

# SYLLABUS OF MINING ENGINEERING

(BRANCH CODE 13)

***Compulsory***

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IC 402 Engineering Management

MN 403 Mining Geology and Development of Mineral Deposits

MN 404 Exploitation of Mineral Deposits

MN 405 Mining Machinery and Material Handling

MN 406 Mine Ventilation and Environmental Hazards

MN 407 Geomechanics and Mine Design

***Optional (Any three from any one Group)***

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**Group I : Mine Environment**

MN 411 Advanced Mine Ventilation

MN 412 Environmental Pollution and Control in Mines

MN 413 Electrical Equipment and Instrumentation in Mines

MN 414 Mine Surveying

MN 415 Mine Management and Legislation

**Group II : Mine Systems**

MN 421 Mine Systems Engineering

MN 422 Economics of Mining Enterprises

MN 423 Geostatistics

MN 424 Quality, Reliability and Safety in Mines

MN 425 Mine Management and Legislation

**Group III : Mining Methods and Planning**

MN 431 Advanced Rock Mechanics

MN 432 Advanced Methods of Mining

MN 433 Mine Planning and Excavation

MN 434 Mine Surveying

MN 435 Mine Management and Legislation

# ENGINEERING MANAGEMENT

## Group A

Management and Organisations

Management process: Definition, planning organizing, directing, controlling, coordinating, types of management.

Organisation Definition, planning, design and development, types of organizations.

Management planning and control: Classical, new classical and modern principles. General Management, scientific management, engineering, management, systems management.

Planning: Procedures, resources and constraints, objectives, goals, policies and procedures.

Control: Setting of reference or standards, appraisal or evaluation, monitoring and controlling, types of control.

Human resource planning and management, selection, recruitment, training, retraining, skill development, competence development, promotion and career development, participative management, trade unions, and collective bargaining,

Management of Physical Resources

Plant: site selection procedures, factors affecting selection. Layout-types and relative merits and demerits, Maintenance-Objectives, different types of associated decisions, strategies for effective maintenance, computer applications.

Material : Functions, objectives, planning and control including inventory models with or without storage costs, price break ( excluding dynamic and probabilistic considerations). Different classes of inventory. Material Requirement Planning (MRP).

## Group B

Financial management: Introduction to standard forms of financial statements, ie., balance-sheet, profit and loss, and income statement. Fixed and current asset items. Fixed and current liability items. Linkage of two successive balance-sheets through income or profit and loss statement. Funds flow statement. Financial ratios and their implications.

Managerial economics: Concepts, theory of production, marginal productivity and cost. Introduction to theory of firm.

Quality management: Quality definition, quality planning, quality control and quality management, Total quality management, ISO 9000 systems, simple quality control techniques like control charts and acceptance sampling.

Marketing management consumer behaviour, market research, product design and development pricing and promotion.

Project management: Introduction. Concept of a project, project management concepts, project simulation, cost or project and means of financing, economic evaluation criteria of the project, project implementation, project planning, scheduling and monitoring, project control (PERT, CPM techniques including crashing). Project evaluation.

Information technology and management. Role of information, management information system and decision support system, Information technology-introduction to e-business, e-commerce and integration tools like enterprise resource planning (ERP).

# MINING GEOLOGY AND DEVELOPMENT OF MINERAL DEPOSITS

## Group A

Physical geology, petrology—sedimentary, igneous and metamorphic rocks. Basic principles of stratigraphy. Structural geology—faults, folds, joints, etc. Process of mineral formation. Classification of mineral deposits.

Mode of occurrence, distribution and origin of important metallic and non-metallic minerals including fuel minerals.

Prospecting and exploration of mineral deposits-geological, geophysical and geochemical methods, groundwater. Geological documentation for mine planning.

## Group B

Introduction of mining technology, classification and properties of explosives and blasting accessories. Mechanics of rock breaking—drilling and blasting. Blasting practices. Blast vibration monitoring.

Mine entries—types, location, orientation, etc. Primary and secondary development underground. Shaft sinking-conventional and special methods. Deeping and widening of shafts, tunnelling.

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# EXPLOITATION OF MINERAL DEPOSITS

## Group A

Methods of working coal by pillar mining methods-applications, layouts, development and extraction by partially and fully mechanised methods. Longwall mining methods. Influence of depth, seam thickness, inclination, etc. Continuous mining.

New developments and special methods of mining thick seams, support of roadways and face supports. Power support. Hydraulic stowing- Subsidence and strata control.

## Group B

Methods of development and sloping metalliferrous deposits—open slopes, filled stopes, shrinkage stapes and caving methods. Handling of ore and waste materials. Stope mechanisation.

Opencast methods of mining—opening a pit layout. Development and design of benches, drilling, blasting, loading and transport Continuous mining systems. Placer mining techniques.

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# MINING MACHINERY AND MATERIAL HANDLING

## Group A

Principles and basic design features of mechanical, hydraulic and pneumatic power transmission. Transport machinery—rope haulage, locomotive, conveyors, their basic construction, operation and safety devices.

Hoisting system—system components, duty cycle, torque time and power time diagrams. Drum and friction winders. Mining pumps—basic construction and operation. Pumping system in underground.

## Group B

Electric, pneumatic and hydraulic drills. Cutting, loading and winning machinery for underground mines. Longwall and open cast mining machinery. Aerial ropeways—classification, construction and operations.

Principles of hydraulic and pneumatic conveying. Storage and reclamation of bulk materials. Developments in bulk materials handling technology.

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# MINE VENTILATION AND ENVIRONMENTAL HAZARDS

## Group A

Heat and humidity in mines. Climate control and air-conditioning. Mine illumination, noise and its control. Mechanics of airflow in mines, distribution of airflow. Natural and mechanical ventilation.

Fan—theory, characteristics, laws and selection of fan installation, series and parallel configuration. Auxiliary and booster ventilation. Ventilation survey and instruments. Ventilation planning and layouts, network analysis.

## Group B

Mine gases—properties, detection, physiological effects, monitoring. Methane layering and methane drainage. Mine dust—physiological effects, monitoring and control.

Spontaneous heating and mine fires. Firedamp and coal dust explosions. Mine inundation, Rescue and recovery. Occupational health.

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# GEOMECHANICS AND MINE DESIGN

## Group A

Physico-mechanical properties of rocks and soils. Deformation characteristics' and time dependent behaviour of rocks. Rock mass classification.

Stress analysis and theories of rock failure. Stress distribution around mine openings. In-situ stress and deformation measure.

## Group B

Design of pillars, support design for mine roadways. Mechanics of caving and support design for Longwall workings.

Rock slope design and design of pit layout, introduction to finite element methods.

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# ADVANCED MINE VENTILATION

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Climate control: Psychrometry, mixing of air flows, hygrometric surveys. Heat stress indices. Heat load sources in mines—estimation. Geothermal heat transfer. Design of air cooling systems: refrigeration, cooling towers, spray chambers, and cooling coils for heat exchange.

Dynamics of air flow: Turbulent flow distribution through rough pipes. Frictional losses. Shock losses-estimation for bends, area changes, splits and junctions. Drag losses. Plotting of pressure gradients for pipe flow.

## Group B

Ventilation networks: Series and parallel systems. Concept of boosters and regulators for flow control. Theory of network analysts: incidence, fundamental, and cut-set matrices. Hardy-Cross iterative procedure. Controlled flow networks—linear programming and CPM applications. Recent developments in mine ventilation.

Natural ventilation pressure. Fan and system interaction, fans in series and parallel. Dust control in underground workings. Controlled recirculation.

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# ENVIRONMENTAL POLLUTION AND CONTROL IN MINES

## Group A

Atmospheric considerations: Basics of meteorology, atmosphere, ozone layer, and green house effect. Contaminant dispersion, plumes from chimney, Gaussian plume dispersion, and isokinetic sampling. Point, line, and area sources of contamination. Significant air pollution parameters, CPCB and NEERI norms, effects, assessment, and sources. Dust control in mines, mills, and haul roads.

Aquatic system: Water cycle. Water quality parameters, standards, measurement, and instrumentation. Heavy metal pollution, acid mine drainage, and sediment loading from mine effluents—problems and control options. Tailing dams—construction aspects and environmental management. Basics of ground water flow and contaminant dispersion.

## Group B

Aspects of land: Soil properties in relation to plant growth, top soil. Soil conservation. Reclamation and revegetation: design of overburden and waste dumps, and embankments. Erosion control and slope stability. Soil amendment schemes. Plant species—suitability and selection. Alternative land uses. Use of flyash in mine reclamation.

Miscellaneous factors; Noise control and ground vibrations. Issues in the preparation of EMP/EIA. Legislation relating to environmental protection. ISO 14000. Visual impact due to mining. Environmental economics and auditing.

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# ELECTRICAL EQUIPMENT AND INSTRUMENTATION IN MINES

## Group A

Mine power supply: Choice of voltage in surface and underground supply; tariff computation; Mine cables-construction, installation, fault location; Gate end boxes and switchgears; Earthing methods; Protective devices; Overload, under voltage, earth leakage, DC supply-rectifiers, storage batteries.

Electrical equipment: Mining transformers, lighting transformers; AC and DC motors—speed torque characteristics, starting, braking speed control; Drives for haulage, ventilation fans, pumps, compressors, electric locomotives, winders; Introduction to thyristor devices; Flame-proof and intrinsic safety.

## Group B

Control and instrumentation: Open- and closed-loop systems, remote control, sequence control, winder control, control of open cast mine equipment; Sensors for measurement of various operational, environmental and safety parameters in underground and open cast mines.

Communication and data transmission: Mine telephone systems; Signalling systems, local area network (LAN)-FOLAN.

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# MINE SURVEYING

## Group A

Chain surveying, Compass-miner's dial. Contouring— characteristics, methods, uses. Levelling instruments-dumpy, tilting, and automatic levels. Levelling procedures, booking. Plane table surveying—methods and uses. Theodolite—different parts, horizontal and vertical angle measurements. Temporary and permanent adjustments.

Traversing—co-ordinate systems, problems, calculation of areas and volumes plotting, triangulation. trilateral ion. Tachometry. EDM—principles of EDM and its applications. Gyrotheodolite—description and applications. Theory of errors. Total station.

## Group B

Correlation through underground and surface surveys. Measurements of depth of shaft. Curves—elements of curves, types, methods of setting out. Slope surveying-tape triangulation, instrumental survey, transfer of stope plan to mine plan, string traverse. Subsidence surveying. Shaft surveying, bore hole surveying.

Open pit surveying. Principles of photogrammetry. Field astronomy. Mine plans and projections. Statutory requirements. GPS and introduction to remote sensing.

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# MINE MANAGEMENT AND LEGISLATION

## Group A

Concept of management, concept of system, production system. Organisation structures, span of control, number of levels and management functions. Production economics—kinds of costs, evaluation of capital investment and capital budgeting. Break even analysis.

Human factor engineering—methods, analysis and work measurement, method study. Time study—types of studies and procedures.

Materials management—purchasing, distribution and inventory- control. Inventory concepts, types of inventories and their relative costs.

## Group B

Development of mining legislation. Principal provision of Mines Act, Mines Rules.

Coal and metalliferrous mine regulations and their interpretation.

Indian Electricity Rules, Mines Rescue Rules, and other related rules. Mine accidents—reports and records. Accident investigation and analysis. Disaster management.

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# MINE SYSTEMS ENGINEERING

## Group A

Introduction to systems engineering. System concept and analysis. Tools and methodologies of Operations Research. PERT/CPM, resource allocation, crashing of network, monitoring and control of projects through network.

Introduction to linear programming: Graphical and simplex method, duality, sensitivity analysis. Transportation and assignment models. Integer programming.

## Group B

Introduction to queuing theory. Basic structure of queuing models. Single channel-single server and other queuing models. Inventory system and models. EOQ and different inventory control systems. ABC analysis. Replacement of capital equipment.

Introduction to simulation, scope and limitation. Simulation of different mining subsystems and total system. Monte Carlo simulation for discrete systems. Some mining-oriented illustrations.

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# ECONOMICS OF MINING ENTERPRISES

## Group A

Principles of micro and macro economics and the application of econometric techniques in mining industry. Mineral statistics—national and global. Important mineral deposits and mine fields in India.

Theory and importance of sampling, different method? of sampling, classification and estimation of reserves. Computation for tonnage average assay width, scoping width, clear width, milling width, etc. Geostatistical techniques of computation of reserves and quality.

## Group B

Financial appraisal methods, NPV, IRR, etc. Risk analysis for mining projects. Valuation of mines and mineral properties.

Methods of financing industrial enterprises. Constitution and organisation of enterprises. Mine productivity, costing; cost accounting and budgetary-control in mines. Taxation, profit and loss accounts, balance-sheet.

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# GEOSTATISTICS

## Group A

Introduction to mineral exploration, estimation of ore reserves, different methods of reserve estimation—geometrical, distance weighting and geostatistical methods, review of geostatistical concepts—spatial statistics and their application in reserve estimation.

Review of basic statistics in mineral appraisal, classical statistics—normal and lognormal distributions and their applications in reserve estimation, grade-tonnage curve; Correlation and regression, auto-covariance and autocorrelation; Theory and methods of sampling—drill hole compositing.

## Group B

Theory of regionalized variables, variogram. semi-variogram—sill, range, nugget effect, properties of variogram— isotropy, anisotropy, variogram models-linear, spherical, exponential, gaussian.

Kriging: Point kriging—kriging system of equations, kriging estimation variance, block kriging, applications of kriging in reserve estimation.

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# QUALITY, RELIABILITY AND SAFETY IN MINES

## Group A

The quality aspects, functional responsibility for quality in a manufacturing system, economics of quality assurance, quality control. QC decision variables. Process control. Control charts. Acceptance sampling, single, double and sequential sampling plans, concept of Total Quality Management (TQM).

Introduction to reliability concepts, basic statistics, probability distributions in reliability evaluation-exponential, normal, lognormal, and Weibull—failure rate, reliability function, application of reliability in mining system.

Network modelling concepts in reliability engineering—series system, parallel system, series-parallel system, partially redundant systems, network modelling of mining systems, reliability evaluation of mining equipment.

## Group B

Safety in Indian mining industry, accident data base, accident analysis—cause of accident, nature of injury, severity of injury, measures of accident rates—frequency rate, severity rate, regulatory measures of accident prevention, proactive, measures of accident prevention.

Basic concept of risk. Risk analysis and mine accidents, hazard tree, fault tree and event tree analysis, systems approach in mine safety, development of safety engineering approaches, human behaviour in mine accidents.

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# ADVANCED ROCK MECHANICS

## Group A

Rock strata characterization: Geological structures in rock mass, characteristics of rock mass, joints in rock mass, joint survey techniques, rock mass classification systems. Methods of determination of strength and deformability of rock and rock mass, failure criteria for rock and rock mass.

Strata mechanics and ground movement—design of underground excavation in competent and incompetent rock, ground movement and control, rock burst theories of subsidence, subsidence prediction and control. Ground control and stabilization .

## Group B

Theories of elasticity—propagation of elastic waves in rock medium and dynamic behaviour of rocks. Factors influencing stress concentration, zone of influence of an excavation, effect of planes of weaknesses and shape of excavation, delinearization of zone of failure. Instrumentation—monitoring instruments, their operation and installation.

Finite element method and boundary element method, their application for stability analysis of excavation and slopes.

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# ADVANCED METHODS OF MINING

## Group A

Recent trend of mechanisation in bord and pillar mining, Longwall mining. Mining of thick seams—methods and design consideration for exploitation of thick seam by inclined slicing and integrated caving, special methods of mining with reference to Indian conditions, salvage operations in Longwall mining; hydraulic mining.

Advanced metal mining—blast hole stoping, raise stoping, pillar recovery. Dilution, loss and recovery in stoping, stope design and production planning. Design

and construction of special underground excavations. Mining in rock burst prone areas. Novel and innovating mining methods—leaching methods.

## Group B

Ore body modelling. Pit geometry, determination or' ultimate pit configuration—different methods. Production planning and calendar plan for mining programme. Equipment selection, design of haul roads.

Inpit crushing and conveying systems. Bucket wheel excavator—general applicability and fundamentals of operation. Cross pit conveying and high angle conveying.

Dump formation, types of waste dumps—internal and external. Dump formation method and corresponding equipment. Dump stability, stabilization methods and monitoring.

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# MINE PLANNING AND EXCAVATION

## Group A

Principles of mine planning, short range and long range planning and their integration. Strategic planning. Preliminary evaluation of mineral deposits. Stages of planning, feasibility study, detailed project report, their preparation. Mine planning, scheduling, monitoring and control. Application of network analysis. Economic productivity indices and estimation of cost and profit.

Theoretical consideration for opening up and development of mine field. Division of mine field and areas. Determination of optimal output, life and size of mine. Design of unit operations. Equipment selection, planning and control.

## Group B

Pit top and pit bottom layout. Planning of power, workshop and surface bulk material handling systems. Planning of layout of waste and overburden dumps. Mine amalgamation, restructuring, reconstruction planning. Post mining land use planning and mine closure planning.

Mechanism of rock breakage and fracture. Rock fragmentation by explosive action, cutting, ripping and impacts. Principles of excavating machines—road headers TBM's, bucket excavators, etc. Excavated material handling systems. Flow of materials in bins and design of chutes. Mechanical and hydraulic transportation of ores and materials.

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