13 Hours)

Solutions of Equations: Solutions of non-linear equations of single variable using bisection method, false position method, Newton-Raphson method, secant method (problem solving, algorithm and computer programming), order of convergence and comparison of these methods Finite difference of interpolation: Forward, Backward, Central, divided differences, Taylor‟s, shift and averaging operators , difference of polynomials, factorial polynomial, Newton forward and Backward difference interpolation, Langrange‟s interpolation, Newton divided difference interpolation(derivation, problem solving, algorithm and computer programming), stirling‟s and Bessel‟s interpolation formula.

UNIT - 2 (12 Hours)

Numerical Solution of Differential Equations: Picard‟s method, Taylor series method, Euler‟s method, modified Euler‟s, Runge-Kutta methods, Milne‟s predictor-corrector method (problem solving, algorithm and computer programming).

Numerical Solution of Partial Differential Equations: solution of Laplace, heat and wave equation by finite difference method.

UNIT - 3 (10 Hours)

Numerical Integration: Newton-Cote‟s quadrature formula, trapezoidal rule, Simpson‟s 1/3 and 3/8 rules, Weddle‟s rule (Problem solving, algorithm and computer programming), Romberg‟s integration (Richardson‟s extrapolation). Comparison of the above methods and error estimation.

Solution to Linear Algebraic Equations: Gauss elimination, Gauss-Jordan, Jacobi‟s, Gauss Seidal methods (problem solving, algorithm and computer programming). Comparison of above methods and concept of ill and well conditioned systems.

UNIT - 4 (13 Hours)

Statistics: Axioms of probability, conditional probability, theorem on total probability, Bayestheorem; Random variables-discrete and continuous; E, V operators, MGF and properties, Standard distributions: discrete-binomial, geometric and Poisson; continuous-uniform-exponential and normal; E, V operators and MGF for those distributions

Recommended Reading

1. B. S. Grewal; Numerical methods; Khanna Pub., New Delhi.
2. P. Kandasamy; Numerical Methods; S. Chand & Co., New Delhi.
3. D. C. Montgomery; Probability and statistics for Engineers; Prentice Hall of India, New Delhi.
4. Balagurusamy; Numerical Methods; Tata McGraw Hill Pub., New Delhi.
5. Ayyub and McCuen; Numerical Methods for Engineers; Prentice Hall, 1996.

MN 5.1 SURVEYING - II

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 5.1	Surveying - II	3	--	2	3	100	25	--	25	--	**150**

Course Objective:

1. Understand advanced surveying terminologies and Methods.
2. Getting familiar with surveying eqiupment and taking measurements.
3. Learn to prepare the survey plans.

Course Outcomes:

The student after undergoing this course will be able to:

1. Understand advanced surveying techniques such as remote sensing and geodetic surveying
2. Plotting contour plans.
3. Understanding different techniques of hydrographic surveying
4. Setting up of works.

UNIT - 1 (12 Hours)

Tacheometric Surveying: General principles of tacheometry and different types of tachometers. Principles of stadia methods. Determination of instrument constants. Derivations of distance and elevation formulae for vertical and normal holding of the staff. Reduction of tacheometric data. Use of tacheometric tables and other graphs.

Introduction to Advanced Instruments: Total Station, GPS receiver.

Hydrographic Surveying: Shoreline survey, River survey, Soundings, Methods of locating soundings, Three-point problem.

UNIT - 2 (12 Hours)

Setting Out Works: Setting out buildings, Culverts, Bridges, Tunnels. Instruments for setting out tunnels; Surface alignment, Setting from ends, Transforming the alignment underground, Transferring levels underground. Accuracy in tunnel surveying.

Curves: Basic definitions, Different types and their characteristics, Simple, Compound and Reverse curves. Methods of setting above curves. Transition curves. Necessity, requirements and methods of introducing super-elevation, Clothoid, Cubic and Spiral curves. Bernoulli's lemniscates, Methods of setting transition curve. Geometry, Setting out, Field problem of circular curve, Transition curve, Combined curve and Vertical curve.

UNIT - 3 (12 Hours)

Remote Sensing: Introduction, Remote sensing system, Data acquisition and processing; Applications; Multi concept in remote sensing. Physical basis of remote sensing. Electro-magnetic radiation (EMR); Nature, Nomenclature and Radiation laws; Interaction in atmosphere; Nature, its effects in various wavelength regions, Atmospheric windows; Interaction at ground surface; Soils and rocks, Vegetation, Water. Remote sensing observation platform, Sensors.

Geographical Information Systems: Introduction, Objectives, Components, Topology, Data model and Data Structure, Errors in GIS, Linkage of GIS to remote sensing, Applications.

UNIT - 4 (12 Hours)

Geodetic Surveying: Definition and scope of geodetic survey. Principles of triangulation and classification. Reconnaissance, Choice of stations, Inter visibility and Height of stations. Signal and its types. Satellite stations and Reductions to centre, Baseline measurement

Recommended Readings:

1. B. C. Punmia, Ashok Kumar and Arun kumar; Surveying Vol. I, II, III; Firewall Media.
2. Kanetkar and Kulkarni; Surveying and Levelling Vol. I and II; A.V.G Publications, Pune.
3. David Clark and John Erick Jackson; Plane and Geodetic Surveying for Engineers; Constable Publishers.
4. S. K. Duggal; Surveying; Tata McGrawHill Pub., New Delhi.
5. Jawahar Lal Sharma; A Text Book of Advanced Surveying; C.B.S. Publishers and Distributors.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. To determine the constants of tacheometer.
2. To determine the reduced levels and distance in tacheometric surveying.
3. Determination of reduced levels using Total Station.
4. Setting out of a typical building plan.
5. To set out a simple circular curve by;
    a) Offset from Long Chord method
    b) Offset from Tangents
    c) Offset from Chord Produce
6. To set out a simple circular curve by any one angular method.
7. Study of sounding methods.
8. Drawing of contour map for a specified area.
9. To use GPS in locating and obtaining time information in all weather conditions, anywhere on or near the earth where there is an unobstructed line of sight to GPS satellites.

MN 5.2 ROCK MECHANICS AND GROUND CONTROL - II

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 5.2	Rock Mechanics and Ground Control - II	3	--	2	3	100	25	--	--	25	**150**

Course Objective:

1. To understand stress analysis around underground excavation.
2. Getting knowledge of rock mass classification developed over a period of time.
3. Understand concepts of underground supports, redistribution of rock pressure and design of supports in underground mines.
4. Solving problems associated with rock burst, caving, subsidence and ground support through stowing and filling.

Course Outcomes:

The student after undergoing this course will be able to:

1. To get familiar with stress-strain measuring instruments.
2. Classify rock mass based on different rock classification systems.
3. Analyze the requirement and extenet of support to excavations.
4. Understand and solve problem associated with roof caving, rock burst, subsidence and stowing.

UNIT - 1 (12 Hours)

Stress Analysis Around Underground Excavation: Introduction, Pre-mining and Induced stresses, Pressure arch theory. Stress distribution around single excavation, Circular, Multiple, Pillar and Irregular shapes. Analytical approaches such as numerical models, FEM, BEM, DEC. Types of stress-strain measuring instruments such as load cells, Strain gauges, etc. Convergence measurement instruments such as dilatometers, Extensometers, Optical gauges, Compressometers, etc. In-situ strength properties of rocks. In-situ stress measurement such as plate load test, Cable jack test, Bore hole test, Dialatometer test, Hydrofracturing, etc. Methods of monitoring rock movement and their limitations.

UNIT - 2 (12 Hours)

Rock Mass Classification: Introduction. Development of classification methods through Terzaghi, Lauffer, Poacher and NATM (New Austrian Tunnelling Method). Rock Quality Designation (RQD). Rock Structure Rating (RSR) system by Wickham. Significance of RSR system. Rock Mass Rating (RMR) by Bieniawski. Parameters used to classify rock mass using RMR system. Modified RMR for mining. Tunnelling Quality Index (Q). Parameters considered in formula for calculation of Q. Concepts of Stress Reduction Factor (SRF) and Excavation Support Ratio (ESR). Comparison of RMR and Q. Application of rock mass classification in solving mining problems.

UNIT - 3 (12 Hours)

Underground Supports: Redistribution of rock pressure on conventional and Powered supports, Theory of reinforcement of rock mass by rock bolting, Cable bolting, Roof trusses, Shotcreting, Fibre reinforced shotcreting etc. Support layouts, Estimation of support resistance. Rock Structure interaction. Relation between support resistance and Rock mass quality. Design of support systems in tunnels, Shafts, Headings, Junctions, Depillaring areas, Gate roadways, Longwall faces and Stopes. The system of spot bolting and Pattern bolting. Mechanism of support by cable bolting. Forces and Displacements associated with cable bolting. Roof stitching.

UNIT - 4 (12 Hours)

Caving: Mechanics of caving. Cavability of rocks. Induced caving. Design of pillars. Determination of shape and size of pillars in coal and hard rock mines. Barrier pillars.

Rock Burst and Coal Bumps: Mechanism, Causes, Occurrence, Estimation of damage, Prediction and Preventive measures.

Subsidence: Theories of subsidence. Factors affecting subsidence. Sub-critical, Critical and Supercritical widths of extraction. Subsidence prediction and control. Design of shaft pillar.

Stowing/Filling: Mechanism of strata control by stowing. Specific precautions while stowing. Effect of shrinkage of stowing material.

Recommended Readings:

1. R. E. Goodman; Introduction to Rock Mechanics; John Wiley and Sons.

2. L. Obert and W. I. Duvall; Rock Mechanics and the Design of Structures in Rocks; John Wiley and Sons.
3. Brady and Brown; Rock Mechanics for Underground Mining; Kluwer Academic Publishers.
4. John A. Hudson and John. P. Harrison; Engineering Rock Mechanics - An Introduction to the Principles; Pergamon Press.
5. M. L. Jeremic; Ground Mechanics in Hard Rock Mining; Oxford and IBH Publishing Co., New Delhi.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. Practice in use of load cells, strain gauges.
2. Practice in use of dilatometers, extensometers, optical gauges, compressometers.
3. Estimation of "Q" for a given rock mass characteristics.
4. Application of rock mass classification in solving mining problems.
5. Design of support layout for a given area underground.
6. Estimation the subsidence area and damage to the surface.
7. Estimation of "RMR" for a given rock mass characteristics.
8. Estimation of stresses around mine openings.
9. Design of hydraulic stowing parameters.
10. Determination of Seismic wave velocity (P and S wave) for inatact rock sample and rock mass.

MN 5.3 MINING MACHINERY - I

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 5.3	Mining Machinery - I	3	--	2	3	100	25	--	25	--	**150**

Course Objective:

1. Introduction to mine pump and compresssor and their utilization in mines.
2. Understand the working proceduer of different excavating and loading machinery which used in mehanised mines.
3. Basic principles and operations of drilling machines and its different components.
4. To understand the construction and technical specifications of transporting machines likes as dumper, conveyor etc.

Course Outcomes:

The student after undergoing this course will be able to:

1. Explain characteristics of mine pumps and compressors and their safely installation in mines.
2. For selecting suitable machinery for better exacavation and transportion for improve mine output.
3. Supervise appropriate and safe installation, use and maintaince of different mining machinery.

UNIT - 1 (12 Hours)

Hydraulic Transmissions: Fundamentals of hydraulic transmission. Cylinders and Accumulators. Different types of valves, Hydraulic coupling and Torque converters, Application in mines, Advantages of hydraulic transmission.

Mine Pumps: Types of pumps. Working head and Efficiencies for centrifugal pumps. Multistage pumps. Performance characteristics. Reciprocating pumps. Construction details. Application of air vessels. Mechanism of cavitation. Turbines. Working principle. Selection, operation and maintenance of pumps. Pump fittings. Submersible pumps. Slurry pumps. Special types of pumps used in mines. Corrosion in mine pumps.

UNIT - 2 (12 Hours)

Compressors: Thermodynamics in air compression. Multi-stage compression. Centrifugal compressors and Principles of operation. Adiabatic efficiency. Design consideration for impeller and Diffusion systems. Performance characteristics. Axial flow compressors, Elementary theory. Stage efficiency and Overall efficiency; Performance characteristics. Axial flow and Radial flow turbines. Impulse and Reaction turbines. Fundamental relations and Velocity triangles; Aerodynamic and Thermodynamic design considerations.

Prime Movers: Diesel engines. Classification and Basic construction features. Operation and Maintenance of its subsystems. Trouble shooting of the engine. Types of electrical motors used in HEMM. Thyristor controlled devices. Concept of motor generator. Basic understanding of prime movers in used in HEMM.

UNIT - 3 (12 Hours)

Excavation and Loading Machinery: Classification. Hydraulic system diagram. Under carriage. Construction details of front end loader, Backhoe and Power shovel. Dragline and its balancing diagram. Bucket wheel excavator. Bucket chain excavator. Surface miners. Design, Construction and Maintenance of opencast loading and Hauling machines. Criteria for selection and Performance of excavating and Loading equipment. Continuous miners. Mine regulations on Heavy Earth Moving Machinery (HEMM).

Auxiliary Machinery: Rippers and Dozers. Types of dozer blades. Technical specification of rippers. Brief description of grader, Scrapper, Clamshell, Lump breaker, Stacker, Spreader, Reclaimer. Cranes. Other ancillary opencast machines; Application. Description and use of transfer conveyors, Mobile conveyor bridges.

UNIT - 4 (12 Hours)

Drilling Machines: Design, Construction and Maintenance of opencast drilling machines. Rotory blast hole drills. Wagon drill. Down the hole drills. Jack hammer drill. Components of drill machine. Different types of drill bits and drill rods.

Transporting Machines: Classification of transport equipments. Understanding of construction and technical specifications of dumpers. Types of conveyors. Construction details of conveyors. Belt, Pulley and Idlers. Brief introduction of booster belt conveyor, Cable belt conveyor, High angle belt conveyor. Construction of aerial ropeway. Application, Advantages and Disadvantages of aerial ropeways. Applicability of rail transport system for surface transport. Concept and Applicabitlity of hydraulic transport. Mine regulation on transport machinery.

Recommended Readings:

1. D. J. Deshmukh; Elements of Mining Technology, Volume III; Denett and Co.
2. S. F. Walker; Mining and Mining Machinery; Nabu Press.
3. G. B. Mishra; Surface Mining; Dhanbad Publ.
4. S. Ghatak; Mine Pumps Haulage and Winding; Lovely Prakashan Publ.
5. Amitosh Dey; Heavy Earth Moving Machinery; Lovely Prakashan Publ.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. Experiments to obtain the characteristic curves of centrifugal pumps.
2. Experiments to obtain the characteristic curves of reciprocating pumps.
3. Study of mine pumps and its parts by visiting the workshop.
4. Study of different parts of compressor.
5. Various tests on diesel and petrol engines.
6. Study of maintenance schedule of excavators.
7. Study of various auxiliary equipments at mineral stock yard.
8. Study of different parts of drilling machine.
9. Study of dumpers and their specifications.

MN 5.4 MINE MANAGEMENT AND LEGISLATION

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 5.4	Mine Management and Legislation	3	1	--	3	100	25	--	--	--	**125**

Course Objective:

1. To understand function of management and its objectives.
2. Having basic idaa about personnel management likes as human resourses, manpower planning in mines,job evalution etc.
3. Understand organisational strauctureof mine industry.
4. To understand about mine act and its provisions.

Course Outcomes:

The student after undergoing this course will be able to:

1. Eligible for organial staructure and managenet concepts for mining enterprises to effectively manage them within the frame work of rules and regulations.
2. Explain general and personal management techniques to manage works in a mine.
3. Having knowledge how to effectively and legally mange a mines.
4. Explain various wages and incentive system and laws.

UNIT - 1 (12 Hours)

Organisation, Administration and Management: General principles of management. Functions of management. Management skills. Scientific management. Management by objectives. Levels of management; Administration. Functions of organisations. Types of organisations. Essentials of a good organisation. Characteristics of mining enterprise. Organisational structure of mining enterprise.

Statutory Requirements of Personnel at Mines: Statutory persons as per mine regulations. Competent persons. Mine officials. Essential qualifications and Norms of appointment of competent persons in mines.

UNIT - 2 (12 Hours)

Personnel Management: Functions of personnel management, Recruitment, Selection, Training and Development of human resources. Promotion and Career development. Job evaluation and Performance appraisal. Motivational techniques and Incentives. Manpower planning in mines. Communication and Leadership qualities.

UNIT - 3 (12 Hours)

Material Management: Introduction. Material planning. Inventory control. Classical EOQ model. Calculation of Economic Order Quantity (EOQ). Inventory optimisation. Purchase and Stores. Nature of inventory. ABC analysis. VED, SDE and MNG analysis.

Industrial Relations: Causes of industrial disputes. Industrial discipline, Grievance redressal mechanism. Trade union movement and Adjudication. Workers' participation in management. Decision making and Problem solving. Conflict management. Value analysis in management. Important provisions of payment of wages act, Workmen's compensation act and Employee state insurance act. Hours and Limitations of employment as per mines act.

UNIT - 4 (12 Hours)

Mining Legislations: Overview of different aspects covered in various acts, Regulations and Rules related to mining such as management, Safety, Welfare and Hygiene, Mineral conservation, Environment protection. Main provisions of mines act. Duties and Responsibilities of mines manager, Mine foreman, Mining mate, Surveyor and other competent persons appointed at mines under mine regulations. Welfare amenities specified under mines rules. Standards for drinking water, Toilets, Rest rooms, Canteen, Cretch, Pit head bath. First aid facilities at mines. Provisions for establishing training centers/facilities for every mine under mine vocational training rules. Initial and Refresher training requirements. Equipments and Personnel at training centres.

Recommended Readings:

1. R. S. Naagarazan; A Text Book on Principles of Management; New Age International Publ.
2. Banga and Sharma; Industrial Organization and Engineering Economics; Khanna Publication, New Delhi.

3. Rakesh and Prasad; Legislation in Indian Mines: A Critical Appraisal; Lovely Prakashan Publ.

4. O. P. Khanna; Industrial Management; Dhanpat Rai and Sons.

5. V. N. Singh; Mine Management; Lovely Prakashan, Dhanbad.

Tutorial Exercise:

- Tutorial classes shall include numerical problems based on EOQ model, Inventory control, Man power planning for mining project, Cost calculation for green field and grey field mining project, etc.

- The exercise shall include assignments based on above syllabus to be completed during Tutorial class.

MN 5.5 SURFACE MINING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 5.5	Surface Mining	3	2	--	3	100	25	--	--	--	**125**

Course Objective:

1. To study the classification of mines, various methods for site preparation and opening-up the deposits.
2. To study open pit design and layouts, different surface mining methods and associated mining machinery.
3. To study the techniques of dump formation and stabilisation and reclamation of dumps.
4. To study cutting, loading and transportation equipment and their applicable conditions.
5. To study drilling and blasting techniques for rock fragmentation.

Course Outcomes:

The student after undergoing this course will be able to:

1. Understand the difference between opencast, open pit and quarries, methods for site preparation and opening-up the deposits.
2. Design surface mine design and layouts with selected mining methods.
3. Realize the importance of waste dump formations and their stabilisation.
4. Select suitable cutting and loading and transportation equipment for known conditions.
5. To apply drilling and blasting techniques for rock fragmentation.

UNIT - 1 (12 Hours)

Introduction: Scope of surface mining in India. Ore bodies amenable to opencast mining. Advantages and Disadvantages of opencast mining over underground mining. Classification of mines. Preparation of site. Grubbing, Scarification, Ripping and Dozing. Selection of machinery for site preparation and Opening up. Different methods of opening up the deposits. Methods of driving box cuts. Pit expansion process. Sequence of extraction and Bench formation. Mine regulations on working near mine boundaries, Steep working etc.

Open Pit Design and Layouts: Important parameters of open pit design; Design of benches. Mine regulations on height, Width and Slope of the benches. Measures adopted for slope stability. Concepts and Significance of stripping ratios. Break even stripping ratio. Life of the mine. Layout planning for horizontal, Inclined and Steep deposits. Factors influencing the choice of layouts. Layouts with in-pit crushing and Conveying. Working benches and Protective berms. Final pit slope angle and Pit limit. Unit operations in opencast mining.

UNIT - 2 (12 Hours)

Surface Mining Methods: Sidecasting and Overcasting. Strip mining. Quarrying. Placer mining. Non-cyclic surface mining with bucket wheel excavators and Continuous surface miners. Selection of methods for bedded deposits, Massive deposits, Pipe type, Cap type and Vein type deposits. Mining of beach sands. Introduction to placer mining. Dimensional stone mining. Surface mining over underground workings. Mining in fiery strata. Problems in deep mining. Slope stabilisation.

Dump Formation : Types of waste dump; Internal and External; Dump formation methods and Equipments used. Layout of waste dumps. Stabilization of waste dumps. Mine regulations on overburden dumps. Reclamation methods using different combination of equipments.

UNIT - 3 (12 Hours)

Cutting and Loading Operations: Basic principles of equipment selection. Selection of machinery for digging and Cutting. Concept of digging face, Shovel approach, Crowding, Swing angle, Depth of cut etc. Selecting optimum bucket capacity. Working out production capacity of hydraulic shovel. Application of backhoe, Dragline. Application of wheel loader and Tractor shovel and Selection of loader bucket capacity. Application of ripper-dozer and Estimating dozer production.

Mine Transport: Overview of various transport systems used in mines. Application of bottom dump wagons. Comparison of transport by rigid frame dump trucks and Articulated dump trucks. Haul road geometry and Construction material. Design of curves and Gradients. Maintanance of haul roads. Machinery requirement, Working out the haulage cycle and Determining number of haul trucks. Application of queueing theory to the loading and Hauling problems. Management of haul fleet. Operator Independent Truck Despatch System (OITDS). Comparison of the systems used for long distance transport such as belt conveyor, Railway and Rope way. Application of high angle conveyors. Safe transport of ore through public roads.

UNIT - 4 (12 Hours)

Drilling and Blasting: Selection of drill machines for open pits. Factors affecting drill performance. Determining number of drill machines for planned production. Factors affecting blast design. Multi row blasting and Blast casting by explosives. Heavy blasting, Mine regulations on opencast blasting. Problems associated with blasting such as ground vibration, Airblast and Flying fragments, Sources of noise in mines. Understanding of loudness and Frequency. Effect of noise. Monitoring of noise and related instrumentation. Control of noise. Causes of ground vibration. Methods of controlling adverse effects. Monitoring ground vibration and related instrumentation.

Recommended Readings:

1. G. B. Misra; Surface Mining; Dhanbad Publishers.
2. B. A. Kennedy; Surface Mining; SME Publishers.
3. Bhandari; Blasting Engineering operations; A. Balkema Publishers.
4. S. K. Das; Surface Mining Technology; Lovely Prakashan, Dhanbad.
5. D. J. Deshmukh; Elements of Mining Technology, Vol. I; Denett andCo., Nagpur.

Tutorial Exercise:

- Tutorial classes shall include numerical problems on transport, stripping ratio, powder factor, Calculation of blast design parameters, production capacity of the loading equipments, etc.

- The exercise shall include assignments based on above syllabus to be completed during Tutorial class.

MN 5.6 UNDERGROUND COAL MINING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 5.6	Underground Coal Mining	3	1	--	3	100	25	--	--	--	**125**

Course Objective:

1. Introduction to coal and undrground coal mining industry.
2. Understand the underground coal mining methods.
3. Basic principles of extraction techniqes.
4. To understand the operations including cutting, drilling, blasting, and loading.

Course Outcomes:

The student after undergoing this course will be able to:

1. Explain characteristics of coal seams in India.
2. Explain board and pillar working in underground mine with proper ventilation.
3. Explain safe and economical coal pillar extraction method.
4. Describe the safe working procedure for mining activities
5. Explain longwall working in underground mine
6. Describe safe stowing practices.

UNIT - 1 (12 Hours)

Introduction: Origin, Coal formation, Coal measuring rocks and their characteristics, Rank of coal. Characteristics of Indian coal deposits. Major coal producing areas in India. Classification of coal seam as per thickness, Depth and Inclination, Factors affecting choice of coal mining methods. Grading of coal.

Coal Mine Development: Practices of opening up coal deposits in major coalfields. Design and Development of panel. Transport and Ventilation arrangements to and from the panel. Classification of mining methods.

Stowing Practice: Principle, Method; mechanical, Pneumatic, Hydraulic; Merits and Demerits with applicability, Collection and Preparation, Transport, Handling and Storage. Arrangement for stowing on the surface and Underground. Shrinkage of stowing material and its effect.

UNIT - 2 (12 Hours)

Bord and Pillar Method of Working: Patterns of development within the panel. Size of panel, Pillars and Headings. Percentage of extraction during development. Unit operations of winning, Loading and Haulage. Methods of pillar extraction. Problems and Issues in depillaring, Extraction by caving and Stowing methods. Systematic supporting rules. Possible mechanisation in Bord and Pillar method. Comparison of thin and Thick seam mining. Work arrangement and Calculation of production. Related mine regulations.

UNIT - 3 (12 Hours)

Longwall Mining: Applicable conditions. Development within the panel in advancing and Retreating system. Optimum length of faces. Single and Double unit longwall faces. Working in dip, Strike and Rise directions. Cyclic and Non-cyclic operations. Systematic support rules. Hydraulic support system. Mechanised cutting and Loading operations. Application of DERDS, SERDS, Armered Face Coveyors, Self advancing hydraulic supports. Work organisation and Calculation of production. Salvage operations in longwall mining. Mine regulations related to longwall mining.

UNIT - 4 (12 Hours)

Thick Seam Mining: Problems in mining of thick seams. Thick seam mining by Bord and Pillar and Longwall methods. Slice method, Sublevel caving, Blasting gallery method, Cable-bolting method. Mining with and without stowing.

Mining in Difficult Coal Seams: Horizon mining for steeply inclined seams. Winning of thin seams. Method for contiguous seams. Considerations while working seams prone to spontaneous heating, Gas outbursts and Bumps. Extraction of seams below important structures and Water bodies. Harmonic mining. Related mine regulations.

Non-conventional Methods: Hydraulic Mining. Coal gasification. Shield mining. Room and Pillar mining, High wall Mining.

Recommended Readings:

1. D. J. Deshmukh; Elements of Mining Technology, Vol I; Central Techno Publications, Nagpur.
2. R. D. Singh; Principles and Practices of Modern Coal Mining; New Age International.
3. S. K. Das; Modern Coal Mining Technology; Lovely Prakashan Publishers.

4. J. G. Singh; Underground Coal Mining Methods; Braj Kalpa Publishers, Varnasi.
5. SME Mining Engineers Handbook on Underground Coal Mining.
6. H. L. Hartman; Introductory Mining Engineering; John Wiley, New York.

Tutorial Exercise:

- Tutorial classes shall include numerical problems on percentage of extraction and recovery in Bord and Pillar method, production calculation for Bord and Pillar and Long wall method, etc.

- The exercise shall include assignments based on above syllabus to be completed during Tutorial class.

MN 5.7 INDUSTRIAL TRAINING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
						Marks					
		L	T	P	Th. Duration (Hrs)	TH	S	TW	P	O	Total
MN 5.7	Industrial Training	--	--	2	--	--	--	25	--	--	**25**

Course Objective:

1. Mining is an experience based industry and on hand practice will provide good exposure to budding engineers.
2. To get aquanted with the mining environment and understand the complexities associated with mining projects.
3. To visit fully mechanised and systematic underground and opencast mines of india.

Course Outcomes:

The student after undergoing this course will be able to:

1. Adjust to the mine environment and have an idea about the mining industry.
2. Understand the planning and execution aspects of actual mines.
3. Get knowledge about latest technology, equipments, softwares, manpower management etc. To become successful engineers and managers.

The industrial training will be organised during summer / winter vacation after IV / V semester examinations for a total duration of four weeks. The class shall be divided into batches of 4 or 5 students and sent to pre-determined mines from where the permissions are obtained. Students may camp at the mines or elsewhere and undergo training as per the direction of mine management.

Examination Scheme: Students shall maintain a field diary to record their daily activities. They shall collect the necessary data and prepare a training report on completion of training. The training report; neatly typed and attached with sketches, diagrams and maps shall be submitted to the department for evaluation and record.

Oraganisation of Training: the following mines/organisations can be considered for training.

1. **Mechanised Opencast Metal Mines:** Iron ore mines in Goa, Malanjkhand Copper Mines of HCL(Madhya Pradesh), Kudremukh Iron Ore Mine(Karnataka), Rampura

Agucha Mines of HZL (Rajasthan), Bailadilla Mines of NMDC (Chattisgarh), SAIL, any other mechanised opencast mines.

2. **Mechanised opencast mines in Coal:** Neyveli mines of M/s Neyveli Lignite Corporation,Kusmunda Mines of South Eastern Coalfields Ltd (Bilaspur, M.P.), Ramagundem mines of Singreni collieries co Ltd, mines of Central Coalfields Ltd., any similar mines.

3. **Underground Metalliferous Mines:** Mines of Manganese Ore India Ltd., Khethri or Kolihan minesof HCL (Rajasthan), Surda or Rakha mines of HCL (Jharkhand), Dariba or Zawar mines of HZL, Hutti Gold Mines Ltd, MOIL, any similar underground metal mines.

4. **Underground Coal Mines:** Mines of Singreni Collieries Co Ltd (Andhra Pradesh), Mines of Western Coalfields Ltd, Mines of South Eastern Coalfields Ltd.

5. **Open cast Captive Mines for Cement Plants:** ACC Ltd., JK Cements, Ultratech Cements, India Cements Ltd., etc.

Essential Contents of Training Report:

1. Name of the mine along with names of owner, agent, manager and other senior officials.

2. Location and a brief history of the mine.

3. Brief geological description along with characteristics of the ore and its marketing scenario.

4. The surface features including mine entries, loading and transport arrangement of ore, disposal of waste, ore beneficiation.

5. Method of working including strata control in underground mines and dump management in opencast mines.

6. Sampling, survey, training and rescue sections.

7. Acknowledgements.

MN 6.1 MINING MACHINERY - II

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 6.1	Mining Machinery - II	3	1	2	3	100	25	--	--	--	125

Course Objective:

1. To study the types, construction, testing and selection of wire ropes.
2. To study the different types of mine winders, accessories and their applications.
3. To know pit top and pit bottom layouts.
4. To know different types of rope haulage, locomotive and conveyor transport.
5. To know the various types of face machinery, construction and operation for coal and metal mines.

Course Outcomes:

The student after undergoing this course will be able to:

1. Select suitable types of wire ropes for different mining applications.
2. Select the suitable mine winders and accessories for a mine.
3. Design pit top and pit bottom layouts.
4. Know different types of mine transport systems used in underground mines.
5. Know the various types of face machinery for coal and metal mines.

UNIT - 1 (12 Hours)

Introduction: Elements of mechanical power transmission -- gear, belt, chain, coupling, clutch and brake. Various sources of power available at mines. Different types of electric power cables used in mines. Indian Electricity Rules with respect to mines. Types of Prime Movers for mining machinery. Principles of flame proof enclosures, principles of intrinsic safety and intrinsically safe apparatus. Protective relays in mine power system. Pneumatic power at mines. Principle of compressor operation.

Wire Ropes: Types and construction, Rope lay, Breaking strength, Space factor, Mass, Factor of safety, Fill factor, Construction efficiency. Examination and care of wire ropes during storage and use. Selection of wire ropes for various purposes, Testing of wire ropes, Rope splicing, Different types of rope capples and process of capping, Mine regulations on wire ropes.

UNIT - 2 (12 Hours)

Mine Winders: Koepe and Drum winders and their applications, head gear, head gear pulley, various shaft fittings such as Keps, rope guides, platforms, Capping and recapping of wire rope, Cage and suspension gear. Different types of winding drums, Safety devices in winders such as over speed and over wind preventers, slow breaking, depth indicator, Methods of counter balancing rope. Duty cycle. Mechanical and electrical braking. Winding from different levels in shaft. Torque time diagram. Ground and tower mounted friction winders, Multi rope winding.

Pit Top And Pit Bottom Layouts: Run round, shunt back, lofco, traverse, turn table, tipplers. Mine tubs. Tub couplings. Mine Regulations on winding.

UNIT - 3 (12 Hours)

Rope Haulages: Different types of rope haulages with their use and constructional details, Tension arrangement for endless haulage. Rope clips, Haulage safety devices, Rope haulage calculations involving tractive effort, B.H.P, ideal gradient, speed and efficiency. Mine Regulations on rope haulages.

Locomotives: Different types with uses, construction and operation of diesel, battery and trolley wire locomotives, Control and breaking systems, Power and capacity assessments, Tractive effort, Drawbar pull, Breaking effort. Constructional features of shuttle cars and man riding systems. Mine Regulations on locomotives.

Mine Track: Track work, turns and crossings, layout of tracks, switch points. Mine Regulation on care and maintenance of mine tracks.

Conveyors: Construction of different types of belt conveyors, chain conveyors, armoured flexible conveyors, stage loaders; main and extensible belt conveyors, Power calculation and selection of conveyors.

UNIT - 4 (12 Hours)

Coal Face Machinery: Coal drill- construction, operation and maintenance. Shearers: Different types, single and double drums; fixed and ranging drums; Left hand and right hand drums, picks and pick boxes, water spraying arrangement. Road header and dint header: Types, drive arrangement, cutting, loading and propel mechanisms. Continuous miner used for bord and pillar mining operation. Construction and operation of tunnel boring machines. Selection criteria of the underground production equipments. Safety and regulations related to underground mining equipment.

Face Machinery Common in Metal Mines: Types of drill machines and their application. Jack Hammers, Simba and Jumbo drills. Mechanical Loaders: Classifications, scope of use of each in different conditions, construction and operations of scraper

loader, pneumatics loaders, gathering arm loader, load-haul-dumper, low profile dump trucks, side discharge loader.

Recommended Readings:

1. S. Ghatak; Mine Pumps Haulage and Winding; Lovely Prakashan Publ.
2. C. F. Statham;Coal Mining Practice-Vol II; Caxton Eastern, Calcutta.
3. R. D. Singh; Principles and Practices of Modern Coal Mining; New Age International.
4. R. T. Deshmukh; Winning and Working Coal in India; ISMAG Co op. Store ltd., Dhanbad.
5. Madisetti A Ramlu; Mine Hoisting; Taylor and Francis Publ.
6. Lewis and Clark;Element of Mining; John Wieley and Sons, New York.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. Study of different means of mechanical power transmission.
2. Study of different types of electrical power cables used in mines.
3. Study of different types of wire ropes used in Mines.
4. Model study of suspension cage gear used for mine hoisting.
5. Study of pit top and pit bottom layouts.
6. Study of rope haulage systems used for haulage in underground mines.
7. Study of track layout in underground mines.
8. Study of various coal face machinery used for underground longwall method of mining.
9. Study of various face machinery used in metal mines.
10. Study and design of belt conveyors for material transportation in mines.

Tutorial Exercise:

- Tutorial classes shall include numerical problems on wire ropes, mine winder, belt conveyor, rope haulage and locomotives.
- The exercises shall include assignments based on above syllabus to be completed during Tutorial class.

MN 6.2 MINE ENVIRONMENT - I

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 6.2	Mine Environment - I	3	1	2	3	100	25	--	25	--	150

Course Objective:

1. To understand the ventilation requirements.
2. To know the various gases found in mine and their detection techniques.
3. Understand the mine ventilation system and mine fans.
4. To understand the design of suitable ventilation structures.

Course Outcomes:

The student after undergoing this course will be able to:

1. Assess quality of air in mine atmosphere.
2. Comprehend principles of ventilation to improve quality of atmosphere in underground mines.
3. Comprehend effect of dust, humidity, temperature and noxiuos gases in mining operations.
4. Describe the safe working procedure for mining activities

UNIT - 1 (12 Hours)

Introduction: Objectives of Mine ventilation, composition of atmospheric air, atmospheric pressure, Barometers. Circumstances needing ventilation support in opencast mines.

Mine Gasses: Different types of gases found in mines. Origin, Occurrence, Physical, Chemical and Physiological properties of mine gases, gassiness of mines. Methane layering. Gas blowers. Instruments for detection of various gases and their working principles. Methane drainage.

UNIT - 2 (12 Hours)

Mine Atmosphere: Permissible concentration of various gases as per mine regulations. Determination of dilution requirements. Types, source, properties and control of mine dusts. Sources of water vapour and heat in mines. Effect of humidity at the work places.

Heat stroke. Hygrometer and Kata thermometer. Methods of improving cooling power of mine air.

Natural Ventilation: Factors causing Natural Ventilation Pressure. Calculation of NVP. Thermo dynamic treatment. The Motive Column. Limitations of NVP. Numerical examples on natural ventilation.

UNIT - 3 (12 Hours)

Mechanical Ventilation: Fan house and Mine regulations related to it. Evasee and its importance. Forcing and Exhaust system of ventilation. Central and bound ventilation system. Ventilation structures for regulation and direction of air current such as stoppings, crossings, doors, air locks and regulators. Ascential and descential ventilation. Homotropal and antitropal ventilation. Air leakages and their prevention.

UNIT - 4 (12 Hours)

Mine Fans: Principal types of mine fans and their suitability, merits, limitation, efficiency and characteristics. Fanlaws. Atkinson‟s formula. Theoretical depression. Manometric, mechanical and over all efficiencies. Fancharacteristic curves and Mine characteristic curves. Operating point. Selection of mine fan, fan testing, output control of fans, air reversal arrangement. Series and parallel operation of mine fans. Regulations on mine fans.

Recommended Readings:

1. D. J. Deshmukh; Elements of Mining Technology Vol II; Vidyasewa Prakashan, Nagpur.
2. G. B. Mishra; Mine Ventilation and Environment; Oxford University Press.
3. V. S. Vutukuri and R. D. Lama; Environmental Engineering in Mines; Trans Tech Publishers.
4. M. J. Mc Pherson; Subsurface Ventilation and Environmental Engineering; Chapman and Hall Publication, London.
5. H. L. Hartman; Mine Ventilation and Air Conditioning; Wiley Publication.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. Measurement of fire damp and other gases using various instruments.
2. Determining dry bulb and wet bulb temperatures and calculation of humidity.
3. Sketching the ventilation network based on given mine plan
4. Study of various ventilation structures.
5. Study of air reversal arrangement.
6. Measurement of head and quantity developed by a laboratory model of mine fan.
7. Study of performance of axial flow fan with changing pitch.
8. Study of characteristic curves of standard mine fans and comparing it with given mine characteristic curves.

Tutorial Exercise:

- Tutorial classes shall include numerical problems on mine gases, Graham's ratio, N.V.P, Evasee, Size of regulators, Atkinson's equation, Air quantity, Theoretical depression of mine fan and efficiency of mine fan, etc.

- The exercise shall include assignments based on above syllabus to be completed during Tutorial class.

MN 6.3 MINERAL PROCESSING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 6.3	Mineral Processing	3	--	2	3	100	25	--	25	--	150

Course Objective:

1. To know the properties of mineral used in mineral processing.
2. To understand the suitable parameters and appropriate machineries for processing various types of minerals.
3. For incease the market value of ore.
4. To give an understanding of the processes involved in separating minerals from their ores, producing the pure metal, and the trading of metals and their financial instruments.

Course Outcomes:

The student after undergoing this course will be able to:

1. Understand the relevance and importance of the Minerals.
2. Identify different processing of Minerals for increase their grade and make company profitable.
3. The student will demonstrate the ability to use appropriate Minerals for appropriate metals extractions for engineering use.
4. Be able to explain the economic relationship between mineral processing and metal production, and its optimisation

UNIT - 1 (12 Hours)

Introduction: Definition, purposes, scope and limitation of mineral processing. Economic justification. Methods of beneficiation, Unit operation in Mineral dressing, properties of mineral used in mineral dressing. Coal washing.

Communition: Definition and objectives, methods of size reduction, Principles, mechanism and theory of crushing-definition, methods, crusher - classification, construction, operations and performance. Crushing circuits. selection of crusher Grinding - definition, purpose, and mechanism. Tumbling mill - type, constructions, operation and performance. grinding circuits. Reduction ratio - definition, types and significance. Breakage rate and factor affecting breakage rate.

Sizing Separation: sizing - definition, purpose, method and principles. Screening - definition. Classification, equipments, screen surfaces, performance of screens and factor affecting performance Laboratory sizing, wet and dry sieve analysis, size distribution, sub-sieve techniques.

UNIT - 2 (12 Hours)

Classification: definition, application and Principles of classification, Equipment, performance of classifier and factor affecting it. Hydro cyclone design.

Concentration: Methods of concentration and their applications, Hand sorting; application, sorting surfaces, machines sorting - application, mechanics of sorting, sorting machines, Gravity separation;-definition, Principles and methods of gravity concentration, equipment and application, performance of gravity separators. Heavy media separation (H.M.S)- definition, principle, heavy media, equipment and application. Floatation-definition, principles and chemistry; reagents - collector, froather and regulator, Floatation equipments. Electrical and Magnetic Concentration-principles, mechanism, fields of applications, limitations, methods, equipment and performance. Miscellaneous methods of concentration.

UNIT - 3 (12 Hours)

Dewatering: Purpose, methods of dewatering. Centrifugal operation of dewatering system. Mechanical and thermal system of dewatering - principle, construction.

Sedimentation: definition, sediment behaviour, equipment, operation.

Filtration: Constant pressure and constant rate filtration. Filtration equipments: construction, Filtration calculation(filtration resistance, pressure drop through filter cake) Introduction to Cyanidation and amalgamation methods, Leaching, Ion exchange, Solvent extraction, etc.

UNIT - 4 (12 Hours)

Plant Practice: Purpose, and types of flowsheets. flowsheet analysis, selection of equipments, control objective, principles of automation, instrumentation, plant design, cost estimation, selection of site. Tailing dam.

Material Handling: Purpose and methods of material handling. Dry handling. Stock piles,bins and hoppers. Transportation of bulk solids, slurry handling. Tailing disposal

Metallurgical accounting and control: Sampling and weighing the ore, moisture and assay sampling, on stream analysis, automatic control in mineral processing.

Recommended Readings:

1. B. A. Wills; Mineral Processing Technology; Pergamon Press, Toronto.
2. Jain, S.K.; Ore Processing A.A.; Balkema Publishers.
3. A. M. Gaudin; Principle of Mineral Dressing; McGraw Hill, New York.
4. S. Venkatachalam; Experiments in Mineral Processing; Oxfors and IBH.
5. E. J. Pryor; Mineral Processing; Pergamon Press.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. Study of grab sampling and different sample division techniques (visit to mine)
2. Calculation of reduction ratio of a crusher and grinder.
3. Determination of the grinding characteristics of a given mineral sample using ball mill.
4. Sieve analysis of a given sample and plotting sizing curve. Screen performance calculation. Any one of the followings:
    i. Concentration of a given mineral sample using mineral jig.
    ii. Concentration of a given mineral using Wilfley table.
    iii. Concentration of a given mineral using froth floatation cell.
    iv. Concentration of a given mineral using magnetic separator.
6. Study of washability characteristics of coal sample using float and sink test.
7. Plotting of sedimentation curve.
8. Visit to a beneficiation plant and study of flowsheets.
9. Calculation of Screen capacity and/or Spiral classifier capacity.
10. Study of various pollution control measures adopted at the beneficiation plant.

MN 6.4 UNDERGROUND METAL MINING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
					Th. Duration (Hrs)	Marks					
		L	T	P		TH	S	TW	P	O	Total
MN 6.4	Underground Metal Mining	3	2	--	3	100	25	25	--	--	150

Course Objective:

1. To understand Basic concept and terminology associated with underground metal mining and present status of Indian metal mining industry.
2. Getting knowledge of Various stoppign methods and its selection based on rock properties.
3. Understand various special metal mining methods developed for specific conditions and type of ore.
4. Understanding Metal Mining Regulations on methods of working.

Course Outcomes:

The student after undergoing this course will be able to:

1. To get familiar with various aspects of underground metal mine development.
2. Select appropriate metal mining method and perform production calculations.
3. Analyze the requirement and extenet mechanization and ventilation required.
4. Understand and Solve problem associated deep mining and rock burst prone areas.

UNIT - 1 (12 Hours)

Fundamentals: Present status of Indian metal mining industry. Scope and limitations of underground mining; Characteristics of metalliferous deposits. Factors determining classification and choice of stoping methods. Choice of level interval and block size, position; excavation and equipping of shaft station, grizzly, Secondary breaking at grizzly, ore/waste bin, main orepass system, underground crushing and loading stations, underground chambers, sump and other subsidiary excavations; Arrangements for ore handling. Understanding of dilution, loss and recovery in stoping.

UNIT - 2 (12 Hours)

Open Stopes: Overhand, underhand and breast stoping. Sublevel stoping, Long hole stoping, Applicability, stope layouts, stope preparation, ground breaking, mucking, ventilation, supporting, haulage and ore transport in each method. Production

calculations and deployment of men and machinery. Chute system of loading, Draw point system in thicker ore bodies.

UNIT - 3 (12 Hours)

Supported Stopes: Post and pillar method, Shrinkage stoping, Cut and fill method, Applicability, stope layouts, stope preparation, ground breaking, mucking, ventilation, supporting, haulage and ore transport in each method.

Caved Stopes: Top slicing, Block caving, Sublevel caving. Large diameter blast hole/DTH, Concept of spherical charge and Vertical Crater Retreat methods; Applicability, stope layouts, stope preparation, ground breaking, mucking, ventilation, supporting, haulage and ore transport in each method.

UNIT - 4 (12 Hours)

Special Metal Mining Methods: Stulled stopes in narrow veins, Squareset stoping, Elements of square set. Resuing; Mining of parallel and superimposed veins; Longwall mining in soft seams; Chatty stoping; Problems associated with faulted, geologically disturbed blocks. Problems of deep mining and their remedial measures, design and layout of stopes in rock burst prone areas. Granite packing; Non-conventional mining methods such as Solution mining, in-situ leaching, borehole mining, underground retorting. Mine Regulations on methods of working.

Recommended Readings:

1. H. L. Hartman; Introductory Mining Engineering, John Wiley and Sons; New York
2. Y. P. Chacharkar; A study of Metalliferous Mining Methods; Lovely Prakashan Pub
3. William A. Hustrulid and Richard L. Bullock; Underground Mining Methods: Engineering fundamentals and international case studies; SME Publications, New York.
4. D. J. Deshmukh; Elements of Mining Technology Vol II; Denett and Co. Publ.
5. A. B. Cummins; SME Mining Engineering Handbook Vol I and II; Society of Mining Engineers of American Institute of Mining, New York.

Term Work:

(The term work shall be completed during tutorial hours and marks to be awarded based on the assessment of assignments conducted)

- The exercise shall include numericals and atleast 4 assignments based on above syllabus to be completed during Tutorial class.

MN 6.5 MINE ECONOMICS AND VALUATION

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 6.5	Mine Economics and Valuation	3	1	--	3	100	25	--	--	--	125

Course Objective:

1. To know the importance of mineral and economic value of mining and mineral deposit and mining industries
2. To know the detail knowledge on economic parameters to run the enterprise successfully.
3. To understand the economics of business enterprise to become a successful manager.
4. Understand about costing, mine finance and mine valuation.
5. To understand the Feasibility Study in case of mining project

Course Outcomes:

The student after undergoing this course will be able to:

1. Explain the importance of mineral and economic value of mining and mineral deposit and mining industries.
2. Learn Evaluation, Sampling, Valuation and mining cost and loss of mineral in mines.

UNIT - 1 (12 Hours)

Introduction: Specific features of Mining Industry. Statistics of important and strategic minerals of India. Conservation of minerals. National mineral policy. Global mineral marketing. Price forecasting and sensitivity analysis.

Fundamentals of Book Keeping: Basic principles of Book Keeping. The journal. Double entry system. The books of account. The balance of various ledger pages. Trail balance. Trading, Working or Manufacturing Account. Suspence Account. Profit and Loss Account. Balance Sheet.

UNIT - 2 (12 Hours)

Costing: Objectives of costing. Elements of cost. Cost Sheet. Standard costing. Fixed and variable costs, Income statements, Break Even Analysis. Depreciation. Methods of

depreciation calculations. Volume-cost-profit analysis. Productivity and cost control. Profit planning.

Mine Finance : Capital and its importance. Sources of finance. Shares and debentures. Equity financing and debt financing. The cost of capital. Royalty, taxes and duties; imports and exports.

UNIT - 3 (12 Hours)

Financial Accounting: Contribution margin. Payback period, Return on capital. Time value of money. Net Present Value and Internal Rate of Return. Method of economic appraisal. Operating expenses or cash outflows. Depletion and Amortazisation. Salvage value. Major fields of study for project evaluation. Concept of opportunity cost. The reserve fund.

Feasibility Study: Objectives of Feasibility Study. Order of Magnitude, Preliminary FS and Detail FS in case of Mining Project. Elements of feasibility study. Mutually Exclusive and Non-Mutually Exclusive Project Analysis.

UNIT - 4 (12 Hours)

Mine Valuation: Purpose of mine valuation. Major factors affecting on the value. Precautions in reserve estimation. Sample salting. The principles of mine valuation. Concept of Safe rate, Normal rate and Speculative rate of interest. Annuity and Sinking Fund. Familiarisation with the mathematical tables for Compound Interest, Present Value, Annuity, Capital Recovery Factor, Sinking Fund Factor, Hoskold‟s Factor etc. Hoskold‟s Formula for mine valuation. Morkil‟s and other classical methods for mine valuation.

Recommended Readings:

1. Ramrao T. Deshmukh; Mineral and Mine Economics; Myra Publ.
2. K. K. Chatterjee; An Introduction to Mineral Economics; New Age International publ.
3. R. K. Sinha and N. L. Sharma; Mineral Economics; Oxford and IBH Pub. Co.
4. Baxter C. H., R. D. Parks, Whitehead W. L and Pardee F. G.; Examination and Valuation of Mineral Property; Addison-Wessley Pub.
5. R. N. P. Arogyaswamy; Courses in Mining Geology; Oxford and IBH Publishing Co. Pvt. Ltd., Delhi.

Tutorial Exercise:

- The tutorial classes shall include problems based on Net Present Value, internal rate of return, Depreciation, Payback period, Hoskold‟s Formula and Morkil‟s Formula, etc.

- The exercise shall include assignments based on above syllabus to be completed during Tutorial class.

MN 6.6 MINE SURVEYING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 6.6	Mine Surveying	3	1	--	3	100	25	--	--	25	150

Course Objective:

1. To study the role, duties and responsibilities of mine surveyors.
2. To study the types of errors in surveying, the methods for computation ofareas and volumes.
3. To study various aspects of surveying in surface and underground applications.
4. To learn the calculation dip/strike, fault calculation, cross measure drift, bore hole related problems.
5. To study the principles of field astronomy and global positioning system.

Course Outcomes:

The student after undergoing this course will be able to:

1. Learn duties and responsibilities of mine surveyors and different types of plans and sections and calculations they need to perform.
2. To compute areas and volumes within permissible errors in surveying.
3. To apply various aspects of surveying in surface and underground applications.
4. To perform calculation related to dip/strike, fault calculation, cross measure drift, bore hole problems.
5. To familarise themselves with the principles of field astronomy and use GPS in mine surveying.

UNIT - 1 (12 Hours)

Introduction: Mine surveying - definition, purpose, difficulties in mine surveying, instrument used. Role and responsibilities of mine surveyor, appointment of mine surveyor. Types of scale. Method of plotting. Enlargement and reduction of plan. Types of plan and section used in mines. Checking accuracy of mine plan, Causes of inaccuracy of mine plan. Plan and sections required for a new mine. Use of level and theodolite.

Errors in Surveying: Classification and types of error, precaution against error, accidental error and the law of probability, principles of least square, true error, apparent error, average error, mean square and probable error, weight of a error and law of weight, limiting error, acceptable limits of error (by DGMS).

Computation of Areas And Volumes: Area and volume of regular figure, methods of area calculations, methods of boundary area calculation, Planimeter.

UNIT - 2 (12 Hours)

Correlation: Underground levelling, underground theodolite survey, purpose,and steps in correlation, methods of correlation ,instrument used,Transferring true meridian from surface control to underground base. Shaft plumbing. Direct traversing in inclined shaft. Comparison of underground and surface traverse. Control of direction and gradient in drifts, tunnels, raises and winzes; application of lasers.

Curve Setting: Purpose, type of curve, Surface methods of curve setting. Road and curve setting, Transition curve and super elevation. Possible obstructions/difficulties in setting curve. Vertical curve. Setting curve underground.

Stope Surveying: Purpose, methods of survey in moderately and steeply inclined ore bodies, flat and vertical ore bodies/seams. Tape triangulation. Traversing. Radiation. Calculating mineral output, percentage of extraction calculation Dip and strike calculation, fault calculation, cross measure drift calculation, Bore hole calculation, Determination of true thickness from core. Subsidence survey.

UNIT - 3 (12 Hours)

Opencast Survey: Purpose of opencast surveying, control point, frame work and development of opencast survey station. Detailed survey of opencast, determination of mine boundary, photometric survey in opencast, measurement of stripping, mineral tonnage and mineral stock calculation. Volume of cutting and embankment, volume and weight of coal and mineral, volume of water in pit calculation, Reserve calculation.

Modern Instruments in Surveying: Electronic Distance Measurement (EDM). Geodimeter, Tellurometer. Electro tape. Total Station, stereoscope; principles of working, type, Construction and application.

UNIT - 4 (12 Hours)

Principles of Field Astronomy: The celestial sphere. Zenith, Nadir, Poles, Equator. Observer's location on earth. Hour-Angle-Equator System. Azimuth and altitude. Relation among Latitude, Altitude and Declination. Astronomical Triangle.

Global Positioning System: Theory and applications in mine surveying. Terrestrial and aerial photogrammetry. Finding height and distance of ground points from photographs, scale of a vertical photograph, photographs versus maps.

Statutory Requirements: Mining plans and sections. General requirement, conventional symbol used for preparation of plans and sections. Statutory requirements under Mine Regulations. Preparation and preservation of plans and sections. Representation of geological and other features on mine plans and sections, survey office.

Recommended Readings:

1. William Wesely Staley; Introduction to Mine surveying;Stanford University Press
2. B. C. Punmia; Surveying Vol. III –12th edition; Lakshmi Publications.
3. T. P. Kanetker and S.V. Kulkarni; Surveying and leveling Vol I and II; Vidyapith Grihan Prakashan, Pune.
4. Ghatak; Mine Surveying Vol. I, II, III; 5th edition, Coal Field Publishers.
5. Jawahar Lal Sharma; A Textbook of Advanced Surveying; C.B.S. Publishers and Distributors.
6. Ghosh; Mine Surveying; Lovely Prakashan Pub., Pune.
7. Raymond E. Davis, Francis S. Foote, J. M. Anderson and E. M. Mikhail; Surveying Theory and Practice; Land Surveyors Pub.

Tutorial Exercise:

- The exercise shall include assignments and numericals based on above syllabus to be completed during Tutorial class.

MN 7.1 MINE ENVIRONMENT - II

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 7.1	Mine Environment - II	3	1	2	3	100	25	--	25	--	150

Course Objective:

1. To provides basic knowledge of mine atmosphere, its ventilation and lighting, its associated problems and remedies.
2. To understand the fundamentals of air flow through mine opening.
3. To know the methods of ventilation.
4. Understand the ventilation survey and illumination survey.
5. To understand the monitoring of underground environment.

Course Outcomes:

The student after undergoing this course will be able to:

5. Planned and execute such that the underground environment is comfortable and healthy for the people to work.
6. Select the suitable fans and drive as well as select proper airways to ventilate whole mine and/or its various parts, economically.
7. Design the best ventilation system to provide most economic and comfortable underground environment.
8. Comprehend importance of lighting in safe mining operations.
9. Describe the safe working procedure for mining activities.

UNIT - 1 (12 Hours)

Air flow through mine openings: Fundamentals of air flow, Reynolds number, laminar and turbulent flow, pressure losses due to friction and shock resistance, resistance of airways; laws of mine air friction, co-efficient of friction, resistance of roadways in series and parallel, air leakages, characteristic of airway and mine, Equivalent Orifice, Economic design of an airway; Distribution of air and flow control devices.

Auxiliary Fan and Booster Fan: Methods of ventilation for narrow headings, contra-rotating axial flow fan, rigid and flexible ducts, installation of booster fans, neutral lines, critical pressure, relevant coal mine regulation.

UNIT - 2 (12 Hours)

Ventilation Survey in Mines: Ventilation standards, Ventilation systems, Central and Boundary Ventilation system, combined system of ventilation; Instruments required for ventilation survey, pressure survey and quantity survey; Calculation of pressure and quantity requirements; Analysis of a simple ventilation system using Hardy-Cross method, monitoring of mine environment; Duties and responsibilities of Ventilation officer, CMR 1957 regulations 32A, 42A (Duties and responsibilities of Ventilation officer), Mine regulations: 130 (Standard of ventilation), 136A (Velocity of air current), 145 (Determination of percentage of inflammable gas and of environmental conditions) and corresponding regulations of MMR 1961.

UNIT - 3 (12 Hours)

Design of Mine Ventilation Systems: Basic principles of ventilation design, steps in ventilation Design. Air distribution with different mining systems, Design of ventilation systems for Board and Pillar and Longwall methods, Design of ventilation systems for various metal mining methods; Computer applications in Ventilation design. Analysis of ventilation cost.

UNIT - 4 (12 Hours)

Mine Illumination: Physics of Light; Light measuring techniques and instrumentation, Physiological requirements for human vision, Illumination Standards for Opencast mines, lighting arrangements for surface, Illumination standards in underground mines, Electric cap lamps, their maintenance and examination, lamp room design and organisation, Lighting from mains, Underground Coal and metal mine illumination, illumination survey, legislations related to Illumination survey.

Recommended Readings:

1. D. J. Deshmukh; Elements of Mining Technology-Vol II; Central Techno Publications, Nagpur.
2. G. B. Mishra; Mine Ventilation and Environment; Oxford University Press.
3. V. S. Vutukuri and R. D. Lama; Environmental Engineering in Mines; Trans Tech publishers.
4. M. J. Mc Pherson; Subsurface Ventilation and Environmental Engineering; Chapman and Hall Publication, London.
5. H. L. Hartman; Mine Ventilation and Air Conditioning; Wiley Publication.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. Measurement of air velocity using anemometer and calculation of air flow.
2. Determination of Air velocity using Pitot tube.
3. Study of various methods for Air Velocity Measurement in Mines
4. Comparing humidity and cooling power based on readings of Hygrometer and Kata Thermometer.
5. Designing a ventilation network involving multiple Bord and Pillar panels and determining the distribution of air based on given data.
6. Designing a ventilation network involving four Longwall faces and determining the distribution of air based on given data.
7. Calculation of booster fan capacity based on given data.
8. Study of ventilation systems for various metal mining methods.
9. Measurement of light intensity and its correlation with distance from source.
10. Design of lighting requirement for the main haulage roadway of a mine.

Tutorial Exercise:

- Tutorial classes shall include numerical problems on Reynolds number, Pressure losses due to friction and shock resistance, Equivalent Orifice, laws of mine air friction, Fan capacity, Pressure and air quantity requirements, Hardy cross method and Light measuring techniques.

- The exercise shall include assignments based on above syllabus to be completed during Tutorial class.

MN 7.2 MINE DISASTER MANAGEMENT

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
					Th. Duration (Hrs)	Marks					
		L	T	P		TH	S	TW	P	O	Total
MN 7.2	Mine Disaster Management	4	--	--	3	100	25	--	--	--	125

Course Objective:

1. To understand overview of disasters in general and mine disasters in particular.
2. To understand the disasters likely to be caused by mining, disaster preparedness and management.
3. Provide conceptual applications of principles of management to mitigate various disasters.

Course Outcomes:

The student after undergoing this course will be able to:

1. Identify and declare a condition safe or unsafe depending upon conditions and criterion presented about the mines.
2. Deal safely with spontaneous heating of coal.
3. Deal with mine explosion and inundation situations.
4. Design safety inspection plan to mitigate problems related to ventilation and fire.

UNIT - 1 (16 Hours)

Introduction to Disaster Management: Definition; Types of disasters, Natural such as Landslides, Cyclones, Earthquakes, Floods, Tsunami; Manmade such as chemical, biological and nuclear; Examples of major disasters in the recent past; Disaster preparedness; Disaster response and mitigation; Rehabilitation, Reconstruction and recovery. Major provisions of Disaster Management Act 2005; Introduction to Mine disasters; Fire, explosion and Inundation.

UNIT - 2 (16 Hours)

Spontaneous Heating: Mechanism, causes, detection, Incubation period, Crossing Point Apparatus, Grahams Index; monitoring and control of spontaneous heating in underground mines, on surface and in coal stacks; Incubation period; Preventive measures.

Fires: Classification of fires, Detection, prevention and control of underground fires; Fire fighting and inertization; fire fighting plan; fire extinguishers; fire stoppings; localization and ventilation control in fire fighting, dynamic pressure balancing; Study of atmosphere behind sealed-off fire areas; Methods of reopening sealed off fire areas; CMR-117 and CMR-118 for surface and underground precautions against fire. CMR-119 on action by individual in case of detection of fire; CMR-120 on equipment for fire fighting.

UNIT - 3 (16 Hours)

Fire Damp Explosions: Gassiness of Mine; Types, causes and mechanism of firedamp; Coward's Diagram; Preventive measures; Investigations after an explosion; Case histories.

Coal Dust Explosions: Types, causes and mechanism of coal dust explosion; Water spraying- Stone dusting, stone-dust and water barriers, quick barriers and triggered barriers; Localization of coal dust explosion; CMR-123 on dust control and stone dust barriers.

Mine Inundation: Causes, Precautionary measures, Precautions to be taken while approaching old workings, Burnside boring apparatus, Design and construction of water dams, Recovery of flooded mines, Dewatering of old working, Water blast; dangers and precautions.

UNIT - 4 (16 Hours)

Mine Rescue and Recovery Work: Different types of rescue equipment including self-rescuer; Mine regulation on rescue apparatus; Test on rescue apparatus: Rescue stations; Recovery and first-aid appliances; Training of personnel and organization of rescue station; Rescue and recovery work in connection with mine disasters; Fresh air base; CMR-125 on recovery and exploratory work; Main provisions of Mine Rescue Rules.

Recommended Readings:

1. M. A. Ramulu; Mine Fires, Explosion, Rescue, Recovery and Inundations; Mukhertu Publishers, Kharagpur.
2. M. A. Ramulu; Mine Disasters and Mine Rescue; Oxford and IBH Publishers.
3. The Mine Rescue Rules; Lovely Prakashan, Dhanbad
4. L. C. Kaku; Fires in Coal Mines; Oriental Publishers.
5. V. S. Vutukuri, R. D. Lama; Environmental Engineering In Mines; Cambridge university press.

MN 7.3 MINE SAFETY AND LEGISLATION

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 7.3	Mine Safety and Legislation	4	--	--	3	100	25	--	--	--	125

Course Objective:

1. To undersatnd various occupational and notified diseses due to mining activity.
2. To undersatnd the different accidents occurs in mines and how can increase the safety of workers and machineries and also to give knowledge about safety engineering and safety education and training.
3. To undersatnd the different statutory provisions of mines Acts, Rules and Regulations essential for mining industries for maintaining law and order as well as safe working conditions in mining areas.

Course Outcomes:

The student after undergoing this course will be able to:

1. Implement various statutory laws in mining areas.
2. Deal safely in any emergency and take right decision for working area.
3. Protect the society and environment in better way.

UNIT - 1 (16 Hours)

Health and Safety: Awareness on Health Safety and Environment policy, Definition of health and safety, Health and Workmen Comfort conditions; Occupational diseases - their causes, nature and prevention.

Management's Role in Safety: Safety organisation mines, role and responsibility of safety officer, Risk Analysis; Fault tree analysis- Methodology, symbols, Boolean techniques, qualitative and quantitative analysis; Creating and maintaining safety awareness; Safety campaign; Safety Audits.

UNIT - 2 (16 Hours)

Classification of Accidents: Statistics, causes, prevention and corrective action; Personal protective equipment; Costs of accidents; Accident investigations, Accident report by mine authorities; Accident proneness; frequency and severity of accident; ZAP

and MAP; Job safety analysis; Court of Enquiry and Accidents enquiry reports; Vocational training as an aid to safety and productivity.

UNIT - 3 (16 Hours)

Mines Act: Provisions of Mines Act 1952 with respect to safety - Medical appliances (Sec. 21), Power of inspector in case of danger (Sec. 22, 22a), Notice of accidents (Sec.23), Appointment of court of enquiry (Sec. 24), Notice of certain diseases (Sec. 25, 26), Publication of reports (Sec. 27).

Mines Rules 1955: Medical examination of persons employed in mines; Workman inspector and safety committee; health and sanitation provisions; first aid and medical appliances.

Mine Vocational Training Rules: Various training schemes; arrangement for refresher training; training centres; qualifications, duties and responsibilities of training officers; stipend and certification.

Indian Electricity Rules: regarding usage of electrical power in mines.

UNIT - 4 (16 Hours)

Mine Regulations: Coal Mines Regulation 1957 – Notices of accidents, disease (Reg. 9, 10,), Appointment of Safety Officers, Officials, Competent persons (Reg.31a, 36), Duties of Safety Officer (Reg.41a), Fencing and gates (Reg. 68, 84, 97, 112, 187), Avoidance of dangers (Reg.114), PPE's (Reg.191), Information about sickness (Reg.192), Place of accident (Reg.199), Emergency plan (Reg.199A); Similar provisions under Metalliferous Mines Regulations 1961.

Recent Technical Circulars: issued by DGMS on safety.

Recommended Readings:

1. P. Seshagiri Rao; Law of Mines and Minerals; Published by Asia Law House, Hyderabad.
2. Rakesh and Prasad; Legislation in Indian Mines Vol. I and II; Mrs. Asha Lata Publ, Varanasi.
3. Kejriwal B. K.; Safety in Mines; Gyan Khan Prakashan..
4. Mines Act 1952, Lovely Prakashan, Dhanbad.
5. Coal Mines Regulation 1957

MN 7.4.1 ROCK FRAGMENTATION ENGINEERING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 7.4.1	Rock Fragmentation Engineering	4	--	--	3	100	25	--	--	25	150

Course Objective:

1. To study mechanisms of rock fragmentation by blasting and energy partitioning during blasting.
2. To learn emerging trends in explosives, bulk loading systems and initiation systems.
3. To learn various blast design approaches for surface mines, blast design and evaluation of blast results.
4. To study blast monitoring tools and techniques, analysis and interpretation.
5. To study environmental impacts of blasting and control methods. analysis s and interpretation

Course Outcomes:

The student after undergoing this course will be able to:

1. Apply the principles of mechanisms of rock fragmentation by blasting and energy partitioning during blasting in the selection of explosives and arriving at blast design parameters.
2. Familarise emerging trends in explosives, bulk loading systems and initiation systems.
3. Apply integrated blast design approach for surface blast design.
4. Familiarise blast monitoring tools and techniques, analysis and interpretation.
5. Assess and control environmental impacts of blasting.

UNIT - 1 (16 Hours)

Explosive-Rock Interaction: Mechanisms of rock fragmentation by blasting. Energy partitioning during blasting. Emerging trends in explosives and bulk loading systems. Emerging trends in initiating systems, analysis of case studies of surface blasting with electronic detonators.

UNIT - 2 (16 Hours)

Blasting in Surface Mines: Controllable and non-controllable factors in rock blasting, Concept of optimal fragmentation, muck pile profiles and their influence on loader productivity. Blast design approaches for surface mines. Fragmentation prediction approaches and KUZRAM model. Software for surface blast design and analysis. Alternative methods for rock breakage.

UNIT - 3 (16 Hours)

Blast Monitoring: Tools and techniques for pre-blast, in-blast and post-blast monitoring; application of high speed videography for burden movement and stemming performance; image analysis techniques for measurement of rock fragmentation by blasting; Instrumentation, field recording and analysis of In-the-hole velocity of detonation measurements.

UNIT - 4 (16 Hours)

Blast Damage and Environmental Impacts: Rock mass damage and its implications; Methods to assess blast damage. Control of blast damage using special techniques like line drilling, smooth blasting and pre-splitting.

Instrumentation and Software: for vibration and air overpressure monitoring and analysis. Various PPV predictor equations; Fast Fourier Transform Analysis for frequency; Projectiles theory based prediction of flyrock. Control of ground vibrations, air overpressure and flyrock; Signature hole method for vibration control.

Recommended Readings:

1. G. K. Pradhan; Explosive and Blasting Technology; Mintech Publications, Bhubaneshwar.
2. Bhandari; Blasting Engineering Operations; Elsevier.
3. E. Lopez Jemino, C. Lopez Jeminino, and Ayala Carced; Drilling and Blasting of Rocks; Taylor and Francis.
4. C. J. Konya and E.J. Walter; Surface Blast Design; Prentice Hall, New Jersy.
5. N. R. Thote and G. K. Pradhan; Mine Blast Evaluation; MINTECH Publications, Bhubaneswar, India.

MN 7.4.2 UNDERGROUND SPACE TECHNOLOGY

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 7.4.2	Underground Space Technology	4	--	--	3	100	25	--	--	25	150

Course Objective:

5. To understand Basic concept and terminology associated with underground metal mining and present status of Indian metal mining industry.
6. Getting knowledge of Various stoppign methods and its selection based on rock properties.
7. Understand various special metal mining methods developed for specific conditions and type of ore.
8. Understanding Metal Mining Regulations on methods of working.

Course Outcomes:

The student after undergoing this course will be able to:

5. To get familiar with various aspects of underground metal mine development.
6. Select appropriate metal mining method and perform production calculations.
7. Analyze the requirement and extenet mechanization and ventilation required.
8. Understand and Solve problem associated deep mining and rock burst prone areas.

UNIT - 1 (16 Hours)

Introduction: Philosophy of tunnelling scope of tunnelling for mining engineers, historical context, tunnel cross-section terminology.

Site Investigation: Site reconnaissance; Ground investigation-Intrusive techniques and Non-intrusive techniques such as seismic methods, bore hole geophysical logging, cross-hole seismic techniques. Laboratory tests-Quality class test for soil, Uniaxial test, consistency of silt and clays, Triaxial test; Ground characteristics/parameters-influencing of layering on modulus of elasticity, squeezing and swelling ground; Ground parameters for tunnel design. Ground classification based on RQD, RMR,Q-Technique; Key information for tunnel design.

UNIT - 2 (16 Hours)

Preliminary Analysis for the Tunnel: Stress pattern in ground, Stability of soft ground, coefficient of lateral earth pressure, preliminary analytical methods-bedded beam spring method, continuum method and tunnel support resistance method; Preliminary Numerical modelling-Modelling the tunnel construction in 2D and 3D.

Ground Improvement Techniques and Lining System: Ground improvement and stabilization techniques- ground freezing, lowering of ground water table, grouting, ground reinforcement, forepoling, face dowels, roof pipe umbrella, compensation grouting and pressurize tunnelling; Tunnel lining system-design requirement, sprayed concrete, ribbed systems, segmental linings, in-situ concrete linings and fire resistance of concrete linings.

UNIT - 3 (16 Hours)

Tunnel Construction Techniques: Introduction, Open face construction without shield- timber heading, open face tunnelling with alternative lining; partial face boring machine, tunnelling shields; tunnelling boring machine- gripper tunnel boring machine, sealed tunnel boring machines, general observations for hard rock tunnel boring machines; tunnels boring machine in soft ground- slurry tunnelling machines, earth pressure balancing machines, multimode tunnel boring machines, choice of tunnel boring machine.

Tunnelling by Drilling and Blasting: Drilling, charging, stemming, detonating; Ventilation; Marking and support; Full face method, Heading and Benching methods of excavation; Controlled blasting; Major Problems in drill blast tunnel method.

Special Methods of Tunnelling: NATM tunnelling method- New Austrian tunnelling method, LaserShell Technique; Cut and Cover tunnels-construction methods, design issues, excavation support method for the side of excavation; Immersed tube tunnels-stages of construction, type of immersed tube tunnels, immersed tube tunnel foundation and settlements, joint between tube elements, Analysis and design; Jacked Box tunnelling – method and key components; Pipe Jacking and micro tunnelling-construction process, maximum drive length for pipe jacketing; horizontal directional drilling.

UNIT - 4 (16 Hours)

Underground Space Construction: Need for Underground Space: Congestion driven needs, storage of materials; Engineering Utilities; Nuclear Waste Disposal; Strategic Utilities; Excavation issues and methods of large and deep caverns - unit operations, different equipment, types of rock pressure and methods to deal, roof and wall supports.

Underground Storage of Grain and Food: their advantages, disadvantages, underground cold storage and cellar for foods and beverages.

Hydropower Tunnels and Caverns: Basic Principles, Layout of power house caverns and desilting chambers. Underground storage for LPG, LNG, Crude and its products – basic principles; Nuclear Waste Disposal: Conditions, effect of radioactivity and heat on surrounding rock, conceptual design of a nuclear waste disposal facility; Defense facilities: Bunkers and shelters, navy bases, air force hangers.

Case Studies: Hydel, Crude Oil, LPG and Nuclear facilities; Preparation of different conceptual plans of underground space applications.

Recommended Readings:

1. David Chapman, Nicole Metje and Alfred Stark; Introduction to Tunnel Construction; CRC Press.
2. Ernest D. Wahlstrom; Tunnelling in Rock; Elsevier.
3. Ray Sterling and Jioan Zhao; Tunnelling and Underground Space Technology; Elsevier.
4. Proceedings of International Conference on Underground Space Technology and the 8th Asian Regional Conference of IAEG 19th January 2011, Bangalore.
5. Proceedings of International Conference on Tunnelling and Ground Space Technology, WTC 2012, 18-23 May 2012, Bangkok.
6. Proceedings of International Conference on Urban Underground Space and Tunnelling 20-22 November 2013, Hong Kong.

MN 7.4.3 PETROLEUM ENGINEERING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 7.4.3	Petroleum Engineering	4	--	--	3	100	25	--	--	25	150

Course Objective:

1. To get basic knowledge of Petroleum Geology and Reservoirs.
2. To understand the techniques of explaration and exploitation of Petroleum.
3. To have a basic understanding recovery and treatment of Petroleum and its products.

Course Outcomes:

The student after undergoing this course will be able to:

1. Understand the geological setting, migration and trapping of peroleum deposits.
2. Understand the methods of Exploration and estimation of Petroleum reserves.
3. Familarise with the recovery and processing of petroleum.

UNIT - 1 (16 Hours)

Petroleum: Its different states of natural occurrence, chemical composition and physical properties of crudes in nature; Origin of petroleum (Organic and Inorganic theories); Bitumen and Kerogen.

Reservoir Rocks: Classification of reservoir rocks – fragmental reservoir rocks and chemical reservoir rocks. General attributes and petrophysical properties; Porosity and Permeability; control of Sediment character on petrophysical properties.

Migration of Oil and Gas: Geologic framework of migration; primary and secondary migration; Geologic factors controlling hydrocarbon migration; Forces responsible for migration, Migration routes and barriers.

Hydrocarbon Traps: Definition; classification of hydrocarbon traps – structural, stratigraphic and combination; Cap rocks – definition and general properties.

UNIT - 2 (16 Hours)

Exploration Methods: Surface indications of subsurface oil and gas accumulations. Regional Petroleum Prospecting – Magnetic, Gravity and Seismic, remote sensing, geochemical; Procedures for data Collection, Correction, Interpretation; Hot spots for oil and gas.

Reserve Estimation: Classification of Reserves (UNFC/SPE), Reserve Status Categories, Methods of Reserve Estimation: Analogy, Volumetric, Material Balance, Model Studies, Production Decline Curves; quality of reserve estimates.

UNIT - 3 (16 Hours)

Drilling: Types of Drilling, Outline of Drilling equipment; drilling complications and mud importance; Deep hole drilling. Introduction to Offshore drilling technology, Fishing tools and Techniques.

Drill Fluids: Drilling Fluid Characteristics; Basic functions, properties, maintenance and treatments of drilling fluids. Classification, Types and applications of Drilling Fluids: Water based, oil based, emulsion based, polymer based, Surfactant based, Foam based and Aerated drilling fluids.

Casing and Cementation: Objectives of cementing, oil well cements, Classification of cement, Cementing equipments. Cementing Methods: Primary cementing, Stage cementing, Liner cementing, Plugging, Squeeze Cementing techniques in practice. Deep well cementing, Characteristics of good quality cementation.

UNIT - 4 (16 Hours)

Well Completion and Production: Logging operations, Logging methods, Interpretation; Oil recovery techniques. Well equipment: Christmas tree, valves, hangers, flow control devices, packers, tubular and flow lines. Introduction to Well completion: Systems, types and applications. Introduction to well servicing and stimulation system – objectives and applications; Production problems.

Introduction to Processing in Oil Fields: GGS/CTF – layout, sequential treatment, separation, storage and transportation of petroleum. Basics of crude oil refining and Natural gas processing. Introduction to petrochemicals.

Recommended Readings:

1. Bjorlykke, K. ; Sedimentary and Petroleum Geology; Springer Publ.
2. Chaudhuri, U. R.; Fundamentals of Petroleum and Petrochemical Engineering; CRC Press.
3. Levorsen, A. I.; Geology of Petroleum; CBS Publ.
4. F. K. North; Petroleum Geology; Allen and Unwin.
5. R.C. Shelley; Elements of Petroleum Geology; Academic Press.

MN 7.4.4 COAL BED METHANE

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 7.4.4	Coal Bed Methane	4	--	--	3	100	25	--	--	25	150

Course Objective:

1. To understand Geological influence on coal, its formation and CBM.
2. To understand characterization of CBM and reservoir rocks
3. To understand methodology to produce CBM
4. To understand utilisation of CBM as source of energy

Course Outcomes:

The student after undergoing this course will be able to:

1. Abel to explain exploration and development of Coal Bed Methane
2. Able to use metane resources for benifeits of industry.

UNIT - 1 (16 Hours)

Introduction: Role of natural gas, conventional natural gas resources. Geological influence on coal; Characteristics of Coal Suitable for CBM Production. Development of Unconventional Gas Resources from Coal; Coal Bed Methane (CBM),Coal Mine Methane (CMM) Enhanced CBM (ECBM),CBM resources.

Overview of CBM Vs. Conventional Reservoir: Gas compostion, Adsorption, water production, gas flow, rock physical properties, gas content, coal rank, gas production.

Coal Chemistry: Molecular structure,Macerals,lithoypes,functional groups, proximate analysis,ultimate analysis.Significance of rank: definition and measurement,vitrinite reflectance measurement,physical properties, volatiles generated, micropores. Cleat system and natural fracturing.

UNIT - 2 (16 Hours)

Sorption: Principles of adsorption; theory, Langmuir Isotherm, similarities of adsorbed methane and liquid behavoir, extended Langmuir isotherm, industry used for

adsorbents, Methane retention by coalseams, Methane contents determination by coal seams,the isotherm for recovery perediction.

Model of the Micropores: pore geometry, Carbon molecural sieves. Coal sorption of other species; swelling of coal matrix, Heavier hydrocarbons,carbon dioxide and Nitrogen. Effect of ash and moisture on methane adsorption.

UNIT - 3 (16 Hours)

Reservoir Analysis: Coal as a reservoir, Permeablity; Drillstem test,slug test,Injuction falloff test, depth effects on permeability, shrinkage and stress effect on permeability, water composition as permeability indicator, relative permeability, Butt and Cleat permeability. Porosity: Gas flow; Diffusion in microspores, Darcy flow in cleats, sorption time. Reserve analysis; Gas in place, decline curves. Well spacing and drainage area. Enhanced recovery

UNIT - 4 (16 Hours)

CBM Well/Hole Construction: drlling; drill bits, drilling fluids. Cementing; foam cement, lightweight additives.

Formation Evaluations, Logging: borehole environment; downhole environment, wireline logging. Total measurement response in coal.Wireline log evaluation of CBM wells. Gas in place calculation. Recovery factor. Drainage area calculations.

Economics of Coal Bed Methane: Recovery; Tax Credit, Measures of Profitability, costs; Drilling and Completion, Water Disposal. Structured Resource Evaluation.

Recommended Readings:

1. Pramod Thakur, Kashy Aminian Steve Schatzel; Coal Bed Methane: From Prospect to Pipeline; Elsevier.
2. John Seidle; Fundamentals of Coalbed Methane Reservoir Engineering; PennWell Corp.
3. Rudy E. Rogers, Kumar Ramurthy, Gary Rodvelt, Mike Mullen; Coalbed Methane: Principles and Practices; Halliburton’s Ramurthy.
4. Romeo M. Flores; Coal and Coal Bed Gas - Fueling The Future; Elsevier.
5. Bondarenko Volodymyr, Kovalevs'ka Iryna, Ganushevych Kostiantyn; Progressive Technologies of Coal, Coalbed Methane, and Ores Mining; CRC Press.

MN 7.5.1 BULK MATERIAL HANDLING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 7.5.1	Bulk Material Handling	4	--	2	3	100	25	--	--	25	150

Course Objective:

1. To introduce the basic principles in material handling, characteristics and classification of materials
2. To study the various bulk handling systems deployed in mineral industry.
3. To study the classification of materials handling equipment
4. To study material transportation and hoisting equipment
5. To study bulk handling equipment and systems

Course Outcomes:

The student after undergoing this course will be able to:

1. Familiarise with the basic principles in material handling, characteristics and classification of materials.
2. Familiarise with the various bulk handling systems deployed in mineral industry to convey the minerals or materials from mines, plants and workshops.
3. Obtain basic knowledge on the classification of materials handling equipment.
4. Select appropriate material transportation system and hoisting equipment
5. Select appropriate bulk handling equipment and systems.

UNIT - 1 (16 Hours)

Introduction to Materials Handling: Definition and Scope of Materials Handling; Importance of Materials Handling; Systems Concept; Characteristics and Classification of Materials; Principles of materials handling.

Unit Load Concept: Definition of Unit Load; Advantages and Disadvantages; Load Unitization Process and Handling Methods.

UNIT - 2 (16 Hours)

Unit Material Handling System: Design of bins and hopper, ore passes, Primary crushing and screening: jaw, cone, roll and gyratory crushers; Rotary breakers; In-pit crushers; single deck or double deck; scalping, vibratory and rotary screens; coal handling plants; rail wagon loading plants; chute design, loading impact protection.

Classification Of Materials Handling Equipment: Basic Equipment Types; Classification of Handling Equipment; Wagon tipplers; bucket elevators.

UNIT - 3 (16 Hours)

Material Transportation: Conveyors (Belt Conveyors; Chain Conveyors Haulage Conveyors; Cable Conveyors Bucket Conveyors; Roller Conveyors; Screw Conveyors; Hydraulic and pneumatic conveying, conveyors (belt, chain, cable belt, high angle, shiftable and pipe conveyor); water transport; materials handling at jetty and barge.

Hoisting Equipment: Parts of Hoisting Equipment; Hoists; Winches; Elevators; Different types of Cranes (Derricks, tower, radial) fork lifters, overhead gantry mat

UNIT - 4 (16 Hours)

Bulk Handling Equipment and Systems: Storage of bulk solids; Stacking, blending and reclaiming of bulk materials; Types of stackers and reclaimers; Design of storage system: material stockpiling and stockpiles, Silos, bins and bunkers; Segregation (size wise and grade wise); Railway sidings; Rapid loading system, Merry-go-round system; Automation and online monitoring of bulk material handling system. Weighing and Control Equipment; various types of weigh bridges; spillage and dust control.

Recommended Readings:

1. Siddhartha Ray; Introduction of Materials Handling; New Age International.
2. Rudenko;Material Handling Equipment; MIR Publishers.
3. Raymond A. Kulwiec; Materials Handling Handbook; John Wiley and Sons.
4. Sharma, S. C.; Materials Management and Materials Handling; Khanna Publishers.
5. K. C. Arora and Vikas V. Shinde; Aspects of Materials Handling; Laxmi publishers.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. To determine the angle of static friction between bulk material and metallic plate.
2. To study and find out the angle of repose of given samples.

3. To study the particle site distribution of given sample by sieve analysis.
4. To study the reduction ratio of ball mill for different samples.
5. To study the reduction ratio and power consumption of ball mill of given sample.
6. To study the reduction ratio of jaw crushers for different samples.
7. To study the flow pattern of different materials in hopper bin.
8. To study the H-Q characteristic of a centrifugal pump.
9. To study bucket elevator system
10. To study the response of different rocks under free fall.

MN 7.5.2 OPTIMIZATION TECHNIQUE IN MINERAL INDUSTRY

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 7.5.2	Optimization Technique in Mineral Industry	4	--	2	3	100	25	--	--	25	150

Course Objective:

1. To study different methods of optimisation
2. To understand application of optimization theories for solving mining problems.

Course Outcomes:

The student after undergoing this course will be able to:

1. Understand various optimization techniques applicable for engineering projects.
2. Apply optimization techniques to solve on field mining problems.

UNIT - 1 (16 Hours)

Minimization and Maximization: using differential calculus, optimization of cut-off grade; Linear Programming –concepts, graphical solutions, Simplex method, primal-dual model, sensitivity analysis.

UNIT - 2 (16 Hours)

Assignment Problems: the Hungarian Method; Transportation problems in mining, Dynamic Programming, stage coach problem and their application in mining. Discrete and continuous probability distributions, stochastic process; Markov chains and its application in mining.

UNIT - 3 (16 Hours)

Network Analysis: problems of shortest path, minimal spanning tree, maximal flow, CPM and PERT, application of network analysis in planning, scheduling the mining project; Queuing System-Basic queuing models with constant arrival and service rates, its application in shovel-dumper system.

UNIT - 4 (16 Hours)

Genetic Algorithms, representation of design variables, objective Function and Constraints, Genetic Operators; Neural-Network based optimization in mining; Inventory model; Definition, deterministic models, probabilistic models and their application to mining.

Recommended Readings:

1. S. S. Rao; Engineering Optimization; New Age International Publishers, Third Edition.
2. A. Ravi Ravindran (Editor); Operations Research Applications; CRC Press.
3. P. K. Gupta and D. S. Hira; Operations Research; Chand Publication, New Delhi.
4. Hamdy A. Taha; Operations Research: An Introduction; Macmillan Publishing Co., Indiannapolis,USA.
5. Kanti Swarup, P.K. Gupta, Man Mohan; Operations Research; Sultan Chand and Sons, New Delhi.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. Determine cut-off grade of ore in a mine.
2. Optimize cost of transportation for supplying coal from mines to various destinations.
3. Determine the optimal assignment of 'm' jobs or workers to 'n' machine in a mine using Hungarian Method.
4. Scheduling of production in a mine.
5. Scheduling of equipment and machinery overhauls in a mine.
6. Performance analysis of mining equipment using Markov Chain.
7. Determine equipment replacement policy in a mine.
8. Optimize mining project completion time.
9. Optimize shovel-dumper system in open cast mine by Queuing System.
10. Optimization of scheduling of drilling, blasting, loading and support operation in development heading.
11. Optimize drilling and blasting cost for surface mine.
12. Determine optimum level of inventory to be maintained in a mine.

MN 7.5.3 COMPUTER APPLICATION IN MINING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 7.5.3	Computer Application in Mining	4	--	2	3	100	25	--	--	25	150

Course Objective:

1. To understand the importance of computer application in different areas pf Mine Management.
2. To get aquainted with mining softwares like CAE studio 3, SURPAC, etc.
3. To understand various softwares dealing with database management systems in Mines.

Course Outcomes:

The student after undergoing this course will be able to:

1. Use Mining softwares for ore body modelling and reserve estimation.
2. Understand the solutions and output developed by Mining Softwares.
3. Use Mining Softwares for planning and other activities.

UNIT - 1 (16 Hours)

Introduction to Computers: Importance of computer application in mining, Different areas of application. Introduction to Computers and hardware for application in mining industry. Computer graphics, model simulation and virtual reality, artificial intelligence, expert system, neural networks, simulated annealing, robotics.

UNIT - 2 (16 Hours)

Software: Application of structured and object oriented programming languages to mining problems like pillar design, blast design, subsidence etc. Introduction to mining application software like CAE STUDIO 3, SURPAC, BLASTWARE, FRAGLYST, GALENA, ANSYS, FLAC, UDEC, STABL, VENTSIM.

UNIT - 3 (16 Hours)

Database Management Systems: Database and Relational database - development of software packages for mining companies – forms, queries and reports: Management

Information System – enterprise resource planning for safety, production machineries, manpower, finance, and other mining operations.

UNIT - 4 (16 Hours)

Problem Solving: Applications in Mining: Ventilation network analysis; online and offline monitoring and control. CAD in mining – geo-statistics, reserve estimation, kriging, block modelling and orebody modelling, pit design and optimization, mine scheduling, Truck dispatch system, blast design etc., digitization and scanning of mine maps - GIS in mining.

Recommended Reading:

1. Ramani R.V., et al.; Computers in Mineral Industry; Oxford and IBH Publishers.
2. Fytas, K. and Singhal, R.K.; Computers Applications in Mineral Industry; A. A. Balkema Publication.
3. R.V. Ramani (Editor); APCOM Proceedings Application of Computers and operations Research in the Mineral Industry, The Society of Mining, Metallurgy and Exploration, Inc.
4. Kadri Dagdelen, Editor; Computer Applications in the Minerals Industries; Colorado School of Mines.
5. E Balagurusamy; Fundamentals of Computers; Mc Graw Hills Publication.
6. S. K. Basandra; Computers Today; Galgotia Publications Pvt. Ltd.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. Data generation, collection and Validation through computers for exploration.
2. Digital Terrain modelling, String and Wire-frame modelling.
3. Ore body modelling and reserve estimation.
4. Open pit Mine planning and design:
    a. Generation of external dumps, mine pit, haulage roads and ultimate pit design.
    b. Excavation Scheduling.
5. Slope stability analysis.

6. Truck dispatch system optimization.
7. Underground Mine planning and design:
    a. Generation of mine entry, mine development.
    b. Excavation Scheduling
8. Development of algorithm/Modelling of airflow through underground workings.
9. Digitisation and scanning of mine plans.
10. Production scheduling for grade control.
11. Management Information System and Database management systems for:
    a. Production reporting.
    b. Statutory report and returns.
    c. Safety Management.
12. Computer programming for mining problems like design of pillars / blast design /Subsidence prediction.

MN 7.5.4 ADVANCED SURFACE MINING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 7.5.4	Advanced Surface Mining	4	--	2	3	100	25	--	--	25	150

Course Objective:

1. To understand the need of surface mining advancements with technological / equipment upgradation.
2. Getting knowledge of various Novel methods of mining, application of GPS and Geomedia software, improved HEMM, transporting equipments.
3. Understand reclamation, ecology and environmental aspects related to surface mining projects.

Course Outcomes:

The student after undergoing this course will be able to:

1. To get familiar with various aspects of surface mining advancements.
2. Selection of appropriate mining methods and equipments in a sustainable way with due diligence to environment and localities.

UNIT - 1 (16 Hours)

Introduction to Surface Mine: Bench Parameters- height of bench, width of bench and slope angle, face length; Stripping ratio, breakeven stripping ratio; Determination of Open/Underground mining boundaries; Issue associated with expansion of deep open pit mines; Factors which influence the quality of run-of-mine coal; Strategies for extraction of low grade mineral deposits; Production target and Life of Mines, environmental condition.

Slope Stability: Types of slope failure; Slope stability analysis for circular, wedge failures; Influence of of geotechnical parameters of rocks, structural, geological, ground water conditions, assessment of drainage requirements.

UNIT - 2 (16 Hours)

Winning Methods and Layouts: Site preparation and ground cleaning; Box cut- types, location in various conditions; approach routes; Excavation of overburden; number of

entries; haulage system; overcasting and side casting by dragline, simple side casting, extended bench side casting, tandem side casting. Over casting by shovels, mobile bridge conveyors, bucket wheel excavator and conveyor bridge combination.

Novel Methods of Mining: Principles, design aspect, advantages and disadvantages of hydraulicking, placer mining, dredging and leaching; mining over old underground workings; Highwall mining; Deep sea mining; Application of GPS and Geomedia software.

UNIT - 3 (16 Hours)

Heavy Earthmoving Machinery: Selection, application, comparison, capacity, operating parameters, safety aspects; advantages and disadvantages of hydraulic excavators, rope shovels, dragline, front-end-loader, bucket wheel excavator, dozers, scrapers, motor grader, hydraulic hammer, rock breakers; clamshell and back hoe; Mining by Surface Miners, In-pit crushing and conveying techniques.

Transporting Equipment: Selection, matching, application, safety aspects, merits and demerits of haulage equipment like, rear discharge dumper, side discharge dumper, bottom discharge dumper. Relative merits between electrical and mechanical drive system. Rail transport system, pipe line transport system and belt conveyors; steep angle conveyors; high angle conveyors; Application of skip transportation and truck lift system in surface mines.

Infrastructural Facilities: Stores, workshops, preventive maintenance and routine condition monitoring, power supply and communication.

UNIT - 4 (16 Hours)

Stacker, Reclaimer and Spreader: Stacker; Storage Stockpiling and blending; Revolving structure, conveyor system, crawler mechanism, auxiliary equipment, technical specifications. Reclaimers and the types of Reclaimers- bucket wheel reclaimer, bridge type reclaimer, stacker cum reclaimer. Spreaders and their selection, different types, spreader system versus truck dumping, advantages and disadvantages of different types of spreaders.

Reclamation, Ecology and Environmental: Land management, protection of forests and wild animals. Water pollution management; Water quality standards and effluent limitation, ground water protection, water pollution problem in lead, zinc and other mineral industry with problem solution. Basic reclamation works, alternatives for land use, using of abandoned mine spaces for waste storage, Reclamation Methods of reclamation of mined out areas, dumps and tailings pond Air pollution management; ambient quality standards, effect on human; Surface mine waste management; Sociological problem and protection of wild life.

Recommended Reading:

1. S. K. Das; Surface Mining Technology; Lovely Prakashan, Dhanbad.
2. G. B. Mishra; Surface Mining; Lovely Prakashan, Dhanbad.
3. W. Hustrulid and M Kuchta; Open Pit Mine Planning and Designing; A A Balkema Publishers.
4. P. Sen and B. S. Choudhary; Proceeding of the 6th National Seminar on Surface Mining; ISM, January 10-11.
5. H. L. Hartman; SME Mining Engineering Handbook, SME Publ.
6. D. J. Deshmukh; Elements of Mining Technology, Vol I; Central Techno Pub, Nagpur.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. Layout of a mechanised surface lime stone mine with an output of 10,000 tonnes/day in flat deposit.
2. Layout of highly mechanised surface copper mines with an output of 5,000 tonnes/day in flat deposit.
3. Layout of surface coal mine with an output of 1000 tonnes/day in a deposit having a gradient of 6O.
4. Layout of highly mechanised opencast coal mine with an output of 5,000 tonnes/day, the deposit is 20 m thick and dipping at 4O.
5. Layout of a highly mechanised surface lead-zinc surface mine with an output of 1.25 million tonnes of ore per annum. The deposit is dipping at 66O and having thickness of 20 m.
6. Layout of highly mechanised surface mines with an output of 2 million tonnes per annum. The deposit is 20 m thick, flat and occurred in the hill top.
7. Layout of a manual surface Iron ore mine, with an output of 1000 tonnes ore per day. The deposit is 10 m thick and dipping at an angle of 45O along the slope of hillock.
8. Layout of a highly mechanised lignite mine with an output of 3 million tonnes of lignite per annum. The lignite deposit is 20 m thick and flat.
9. Determination of pit slope angle from the given parameters like bench height, bench width, number of benches etc by both graphical and numerical methods.
10. Estimation of total inflow of water into the pit accounting for groundwater and rain water.
11. Surface Mine visit for better understanding of latest methods and machineries.

MN 7.6 PROJECT

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 7.6	Project	--	--	4	--	--	--	--	--	25	25

Guidelines for Project Work:

1. Project can be undertaken in-house or in an industry or in a research /service organization.
2. Generally a Project batch consists of two to four students.
3. The Project Synopsis should be prepared in the beginning of the term and approved by a designated departmental committee.
4. The topic of the project may be in the area related to mining, or it may be multidisciplinary. It may involve investigation/ analytical study / experimental work / fabrication / Statistical study / simulation etc. it may also be field oriented. The project should be preferably being taken in the latest trends in Engineering and Technology.

Project Report:

The Project (Interim) report shall consist of the following:

a. Problem identification.

b. Statement of problem.

c. Formulation of the objective and Scope of the study.

d. Literature review.

e. Methodology to be adopted.

Review:

Monthly review to assess the progress of the project work will be conducted by the Guide. Students shall submit project reports to the department and make a presentation before the departmental committee at the end of Semester.

MN 8.1 MINE PLANNING AND DESIGN

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 8.1	Mine Planning and Design	4	1	--	3	100	25	--	--	--	125

Course Objective:

1. To study the objectives and the principles of mine planning, mine planning process, stages of mine planning and input information required for mine planning and design.
2. To study planning and design of surface mines covering optimum output, life of the mine, pit configuration, mine entries, production planning and scheduling.
3. To arrive at a suitable exploitation strategy for a mineral deposit within legal, financial and regulatory requirements and constraints.
4. To identify the sources of uncertainty and risk management, various stages in project implementation, import of technology.
5. To study various aspects of Mine closure plan and R and R plan, Appraisal of Mining Project, Cost profit analysis.

Course Outcomes:

The student after undergoing this course will be able to:

1. To integrate all the activities involved in the overall mining process that will meet required production, productivity, health, safety, environment, and cost criteria.
2. To apply the objectives and the principles of mine planning, mine planning process, stages of mine planning and input information required for mine planning and design.
3. To understand and execute the mine plans at a suitable exploitation strategy for a mineral deposit by surface and underground mining.
4. To identify the sources of uncertainty and risk management, various stages in project implementation, import of technology.
5. To study various aspects of mine closure plan and randr plan, appraisal of mining project, cost profit analysis.

UNIT - 1 (16 Hours)

Introduction to Mine Planning: Objectives and Principles of mine planning, Mine Planning Process, Scientific and engineering approach to mine design. Strategic planning; Stages of mine planning - Long Range Planning, Short Range Planning, division of a coal field into mining blocks; Technical, Economical and environmental information required for mine planning; Techno-economics of opencast versus underground mining operations.

UNIT - 2 (16 Hours)

Surface Mine Planning: Determination of optimum output, life of a mine and size of mine, Taylor's mine life rule, ultimate pit configuration. Optimum location of mine entries, Technical and economic considerations in opening up, bench formation and ultimate pit configurations; Determining Pushback Parameters, Pushback Selection/Mining Sequence, Production planning and scheduling, calendar plan, mine equipment planning, Grade control strategies, infrastructure planning. Systems of overburden removal and planning of layouts for stipulated production; Drainage Planning and Arrangement, Reclamation Planning - Planning for reclamation of mined out areas, open pits, waste dumps and tailings pond, The Detailed Mine Plan, Surface Plan.

UNIT - 3 (16 Hours)

Underground Mine Planning: Capacity of a Mine; Delineation of mining area; Annual output and life of the mine; Design of mine entry systems- Opening of single and multiple seams/veins at various inclinations – Type (shaft, incline or adit), number, location and design; Division of the mining area into working units on district and level pattern.

Coal Mining: Dimensions of panels and blocks; Selection of mining methods; design of coal pillars, Layout of development drives, size of panels, length, number and position of Longwall faces, layout of drainage system, production schedule and monitoring, mine economic analysis.

Non-Coal Mining: Selection of mining methods; Design of Crown pillars, Layout of development drives, Stope design, layout of drainage system, production schedule and monitoring, mine economic analysis.

UNIT - 4 (16 Hours)

Project Implementation and Monitoring: Social, Legal, Political and Economic aspects of mine planning, Sources of uncertainty in mining projects; assessment of alternatives

and risk. Various stages in project implementation, import of technology, Identification of activities for outsourcing, Need of Mine closure plan and RandR plan, Sources of funds, Social responsibility, Quality assurance plan, resource management, time management,. Appraisal of Mining Project, Cost profit analysis.

Recommended Reading:

1. William A. Hustrulid, Mark Kuchta; Fundamentals of Open Pit Mine Planning and Design, Vol I and Vol II; Elsevier.
2. Hartman; Introductory Mining Engineering; John Wiley and Sons Inc.
3. Jayant Bhattacharya; Principles of Mine Planning; Allied Publishers, Delhi.
6. S. K. Das; Modern Coal Mining Technology; Lovely Prakashan, Dhanbad.
7. R. D. Singh; Principles and Practices of Modern Coal Mining; New Age International (P) Ltd. Publishers.

Tutorial Exercise:

- The exercise shall include assignments and numericals based on above syllabus to be completed during Tutorial class.

MN 8.2 MINE ENVIRONMENTAL MANAGEMENT

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 8.2	Mine Environmental Management	4	--	2	3	100	25	--	25	--	150

Course Objective:

1. To understand the environmental changes caused by mining projects and occupational health hazard associated with minining activities.
2. Getting knowledge of Air and water pollution from mining and its management.
3. Understand concept of land reclaimation and environmental planning for mining project.
4. Understanding different environment related rules and regulations pertaining to mining.

Course Outcomes:

The student after undergoing this course will be able to:

1. To get familiar with various aspects of Envoronmental Control in Mines and Mining Projects.
2. Select appropriate management techniques for minizing and managing air and water pollution.
3. Analyze the requirement and compliance of environment related rules and regulations pertaining to mining.
4. Understand and Solve problem associated with land reclaimation and soil degradation.

UNIT - 1 (16 Hours)

Man and Mine Environment: Changes of social environment caused by mining: Socio-economic factors; Occupational health hazards due to mine dust, poor lighting, ventilation, noise and vibration. Land Degradation, Textural classification and properties of soil. Visual Impact and landscape planning.

Assessment of Environmental Degradation: Environmental crisis and action strategies for sustainable development. Environmental awareness. Introduction to resettlement and rehabilitation plan. Main provisions of Land Acquisition Act, An understanding on National Rehabilitation and Resettlement Policy, 2007.

UNIT - 2 (16 Hours)

Air Pollution: Sources, ill effects, measurement and monitoring, standards: Preventive and mitigating measures. Dust in mines: Dangers, formation, prevention and suppression. Wind rose diagram, Calculation of Ground Level Concentration of air pollutants; Dust sampling apparatus, their construction and applications. Main provisions of The Air (Prevention and Control of Pollution) Act, 1981.

Water Pollution: Water quality standards; Water pollution Acts; Water Quality Criteria; Water Pollution in Mining Areas; Water Management; Water Pollution and Management strategies for controlling seepage and run-off. Acid Mine Drainage- Sources, mechanism of formation and ill effects; Preventive and mitigating measures. Alkaline Mine waters. Control of Ground water pollution and depletion. Ground water recharging techniques. Main provisions of The Water (Prevention and Control of Pollution) Act, 1974.

UNIT - 3 (16 Hours)

Land Reclamation: Introduction about reclamation, land use pattern in India, types of reclamation, reclamation plan, content and standards of reclamation, cost of reclamation, statutory provision on afforestation.

Noise and Vibration Control: Fundamentals of Noise, Sources and measurement of noise; Noise Impacts- Auditory effects, physiological effects, effect on task performance, other effects. Noise Impact Index assessment .Preventive and mitigating measures. Blast Induced Vibration, ground vibration prediction, vibration standards, vibration control, noise and overpressure. Main provisions of The Noise Pollution (Regulation and Control) Rules, 2000.

Environmental Planning: Environmental planning procedures, types of permits and approvals required for mining projects, Environmental policies.

UNIT - 4 (16 Hours)

Environmental Impact Assessment: Environmental Impact Assessment, EIA methodology, legislative requirements. Contents of EIA documents. Environmental Audit: Definition, purpose, types of audits, procedure, outcomes of environmental audits. Important notifications issued by Ministry of environment and forest, The Wildlife (Protection) Act- 1972, National Conservation Strategy-1992. Forest (Conservation) Act 1980 and Forest Conservation Rules 1981 related to Mining. Main provisions of Environmental Protection Act 1986.

Environmental Economics: Environment as a capital, Environmental economics, Economic policies and environment. Valuation Techniques, Cost benefit analysis. Concept of carbon trading; Corporate Social Responsibility: Role, Implementation and Societal Benefits.

Recommended Reading:

1. N C Saxena, Gurdeep Singh, Rekha Ghosh; Environmental Management in Mining Areas; Scientific Publishers.
2. Larry W. Canter; Environmental Impact Assessment; McGraw-Hill Education (India) Pvt Ltd.
3. R K Suri et al.; Mining Environmental and Forests; Soc. of Forest and Environmental Managers.
4. B B Dhar; Mining Envirnoment; Taylor and Francis.
5. Karlheinz Spitz, John Trudinger; Mining and the Environment: From Ore to Metal; CRC Press.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. Study of Occupational health hazards and their remedial measures.
2. Measurement of dust contents with the help of dust sampler.
3. Sound level meter and measurement of noise level produced by various mining machineries.
4. Mine visit for study of Reclamation of dumps for mechanized opencast mines.
5. Collection of various field data and their evaluation for preparation of EMP of mines.
6. Measurement of vibrations produced in mines by seismograph.
7. Measurement of pH value and turbidity of water samples collected from mine discharge.
8. Preparation of EIA from given data.
9. Case study on Acid mine drainage.
10. Case study of reclamation and valley filling.

MN 8.3.1 ROCK SLOPE ENGINEERING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 8.3.1	Rock Slope Engineering	3	1	--	3	100	25	--	--	25	150

Course Objective:

1. To study the influence of various geological, hydrogeological parameters that effect slope stability.
2. To study the mechanics of plane, wedge, circular and toppling failures.
3. To know various conditions for different modes of failure and the analysis slope failures.
4. To study the techniques for analysis and design of pit slopes and waste dumps and remedial measures for stabilizing slopes.
5. To Field instrumentation and monitoring of open pit and dump slopes.

Course Outcomes:

The student after undergoing this course will be able to:

1. To apply basic principles of rock slope engineering for design and analyse rock slopes for safe and economic operations.
2. To identify the modes of failure - plane, wedge, circular and toppling failures.
3. To design and analyse the slope considering the geological, hydrogeological factors and design parameters.
4. To suggest and implement remedial measures for stabilizing slopes, wherever necessary.
5. To plan field instrumentation and monitoring of open pit and dump slopes.

UNIT - 1 (12 Hours)

Rock Slope Engineering: Types of slope failure; Principles of rock slope engineering; Parameters related to slope stability; Slope stability problems in opencast mines; Consequences of slope failures.

Geological factors Affecting Slope Stability: Shear strength of intact rock; Shear strength of discontinuities; Scale effects and rock strength, Friction angle of rock surfaces, Shearing on an inclined plane, Shear strength of rock masses by back analysis

of slope failure, Hoek–Brown strength criterion for fractured rock masses, Generalized Hoek–Brown strength criterion, Mohr–Coulomb criterion, Estimation of rock mass strength, disturbance factor; Effect of slope geometry, equipment loading, dynamic loading, any other external loading and time.

UNIT - 2 (12 Hours)

Effect of Ground Water on Rock Slopes: Hydraulic conductivity and flow nets, Ground water flow in fractured rock, Measurement of water pressure, Field measurement of hydraulic conductivity, Influence of water on shear strength of discontinuities; Estimation and measurement of permeability and water pressure; Graphical solution of seepage problems (flow nets), seepage forces and seepage patterns under different conditions.

Modes of Slope Failure: Mechanics of slope failure – plane, wedge, circular, toppling, buckling, block and key block failures. Examples of pit slope and dump slope failures.

UNIT - 3 (12 Hours)

Plane failure: General conditions for plane failure, Plane failure analysis, Critical tension crack depth and location, Critical slide plane inclination, Analysis of failure on a rough plane.

Wedge failure: Definition of wedge geometry; Analysis of wedge failure; Wedge analysis including cohesion, friction and water pressure; Wedge stability charts; Example of wedge analysis charts; Comprehensive wedge analysis.

Circular failure: Conditions for circular failure and methods of analysis; Circular failure charts; Location of critical slide surface and tension crack; Examples of circular failure analysis; Detailed stability analysis of circular failures - method of slices.

Toppling failure: Types of toppling failure; Kinematics of block toppling failure; Limit equilibrium analysis of toppling; Stability analysis of flexural toppling.

UNIT - 4 (12 Hours)

Analysis and Design of Pit Slopes and Waste Dumps: Analytical, deterministic, probabilistic approaches and numerical analysis of rock and soil slopes; Slope analysis and factor of safety using limit equilibrium methods; Application of RMR/RSR/SMR classification in slope stability evaluation; Sensitivity analysis, Load and Resistance Factor, Stereographic analysis of structural discontinuities, Pole plots and contour plots, Pole density, determination of possibility and type of failure based on structural analysis.

Remedial measures for Stabilizing Slopes: Stabilisation and strengthening of slopes - Slope geometry configuration; wall control blasting techniques; Slope drainage systems and practices; rock reinforcement.

Field Instrumentation and Monitoring: Instrumentations for monitoring slope movements. Surface monitoring methods; Crack width monitor; Global positioning system; Sub-surface monitoring methods- Time–domain reflectometry; Time–movement and time–velocity plots.

Mine Regulations: Related to rock slopes in surface mining.

Recommended Readings:

1. E. Hoek and J. W. Bray; Rock Slope Engineering; Institute of Mining and Metallurgy.
2. M. G. Anderson and K. S. Richards (Eds); Slope stability—geotechnical engineering and geomorphology; Wiley, Chichester.
3. C. O. Brawner, and V. Milligan; Stability in Open Pit Mining; SME.
4. C. O. Brawner; Stability in Surface Mining; SME.
5. S. D. Priest; Hemispherical Projection Methods in Rock Mechanics; George Allen and Unwin.
6. D. F.Coates; Pit Slope Manual; CANMET.

Tutorial Exercise:

- The exercise shall include assignments and numericals based on above syllabus to be completed during Tutorial class.

MN 8.3.2 GEOSTATISTICS

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 8.3.2	Geostatistics	3	1	--	3	100	25	--	--	25	150

Course Objective:

1. To provide knowledege of geostaticcs and its application in mining industry.
2. Introduction to Stationary, Regionalized Variables and its distribution.
3. To understand different semi-variogarm model.
4. Obtain knowledge of interpolation methods and their limitations.

Course Outcomes:

The student after undergoing this course will be able to:

1. To provide knowledege of geostaticcs and its application in mining industry.
2. Introduction to Stationary, Regionalized Variables and its distribution.
3. To understand different semi-variogarm model.
4. Obtain knowledge of interpolation methods and their limitations.

UNIT - 1 (12 Hours)

Classical Statistical Distributions: Normal and lognormal, their applications in resource evaluation.

Deterministic Mathematical Models: Independent random model, trend with random noise, correlated random models and trend with correlated random residuals.

Geostatistics: Definition, schools of thought; stationary assumptions and regionalised variables; purpose, need and applications conditions.

UNIT - 2 (12 Hours)

Semi-variogram and Co-variogram: Definitions, characteristics, and computation in one, two and three dimensions; various models of variogram – random model, spherical model, exponential model, Gaussian model, linear model, de Wijsian parabolic model; associated difficulties namely anisotropy, non-stationarities, regularisation, presence of nugget effect and presence of trend, sill and range.

Extension, Estimation and Dispersion Variance: Calculation by discretisation and auxiliary functions.

UNIT - 3 (12 Hours)

Kriging: Definition and derivation of kriging system of equations, Indicator kriging. Practice of kriging- steps and procedure. Practice of semi-variogram modelling.

Integrated Geological and Geostatistical System: statistical analysis, comparative analysis, geeostatistical structural analysis, trend analysis, point kriging cross validation, block kriging.

UNIT - 4 (12 Hours)

Geostatistical Applications: Optimisation of exploration drilling, calculation of mineral inventory, establishment of grade-tonnage relations, misclassified tonnage- actual versus estimated; grade control plan, geostatistical case studies of selected mineral deposits; Application in environmental assessment.

Recommended Readings:

1. A. J. Sinclair and G. H. Blackwell; Applied Mineral Inventory Estimation; Cambridge University publication.
2. B. D. Ripley; Spatial Statistics (Wiley Series in Probability and Statistics); Wiley-Interscience, New edition.
3. Schabenberger and Gotway; Statistical Methods for Spatial Data Analysis; Taylor and Francis Publ.
4. Pela J Diggle, Paulo J Ribeiro; Model Based Geostatistics; Springer.
5. Wckernagel, Ham; Multivariate Geostatistical; Springer.

Tutorial Exercise:

- The tutorial classes shall include numericals on Normal and log-normal distribution, Semi-variogram and Co-variogaram model, Kriging, Mineral inventory, Grade-tonnage relationship, Grade conrtrol plan etc.

- The exercise shall include assignments based on above syllabus to be completed during Tutorial class

MN 8.3.3 SMALL SCALE MINING AND OCEAN MINING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 8.3.3	Small Scale Mining and Ocean Mining	3	1	--	3	100	25	--	--	25	150

Course Objective:

1. To provide basic knowledge about occurrence and properties of various stones found in India and development of mine and procurement of various machineries used in stone mining industries.
2. To know the concept of dimensional stone mining and ocean mining.
3. To understand the importance and current practices of small scale mining.
4. To know the various machines and cutting tools used in dimensinal stone mining.
5. To understand the methods of ocean mining and future trends.

Course Outcomes:

The student after undergoing this course will be able to:

1. Illustrate various properties of dimensional stones.
2. Assess and explain various statutory requirements for effective mining of dimensional stones.
3. Select and explain the suitable methods in case of ocean mining.

UNIT - 1 (12 Hours)

Introduction to Small Scale Mining: Concept of small scale mining; Small scale mines – worldwide, Indian Policy in small scale mines – practices, policies and perspectives, Problems of small scale mines – financial, legislative support, technical expertise, Environmental obligations; Safety, health and training; Environmental impacts and protection; Quality control, marketing and export of minerals.

Small Scale Mining Resources: Classification and mode of occurrence of granite and other minor minerals; Physical, mechanical and chemical properties; Geological aspects of mining, Dimensional stone mining; Case studies of mining of minerals like sandstone, marble, beach sands, alluvial mining, mica, barytes, diamond and gemstones, etc.

UNIT - 2 (12 Hours)

Mining of Dimensional Stones: Various techniques of dimensional stone mining – conventional and novel techniques, recent trends; 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; Gang-saw; 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; Hydraulic jacks.

UNIT - 3 (12 Hours)

Introduction to Marine Mining: Introduction to marine environment; development and status of ocean resources of mining in Goa, other parts of the country and worldwide; Ocean profile; Ocean floor topography; Economic exclusive zone and fundamentals of law of the sea, coastal zone and its characteristics.

Marine Geology And Resources: Physical and chemical properties of seawater; overview of marine mineral deposits; Deep-sea bed mineral resources; Polymetallic nodules; sulphate nodules; Chemicals from the ocean; Dissolved and undissolved mineral deposits, sea water as resource and beach placers.

UNIT - 4 (12 Hours)

Exploitation Of Marine Deposits: Shallow and deep sea bed; Oceanographic instruments, Mining of manganese nodules, Deep sea drilling methods, Ocean bottom samplers, Drag buckets, Grab buckets; Coring systems; Ocean bathymetry; Temperature measurement systems; Water samplers; Ocean dynamic analysis; Beach placer mining; Underwater photographs; Vehicles and transportation; offshore oil platforms.

Recommended Readings:

1. Ghose, A. K.; (Ed). Small Scale Mining – A Global Overview; Oxford - IBH Publishers.
2. Rathore, S. S.; Dimensional Stone Technology; Himanshu Publications, Udaipur-Delhi.
3. Chatterjee, S. K.; An Introduction to Mineral Resources; Wiley Eastern Ltd.

4. Herbich, J. B.; Coastal and Deep Ocean Dredging; Gulf Publishing Co. Houston.
5. Murthy, T. K. S.; Mining the Ocean; CSIR Golden Jubilee Series, CSIR Publications, New Delhi.

Tutorial Exercise:

- The exercise shall include assignments and numericals based on above syllabus to be completed during Tutorial class

MN 8.3.4 GEODETIC SURVEYING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 8.3.4	Geodetic Surveying	3	1	--	3	100	25	--	--	25	150

Course Objective:

1. To study advanced surveing techniques covering large areas.
2. To get familier with modern equipments and methods in Geodetic surveying.

Course Outcomes:

The student after undergoing this course will be able to:

1. Understand advanced geodetic surveying techniques and its applications.
2. Utilise knowledge of GPS and GIS based systems in mining.

UNIT - 1 (12 Hours)

Geodetic Surveying: Definition, importance, objectives, concept of geoid and reference spheroids, co-ordinate systems, geoid undulation, deflection of vertical, datum-horizontal and vertical.

Triangulation and Trilateration: Network and strength of figures, field work-selection of stations, Importance of accuracy in base line measurement, measurement by different methods and satellite stations.

Traversing: Theory and principles associated with traversing, Balancing of traverse, Numerical examples related to traversing and joins.

UNIT - 2 (12 Hours)

Modern Surveying Instruments and Techniques: Principles of EDM-electronic distance measurement technique, Electronic theodolite and total station; Concept and definition of Digital Terrain Models (DTM); Use of Auxiliary Telescope and its importance. LIDAR (Light detection and ranging) - introduction, concept, overview, structure, classification, application and data processing.

UNIT - 3 (12 Hours)

Subsidence Monitoring: Introduction, terminology, subsidence parameters, subsidence prediction methods; Precise levelling, Monitoring of small ground movements and data analysing techniques.

Global Positioning Systems (GPS): Principle of GPS measurements, various applications of GPS; adjustment/calibration and care of Differential GPS; Various modes of observations; transformation from one system to another system of coordinates, GPS data processing. Signal structure of GPS, pseudo range and phase observables, recent advances- such as GLONASS, Galileo and GNSS.

UNIT - 4 (12 Hours)

Geographical Information System (GIS): Concepts, essential components, data acquisition, raster and vector data, Geo-referencing, topology and spatial relations, 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, Triangulated Irregular Network (TIN), various GIS packages and their salient features.

Recommended Readings:

1. Samir Kumar Das; Information Technology in Mining; Lovely Prakashan Dhanbad.
2. S. K. Duggal; Surveying Volume-II; Tata Mc Graw Hill Publishers, New Delhi.
3. W. Schofield; Engineering Surveying; Replica Publications Delhi.
4. T. P. Kanetkar / Kulkarni; Survey and Leveling Vol.1, 2 and 3; Vidya Griha Prakashan, Pune.
5. B. C. Punmia / AK Jain; Surveying Vol.1, 2 and 3; Laxmi Publications, New Delhi.
6. David Clarke; Plane and Geodetic Surveying; CBS Publ. and Distributors.

Tutorial Exercise:

- The tutorial classes shall include numericals on triangulation survey, traversing and joins, Precise levelling and Subsidence Monitoring.

- The exercise shall include assignments based on above syllabus to be completed during Tutorial class

MN 8.4.1 ENTREPRENEURSHIP DEVELOPMENT

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 8.4.1	Entrepreneurship Development	3	--	2	3	100	25	--	--	25	150

Course Objective:

1. Understanding of the basic terms, concepts of Entrepreneurship.
2. Understanding the scope and opportunities for an Entrepreneur.
3. Role of small-scale industry in national development.
4. Project identification, project formulation and project monitoring.
5. Sources of funding for executing the business and issues related to human resources, legal aspects and marketing of products.

Course Outcomes:

The student after undergoing this course will be able to:

1. Gain knowledge on basics of entrepreneurship.
2. Gain knowledge of business entity, source of capital and financially evaluate the project
3. Aware of professional, ethical, and social responsibilities of a business.
4. Launch the individual's career as entrepreneur.
5. Create appropriate a business model

UNIT - 1 (12 Hours)

Entrepreneur: Evolution, Characteristics, Types, Functions of Entrepreneur.

Entrepreneurship: Concept, Need, Problems, Stages, Growth in India, Role in Economic Development and its Barriers. Recent Trends, Motivation, Theories, factors, Entrepreneurial Competencies.

Small Enterprises: Definition, Characteristics, Relationship between Small and Large Units, Rationale, Objectives, Scope, Opportunities for an Entrepreneurial Career, Role of small Enterprise in Economic development, Problems of SSIs.

UNIT - 2 (12 Hours)

Small - Scale Industry: Definition, Characteristics, Need and rationale, Objectives; scope; role of SSI in Economic Development. Advantages of SSI, Steps to start an SSI-government policy towards SSI; Different policies of SSI; government support for SSI. Impact of Liberalization, Privatization, Globalization on SSI, Effect of WTO/GATT supporting agencies of Government for SSI, meaning; Nature of support; Objectives; Functions.

UNIT - 3 (12 Hours)

Project Identification and Selection (PIS): Business ideas, Market Survey, Meaning of project, Project identification, Project selection, Project formulation: Meaning, Significance, Contents, Formulation, Planning Commission's guidelines for formulating a Project Report, Specimen of a Project Report, Network analysis, Common errors in Project formulation, Project appraisal concept, Methods of project appraisal, Intellectual Property.

UNIT - 4 (12 Hours)

Financing Of Enterprises: Need for Financial Planning, Sources of finance, Capital Structure, Term-loan, Sources of Short-Term Finance, Capitalization, Venture capital, Export Finance, Institutional Finance To Entrepreneurs, Preparation of Business Plans, Commercial Banks, Other financial institutions.

Institution Support to Entrepreneurs: Need for Institutional support - Small Entrepreneurs: NSIC, SIDO, SSIB, SSICS, SISI, DICs, Industrial Estates Specialized Institutions, TCOs Brief introduction about Marketing of products and services, Human resource issues, Total quality management issues for small enterprises, Growth strategies in small businesses, sickness in small businesses, small enterprises in international business.

Recommended Reading:

1. Poornima M Charantimath; Entrepreneurship Development - Small Business Enterprises; Pearson Education.
2. Vasant Desai; Dynamics of Entrepreneurial Development and Management; Himalaya Publishing House.
3. Bragg A. and Bragg M; Developing New Business Ideas, a step-by-step guide to creating new business ideas worth backing; Financial Times, Prentice Hall.
4. P. C. Tripathi, P. N. Reddy; Principles of Management; Tata McGraw Hill.

5. Robert Lusier; Management Fundamentals - Concepts, Application, Skill Development; Thomson.
6. S S Khanka; Entrepreneurship Development; S Chand and Co.
7. Rao and Pareek; Handbook of Entrepreneurship; Wordpress.
8. Forbat, John; Entrepreneurship; New Age International.
9. Havinal, Veerbhadrappa; Management and Entrepreneurship; New Age International
10. Desai, Vasant; Project Management and Entrepreneurship; Himalayan Publishing House, Mumbai.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. Visit to 3 or 4 small scale industries in industrial estate and preparation of report.
2. Identify some successful and unsuccessful ventures from a variety of sectors through internet, journals, business magazines, etc. and enumerate the reasons for their success and failure.
3. Ideate a few business plans through observation, discussion and literature survey (internet, newspaper, journal, business magazines and Govt. bulletins) and select the best one using Discounted Cash Flow and other methods.
4. Working on Business Model Canvas.
5. Identify raw materials/other input resources required for the selected business plan, and their source of procurement through internet, business magazines, etc.
6. Approach banks/financial institutes and discuss concerned officials to find the terms and conditions for availing business loans and, also prepare a comparative report to source of funds to start a business enterprise.
7. Estimate the cost of production and calculate Break Even Point for selected business plan.
8. Determine average cost of funds if raised from various sources.
9. Estimate working capital required for the selected business plan.
10. Identify approvals and sanctions required from Govt. and other agencies.
11. Enumerate the activities which are critical for the completion of the project and estimate its completion time using CPM and PERT techniques.
12. Prepare Feasibility Report for a given business plan.

MN 8.4.2 EXPLORATION GEOLOGY

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 8.4.2	Exploration Geology	3	--	2	3	100	25	--	--	25	150

Course Objective:

1. To study prospecting and exploration techniques.
2. To understand the importance of Stereograpgic Projections and Remote Sensing.
3. To Study of geophysical and geochemical techniques of exploration.
4. To study the classification and estimation of ore reserves.

Course Outcomes:

The student after undergoing this course will be able to:

1. Understand the techniques of geological mapping and field data collection.
2. Plot stereographic projection and flow nets.
3. Understand the logging operations and log interpretation.
4. Read and understand the maps, sections and Mine plans.

UNIT - 1 (12 Hours)

Introduction: Scope of Exploration Geology, Introduction to important mineral resources in India and world. Main features of Mineral Concession Rules and Mineral Conservation and Development Rules. Different methods of prospecting, reconnaissance Survey. Various exploration and sampling techniques: Techniques of geological mapping, field data collection: attitude of beds, foliation, lineation, joints, and their analysis.

Stereographic Projections: Principle, Definition, Procedure and application in Mining Geology

Groundwater: Occurrence, Origin, importance in mining. Concept of Flow Nets

UNIT - 2 (12 Hours)

Remote Sensing: Fundamentals, Applications in geology, ground water and natural resource management. Aerial Photography.

Exploratory Drilling: Diamond drilling, Collection and stacking of core. Bore Hole Logging;Introduction logging methods, preparation of lithologs, log interpretation.

Underground Exploration: Exploratory mining by shafts, drifts and cross-cuts, Definition drilling.

UNIT - 3 (12 Hours)

Geophysical Exploration: electrical method: Principles, instrumentation, field procedure and interpretation using electrical methods. Electrical profiling and sounding using Wenner and Schlumberger configurations. Principles and fundamental procedures of data collection and interpretation.

Seismic Methods: Principles, instrumentation, survey procedures and interpretation using seismic methods. Correction applied to seismic data.

Gravity and Magnetic Methods: Principles-field methods-gravimeters-corrections, interpretation of gravity data. Corrections and applications. Principles, instrumentation, field procedures and interpretation of magnetic data.

UNIT - 4 (12 Hours)

Geochemical Exploration: Principles and Methods; Interpretation of Geochemical Data

Estimation of Reserves: Classification, methods, interpretation. Ore reserve classification as per UNFC.

Geological Maps: Map reading, interpretation of geological sections.

Production Planning: Usage of mine sections and Sampling data in production planning.

Recommended Reading:

1. Hartman H. L., Jan M. Mutmansky; Introductory Mining Engineering; John Wiley and Sons.
2. Roger Marjoribanks; Geological Methods in Mineral Exploration and Mining; Springer
3. R. N. P. Arogyaswami; Courses in Mining Geology; Oxford and IBH Publ.
5. T. S. Ramakrishna; Geophysical Practice in Mineral Exploration and Mapping; GSI Publ.

6. R. Dhana Raju; Handbook of Mineral Exploration and Ore Petrology; GSI Publ.
7. Charles J. Moon, Michael K.G. Whateley and Anthony M. Evans (Ed); Introduction to Mineral Exploration; Blackwell Publ.
8. Charles H. and Roland D. Parks Baxter; Examination and evaluation of Mineral Property; Addison-Wesley Pub Co.
9. Peters W.C; Exploration and Mining Geology Wiley; New York.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. Geological Mapping with compass and tape.
2. Tabulation of the bore hole data using bore-hole logs.
3. Given a toposheet and the Bore Hole data of an area, draw sections at different intervals.
4. Bore Hole Problems to ascertain Dip, Strike and Fault.
5. Reserve Estimation Problems (Different Methods).
6. Calculation of stripping ratio from sections and given data.
7. Production Planning based on mine section and Sampling data
8. Interpretation of Geophysical Resistivity and Seismic Refraction survey data.
9. Interpretation of Aerial Photographs.
10. Completion of Outcrops from the available data (number of outcrops, dip and strike given).
11. Stereographic projections based on the strike and dip data.
12. Basics of Groundwater Flow Nets (drawing of flow nets and their interpretation).

MN 8.4.3 COMPUTER PROGRAMMING (OOPS) IN C++

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 8.4.3	Computer Programming (Oops) in C++	3	--	2	3	100	25	--	--	25	150

Course Outcomes:

1. Understand and use simple programs using C++.
2. Develop interest in C++programming language for mining applications.
3. Teaches you about how compilers lay out data in memory
4. Manipulate various C++ datatypes, such as arrays, strings, and pointers
5. Isolate and fix common errors in C++ programs
6. Use memory appropriately, including proper allocation/deallocation procedures
7. Students demonstrate they can define and apply the basics of a programming language.

Course Objectives

The student after undergoing this course will be able to:

1. To ensure understanding of basic concepts and principles of Object Oriented Programming.
2. To demonstrate usage of control structures, modularity, I/O. and other standard language constructs.
3. To demonstrate usage of data abstraction, encapsulation, and inheritance.
4. To ensure understanding of Approaches to Software Design and Modellingusing UML, understanding of Inheritance and Polymorphism, File and Streams
5. To Learn syntax, features of, and how to utilize the Standard Template Library and Graphics.
6. To ensure understanding of Approaches to Software Design and Modellingusing UML, understanding of Inheritance and Polymorphism, File and Streams
7. The primary objective is to provide students with the skills necessary for "programming" and "problem solving" skills in C++.

UNIT - 1 (12 Hours)

Introduction to Object Oriented Programming: Principles of object oriented programming, object-oriented paradigm. Overview and Benefits; Approaches to

Software Design, Evolution of the Object Model, Benefits of Object Programming, Modelling using UML:UML overview, Nature and purpose of models, Static view, Use case view, Static machine view, Activity view, Interaction view.

UNIT – 2 (12 Hours)

C++ Fundamentals: Abstract data types (ADT), Encapsulation and information hiding, tokens, expressions, control structures, functions, Classes and Objects, Constructors and destructors.

Overloading: Function overloading, operator overloading, Overloading types, and rules, explicit and implicit type conversion operators.

UNIT - 3 (12 Hours)

Inheritance: Multiple inheritance, hybrid inheritance.

Polymorphism: Concepts of polymorphism

File and Streams: I/O streams and classes, Manipulators, Classes for file streams, file I/O operations and functions.

UNIT - 4 (12 Hours)

Template: Template functions and classes, implementation

Exception: Exception handling: Need, Throwing mechanism, try, catch block.

Introduction to the Standard Template Library: Components of STL, Containers, Algorithms, Iterators, Applications.

Graphics: Graphics functions

Recommended Reading:

1. E Balaguruswamy; Object oriented programming with C++; Tata McGraw Hill.
2. K R Venugopal Rajkumar, T. Ravishankar; Mastering C++; Tata McGraw Hill
3. J.Rumbaugh et al; The UML Reference Manual.
4. Herbert Schildt; Teach yourself C++; TMH.
5. J. R. Hubbard (Schaum's Outlines); Programming with C++; McGraw Hill.
6. D. Ravichandran; Programming with C++; McGraw Hill.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

The practical work in this course will be based on the series of programming exercises, which will reinforce the concepts of object Oriented Paradigm (OOP). The programming will be implemented on Turbo C++ or Borland C++ Compiler. The List of Programming exercises will be based on the following constructs.

1. Input and Output statement
2. If statement, Switch statement, Conditional operation statement
3. For statement, While statement, Do-While statement
4. Functions, Objects and Classes
5. Arrays, Strings
6. Files and Streams
7. Pointers
8. Operator Overloading
9. Inheritance
10. Polymorphism
11. Templates
12. Graphics

MN 8.4.4 ROCK EXCAVATION ENGINEERING

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 8.4.4	Rock Excavation Engineering	3	--	2	3	100	25	--	--	25	150

Course Objective:

1. To provide basic knowledge about phyico-mechanical properties of rock/rock mass.
2. To understand the concept of rock excavation methods, their importance, and current practices and future trends.

Course Outcomes:

The student after undergoing this course will be able to:

1. To identify the information that can be used to ascertain the most efficient method for rock excavation.
2. Assess and explain drillability, cuttability and blastibility.

UNIT - 1 (12 Hours)

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 methods. Application of compressive, tensile and triaxial strengths, index tests and abrasivity, anisotropy, elasticity, porosity, discontinuities and jointing in rock excavation process. Rock breaking processes: Primary, Secondary and Tertiary, Energy consumption computations.

UNIT - 2 (12 Hours)

Drilling: Advances in drilling equipment, pneumatic versus hydraulic, design and operating parameters of surface and underground drilling; Jumbo drills; mechanics of rock drilling; rotary, percussive, rotary-percussive; Parameters influencing drilling performance; determination of drillability (penetration rate) and rate of drilling; Bit wear; bit selection; economics of drilling; Novel methods of drilling.

UNIT - 3 (12 Hours)

Blasting: Explosives and their selection criteria for rock excavation; blast design for surface excavations and optimisation; advanced blast initiation systems; blast performance evaluation, Advances in image processing techniques for fragmentation analysis; techno- economic and safety aspects of surface and underground blasting; advances in blast design for underground excavations; Blast damage indices; contour blasting; computer aided blast designs. Under water drilling and blasting.

UNIT - 4 (12 Hours)

Rock Cutting: Theories of rock tool interaction for surface excavation machinery – rippers, dozers, BWE, continuous surface miners; cutting tools, mechanics of cutting/ripping, parameters influencing performance of a ripper, determination of rippability/cuttability and production rate; 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.

Recommended Reading:

1. D. J. Desmukh; Elements of Mining Technology; Vol.3, Denett and co.
2. Amitosh Dey; Heavy Earth Moving Machinery; Lovely Prakashan Publication.
3. G. K. Pradhan; Explosive and Blasting Technology; Mintech Publications, Bhubaneshwar.
4. Bhandari; Blasting Engineering operations; Balkema.
5. Carlos Lopez Jimeno; Drilling and Blasting of Rocks; CRC Press.
6. Carcedo F. J.; Drilling and Blasting of Rocks; Balkema.
7. Clark, G. B., Principles of Rock Fragmentation; John Wiley and Sons, New York.
8. Ratan Raj Tatiya; Surface and Underground Excavations; (methods, techniques and equipment's); CRC Press.

List of Experiments:

(At least 8 experiments should be conducted from the list of experiments)

1. Determining uniaxial compressive strength and strain of rocks and calculation of elasticity.
2. Determination of Schmidt rebound number of rock sample by using Schmidt

hammer and calculation of strength.

3. Determination of rippability characteristics of rock mass for given rock mass properties.
4. Determination of drillability of rocks for given rock properties.
5. Measurement of Ultrasonic wave velocity (P-wave and S-wave) and calculation of modulus of elasticity, modulus of rigidity and poison's ratio for rock samples.
6. Determination of Abrasivity of rocks using Cerchar Abrasivity testing machine.
7. Determination of blast damage indices for given rock properties
8. Measurement of dynamic wave velocity for insitu rockmass.
9. Measurement of peak particle velocity and air pressure using blasting seismograph.
10. Determination of Cerchar hardness index and penetration rate of rock samples using Cerchar hardness testing machine.

MN 8.5 PROJECT

Subject Code	Name of the Subject	Scheme of Instruction Hrs/Week			Scheme of Instruction						
		L	T	P	Th. Duration (Hrs)	Marks					
						TH	S	TW	P	O	Total
MN 8.5	Project	--	--	8	--	--	--	75	--	75	**150**

Guidelines for Project Work:

1. Students shall carry out the required experimental / field/ numerical / analysis/ design / any other work related to the project during the semester.
2. Students shall perform the project work using institute / industry facilities.
3. Students shall maintain a project book including observations, readings, calculations and all other relevant data related to the project.
4. Student shall continuously update the project book and submit the same to the guide.

TERM WORK:

Project Report: It is expected to show clarity of thought and expression, critical appreciation of the existing literature, and analytical, computational, experimental aptitudes of the student through project report.

The Project report shall be submitted in a standard format and shall consist of the following:

a. Statement of problem
b. Objective and Scope of the study
c. Literature review
d. Methodology
e. Results and Discussions
f. Conclusions
g. References

Review:

Regular review to assess the progress of the project work will be conducted by the Guide. Students shall submit final project report to the department in the form of hard and soft copy after answering the final examination.