## Course Structure for M.Tech. (Mining Engineering)

### M.Tech. (Mining Engineering) Part – I Semester – I

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<td>MN5101</td>
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<tr>
<td>MN5102</td>
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<td>MN5103</td>
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| TOTAL OF PRACTICAL | 3 | 2 |

| TOTAL OF SEMESTER – I | 18 | 17 |

*ELECTIVES:
- MN5104: Eco-friendly Mining
- MN5105: Physical and Numerical Simulation
- MN5106: Geo-informatics
- MN5107: Reliability Engineering
- MN5108: Safety and Risk Management in Mines

### M.Tech. (Mining Engineering) Part – I Semester – II (MINE PLANNING)

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| TOTAL OF PRACTICAL | 5 | 3 |

| TOTAL OF SEMESTER – II | 20 | 18 |

*Open Elective from other departments/schools

** Departmental Electives
- MN5201: Underground Mine Planning
- MN5202: Surface Mine Planning
- MN5203: Planning for Underground Mechanization
- MN5204: Mine Environment Planning
- MN5205: Systems Engineering
- MN5206: Applied Geology in Mine Planning

Note: Dissertation topic to be allotted during this Semester.
# Syllabus for M. Tech. (Mining Engineering) Part – I Semester – II
## M.TECH. (MINING ENGINEERING) PART – I SEMESTER – II
### (ROCK MECHANICS)

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*Open Elective from other departments/schools

** Departmental Electives

- MN5211: Rock Slope Engineering
- MN5212: Underground Space Technology
- MN5213: Rock Fragmentation Engineering
- MN5214: Practices of Rock Mechanics Instrumentation
- MN5215: Rockmass Structures
- MN5216: Subsidence Engineering
- MN5217: Engineering Geology
- MN5218: Drilling Technology

** Note: Dissertation topic to be allotted during this semester.**

### M.TECH. (MINING ENGINEERING) PART – I SEMESTER – II
### (MINE ENVIRONMENT)

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*Open Elective from other departments/schools

** Departmental Electives

- MN5221: Environmental Planning and Management in Surface Mines*
- MN5222: Planning and Design of Mine Ventilation Systems*
- MN5223: Environmental Hazards and Disaster Management in Mines*
- MN5224: Global Environmental Issues *
- MN5225: Clean Coal Technology*
- MN5226: Waste Management in Mines

** Note: Dissertation topic to be allotted during this semester.**

Department of Mining Engineering, Institute of Technology, Banaras Hindu University, Varanasi
### M.TECH. (MINING ENGINEERING) PART – II SEMESTER – III
#### (MINE PLANNING)

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### M.TECH. (MINING ENGINEERING) PART – II, SEMESTER – III
#### (ROCK MECHANICS)

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### M.TECH. (MINING ENGINEERING) PART – II, SEMESTER – III
#### (MINE ENVIRONMENT)

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### M.TECH. (MINING ENGINEERING) PART – II SEMESTER – IV
#### (MINE PLANNING)

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### M.TECH. (MINING ENGINEERING) PART – II SEMESTER – IV
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M.TECH (MINING ENGINEERING) PART – I SEMESTER – I

MN5101: OPERATIONS RESEARCH (3 Credits)

Introduction to Operation Research

Basic concepts.

Linear Programming

Simplex methods, dual problem and post optimality analysis.

Dynamic Programming

Concept, recursive equation approach, computational procedure, forward and backward computations and problems of dimensionality.

Network Analysis

Network representation, critical path calculations, probability and cost considerations in project scheduling, construction of time chart and resource leveling.

Inventory Models

Definition, deterministic and probabilistic models.

Queuing Theory

Basic concepts, axiomatic derivation of the arrivals and departures, distribution for Poisson queues, Poisson queuing models, non-Poisson queuing models, queuing models with priorities for service.

Non-linear Programming

Unconstrained external problems, constrained external problems, programming – separable, quadratic, stochastic and geometric.

MN5102: APPLIED ROCK MECHANICS (3 Credits)

In-situ Stresses

In-situ stresses in the earth’s crust. Methods of in-situ stress determination.

Stress Around Mine Openings

Distribution of stresses around mine openings of various shapes.

Design of Mine Openings and Pillars

Design of Supports

Rock bolting, cable bolting, roof stitching, shotcreting, support for bord and pillar and longwall workings.

Goaf Support

Mechanics of caving and filling.

Rock Bursts and Bumps

Mechanism, prediction and control.

Subsidence

Mechanism, prediction and control. Design of shaft pillar.
MN5103: PROJECT MANAGEMENT (3 Credits)

Financial Analysis

Personnel Management

Work Study
Time and motion study.

Inventory Planning and Management

Purchasing and Tendering
Purchase procedures in public sector. Preparation of tender documents.

Project Monitoring

Industrial Disputes
Types and causes of industrial disputes. Settlement of industrial disputes.

Mine Closure Planning

Quality Management
Concepts, practices and trends.

Electives (any two)

MN5104: ECO-FRIENDLY MINING (3 Credits)

Overview

Environmental Parameters
Water quality – physical, chemical, biological, criteria and standards. Classification and chemistry of major air pollutants. Soil chemistry – nature and importance of soil, soil properties, soil amendments.

Waste Management

Mine Closure
Principles, planning, financial provisions, implementation, standards for closure criteria, systems approach for mine closure and development of closure plan.

Environmental Policies and Laws
Legal provisions for environmental protection – various acts, rules and regulations.
MN5105: PHYSICAL AND NUMERICAL SIMULATION (3 Credits)

Principles and Basic Concepts of Simulation

Physical Modelling

Principles and methodology of physical modelling. Dimensional analysis. Materials used.

Boundary Element Method

Flamant’s problem, Kelvin’s problem, fictitious stress method, displacement-discontinuity method and direct boundary method.

Finite Difference Method

Concept, formation of mesh. Patterns, solutions and application in mining related problems of finite element and finite difference method.

MN5106: GEO-INFORMATICS (3 Credits)

Introduction to Geo-informatics and its Application to Mining Engineering.

Principles of Geo-informatics

Basic concepts. Management information systems (MIS) and expert systems in mining. Role of geo-informatics in micro-mechanics, fractal analysis and damage mechanics. Micro-Instrumentation.

Geological Discontinuities

Geological discontinuities and presentation of data.

Remote Sensing

Basic concepts, sensors, remote sensing system, objects and image and its applications.

Geographic Information System (GIS)

Components, capabilities and applications.

Global Positioning System (GPS)

Concepts, principles and applications.
MN5107: RELIABILITY ENGINEERING (3 Credits)

**Basic Concepts of Reliability**


**Design for Reliability**


**Component Reliability and Hazard Models**

Component reliability from test data. Mean time to failure. Time dependent hazard models – field data curves, constant hazard, linear hazard, non-linear hazard, gamma and other models.

**Reliability Assessment Approaches**


**Equipment Reliability Analysis**

Failure rate data, sources of failure rate data, classification of failure rate data, failure rate and time calculation. Analysis of mining equipment reliability.

MN5108: SAFETY AND RISK MANAGEMENT IN MINES (3 Credits)

Source of risk and hazard in mines.

Accident analysis and control.

Cost of accident.

System engineering approach to risk and safety.

Hazard identification techniques,


Safety audits and control.

Human behavioural approach in safety.
M.TECH. (MINING ENGINEERING) PART – I SEMESTER – II
(Mine Planning)

Electives (any four)

MN5201: UNDERGROUND MINE PLANNING (3 Credits)

Mining Industry in India – An Overview

Characteristics of Planning Process

Scope of mining activities. Stages of mine planning.

Feasibility and Project Reports

Contents, preparation and evaluation. Preparation of mine plan and mine environmental plan.

Capacity of a Mine

Delineation of mining area. Annual output and life of the mine.

Mine Entries

Opening of single and multiple seams/veins at various inclinations – Type (shaft, incline or adit), number, location and design.

Division of Mining Area

Division of the mining area into working units on district and level pattern. Dimensions of panels and blocks.

Production Planning and Scheduling

MN5202: SURFACE MINE PLANNING (3 Credits)

Technical and Economic Consideration

Technical and economic considerations in opening up, bench formation and ultimate pit configurations.

Layout Planning

Systems of overburden removal and planning of layouts for stipulated production.

Surface Mining Equipment and Operational Planning


Blast Design for Fragmentation and Casting

Recent Advances in Drilling, Blasting, Loading and Transport Operations

Drainage Planning and Arrangement

Reclamation Planning

Planning for reclamation of mined out areas, open pits, waste dumps and tailings pond.

Computer Applications in Surface Mine Planning.
MN5203: PLANNING FOR UNDERGROUND MECHANISATION (3 Credits)

Overview of Mechanization
Need for mechanization of mines. Social and organizational aspects and desired level of mechanization in India.

High Speed Underground Development
Shaft sinking, drifting and boring machines, raise boring machines, road headers and tunnel boring machines.

Bord and Pillar Mining
Continuous miners, loaders and shuttle cars, LHDs and SDLs. Roof bolting machines.

Powered Support Longwall Faces
Types of equipment, installation, operation and salvaging. High speed development of gates.

Mechanization in Different Stoping Methods

Transport Planning
Application of different transport systems.

Maintenance Planning
Planned, preventive and predictive maintenance. Condition monitoring of equipment.

Other Aspects of Mechanization
Techno-economic indices of mechanized systems. Equipment availability, utilization and reliability.

MN5204: MINE ENVIRONMENT PLANNING (3 Credits)

Environmental Standards
National and International standards of various environmental parameters.

Environmental Impact Assessment (EIA)
Framework for EIA, screening, scoping and baseline studies. EIA methodologies and their applicability, Environmental Impact Indices, uncertainties in EIA.

Environmental Management Plan (EMP)
Scope, structure and legislative requirements. Preparation of EMP.

Ventilation Planning
MN5205: SYSTEMS ENGINEERING (3 Credits)

Basic Concepts
Concept of systems and sub-systems with examples.

Development of Systems

Phases

Steps
Single thread, high traffic and competitive design.

Components
Inputs, communication, logical control, reflexive control and handling outputs.

Tools

Applications
Applications to the integrated design of winning, transport, ventilation, drainage and ground control in underground and surface mines.

MN5206: APPLIED GEOLOGY IN MINE PLANNING (3 Credits)

Reconnaissance and Prospecting
Terrestrial, aerial and satellite imagery methods. Photo geology. Collection, presentation and evaluation of geological data.

Geological Mapping for Surface and Underground Deposits
Basic maps and survey control, equipment and procedures.

Hydro Geology
Joint water pressure analysis. Estimation of make of water.

Ore Reserve Estimation
Sampling methods, pattern spacing of holes, grade and tonnage calculation, applications of geostatistics.

Mining Operations
Ore body evaluation, district exploration, 3-D exploration logging, shear zone demarcation, joints and discontinuity survey and Joint characterization.
**Electives (any four)**

**MN5211: ROCK SLOPE ENGINEERING (3 Credits)**

**Role of Slope Stability in Economic Design and Operation of Open Pit Mines**

**Types and Mechanics of Slope Failure**

Types of slope failure, falls, slides and flows. Mechanics of slope failure – plane, wedge, circular, toppling, buckling, Prandtl type, block and key block failures.

**Factors Affecting Slope Stability**

Geological factors, slope geometry, ground water, equipment loading, dynamic loading and effect of time.

**Slope Stability Analysis**


**Design of Waste Dumps and Tailings Dams**

**MN5212: UNDERGROUND SPACE TECHNOLOGY (3 Credits)**

**Tunnel Driving Techniques**

Drilling and blasting. Tunnel boring machines. Tunnel shield supports, remote control and automation of supports. Tunneling shield system with road headers. Tunnel lining – design, reinforcement and adhesives, changes of curvature, strain and stress measurement. Rock anchoring and bolting.

**Design and Construction of Large Underground Excavations**

Rock conditions and initial state of stress. Dimensions, shape, structural behaviour, methods and sequence of excavations.

Power stations. Storage caverns. Metro railways. Large diameter trenches for communication, radioactive disposal and excavation for defence purposes.

**Stability Analysis**

Structurally controlled instability, influence of size and in-situ stresses.

Instrumentation, monitoring and analysis.
MN5213: ROCK FRAGMENTATION ENGINEERING (3 Credits)

Fragmentation by Blasting

Fragmentation Measurement Methods
Application of high speed videography and image analysis techniques for measurement of rock fragmentation by blasting, blast surveys, audits and documentation for monitoring of fragmentation. Computational methods.

Blasting Nuisances
Blasting damages, ground vibrations, airblasts and flyrocks. Mitigation of damages due to blasting.

Mechanical Methods of Fragmentation
Mechanism of fragmentation by water jets, shearers and ploughs, roller and disc cutters.

Special Blasting Techniques
Underwater blasting, demolition blasting, smooth blasting and hot hole blasting.

Alternative Methods for Rock Fragmentation
Physical, chemical and nuclear methods.

MN5214: PRACTICES OF ROCK MECHANICS INSTRUMENTATION (3 Credits)

Load and Pressure Measuring Instruments
Load cells, pressure measuring instruments – stress capsules, stress meters, borehole pressure cells and flat jacks. Strain gauges and transducers, readout units, sensors, transmitters and data acquisition systems.

Deformation and Strain Measuring Instruments
Convergence meters, convergence recorders, tape extensometers, bore hole deformation gauge, multipoint borehole extensometers and bore hole camera.

Testing Equipment
UTM, MTS and acoustic emission equipment. Rock bolt pull tester.

Soil Mechanics
Instrumentation for shear strength and bearing capacity of soils.

Applications
Mining and Civil Engineering applications.
MN5215: ROCK MASS STRUCTURES (3 Credits)

Syngenetic and Epigenetic Structures.

Syngenetic structures in rocks – origin, types, effects on strength, suitability as building stones and sites for engineering projects.

Epigenetic structures – origin, types, characterization and significance for engineering projects.

Rock Mass Classification

Concept and analysis of rock mass fabrics. Rock mass deformation and discontinuities.

Site Characterization

Scale dependence of properties, description and characteristics of discontinuities.

Intact Rock

Application of linear elastic fracture mechanics, stresses and strains in rocks, failure criteria, failure modes and post failure behaviour.

Fractured Media

Detection, mapping and representation of the discontinuity system, effect of large fractures, uncertainty in fractured rock models and graphical techniques of recording discontinuities.

MN5216: SUBSIDENCE ENGINEERING (3 Credits)

Theories of surface and sub-surface subsidence due to mining and non-mining causes. Zones of movement in the overlying beds. Rock kinematics.


Special mining layouts to minimize subsidences. Impact of subsidence on structures. Design of shaft and safety pillars.
MN5217: ENGINEERING GEOLOGY (3 Credits)

Genetic rock structures and their significance.


**Joints**

Joint sets, joint surfaces and their characterization.

**Faults**

Types of faults and their characterization.

**Mapping and Interpretation of Geological Structures**

Equal area and stereographic projection, Pi diagrams, contour diagrams, beta diagrams, aerial photography and remote sensing.

MN5218: DRILLING TECHNOLOGY (3 Credits)

**Drilling Methods**


**Drilling Principles**

Mechanics of percussive and rotary drilling.

**Exploratory Drilling**

Diamond drilling – types, rods, barrels and bits. Overburden blast hole drilling. Rotary blast hole drilling – components of drilling rigs, roller bits, rigs and rock compatibility.

**Production Drilling**

Percussive drilling – drill design, variants, wave theory, classes of drills mounting, bit types, stems, complete failures and life.

Down-the-hole drilling – hammers, high air pressure drill string, rigs, hydraulic and pneumatic rotary heads, drilling technique.

**Rotary Mining Drills**

Classification, advantage, limitations and constructional features of rotary cutting and rotary crushing drill rigs.

**Specialized Drilling Techniques for Mining, Petroleum and Construction Industry**
M.TECH. (MINING ENGINEERING) PART – I SEMESTER – II
(Mine Environment)

Electives (any four)

MN5221: ENVIRONMENT PLANNING AND MANAGEMENT IN SURFACE MINES (3 Credits)

Overview

History of environmental problems in mines and present environmental scenario. Techno-economics of environmental management.

Environmental Parameters and Standards


Environmental Impact Assessment (EIA)

Framework for EIA, EIA methodologies and their applicability. Uncertainties in EIA.

Environmental Management Plan (EMP)

Legislative requirements of EMP.

Preparation and appraisal of EMP report.

MN5222: PLANNING AND DESIGN OF MINE VENTILATION SYSTEMS (3 Credits)

Ventilation Requirements in Mines

Various systems of mine ventilation. Short-term and long-term ventilation planning.

Ventilation Network Analysis


Heat Transfer

Heat transfer in mine airways due to conduction, convection and radiation, heat transfer at wet surfaces, sources of heat in longwall working panels and computation of heat load in mines.

Design of auxiliary ventilation system for long heading and longwall panel.

Recirculation of Mine Air

Concept of controlled recirculation, design of controlled recirculation system for long heading and working panel. Application of tracer gas in mine ventilation system study – concept, desirable properties, estimation of air quantity using tracer gas technique, application in leakage and recirculation study.

Design of Methane Drainage Systems
MN5223: ENVIRONMENTAL HAZARDS AND DISASTER MANAGEMENT IN MINES (3 Credits)

Mine Fires


Explosions

Types, mechanisms, prevention and recovery.

Inundation

Causes of inundation and preventive measures, detection of water bodies, precautions while approaching water bodies, water dams and barriers against failure, dewatering, case histories of inundation.

Mine Occupational Diseases

Pneumoconiosis, silicosis, asbestosis, siderosis, manganese poisoning, cyanide poisoning, heat and thermal stresses, nystagmus, radiation hazards, hazards from polyurethane, dermatitis, carbuncles, over-exertion, athlete’s foot, noise induced hearing loss and white finger.

Disaster Management


MN5224: GLOBAL ENVIRONMENTAL ISSUES (3 Credits)

Environmental Issues


Environmental Protection Strategies


Recommendations of international summits and their implications on mining activities.

Standards and Legislation

National and international standards for various environmental parameters. Indian legislation on environment.
MN5225: CLEAN COAL TECHNOLOGY (3 Credits)

Coal Utilization


Pre-Combustion Technology


Combustion and Post-Combustion Technology

Necessity, scope and limitations of combustion and post-combustion clean coal technologies. Developments, basic principles, operating features of clean coal technologies. Selection, performance and related environmental problems and their control.

Wastes and Pollutants

Characterization, impacts, control, treatment and safe disposal of wastes and pollutants released from various stages of clean coal technologies. Utilization of wastes and pollutants.

MN5226: WASTE MANAGEMENT IN MINES (3 Credits)

Chemical aspects of environmental pollution by mine wastes and their impact.

Production and characterization of solid wastes in different types of mines.

Generation and characterization of mine effluents and leachate.

Tailings – characterization, technical issues, sampling and analysis, site selection and design of tailings impoundment, tailings dam failure.

Management of different types of mine wastes.