**Department of Mining Engineering,**
**Faculty of Engineering & Technology,**
**AKS, University, Satna, M.P.**

# Study and Evaluation Scheme

# Of

# Master of Technology

# Part Time (Duration-3 Years)

**(Applicable w.e.f Academic Session 2020)**

**COURSE STRUCTURE FOR M.Tech. Part Time (MINING ENGINEERING)**

## M. Tech. Part Time (MINING ENGINEERING) SEMESTER – I

| SEMESTER – I | | | |
|---|---|---|---|
| **SUBJECT CODE** | **SUBJECT** | **CONTACT HOURS/ WEEK** | **CREDITS** |
| **THEORY** | | | |
| | Operations Research | **03** | **03** |
| | Project Management | **03** | **03** |
| | *Elective – I | **03** | **03** |
| | Operations Research-LAB | **03** | **02** |
| | TOTAL | **12** | **11** |

*Physical and Numerical Simulation
*Geo-informatics

| SEMESTER – II | | | |
|---|---|---|---|
| **SUBJECT CODE** | **SUBJECT** | **CONTACT HOURS/ WEEK** | **CREDITS** |
| **THEORY** | | | |
| | Applied Rock Mechanics | **03** | **03** |
| | **Elective – II | **03** | **03** |
| | **Elective – III | **03** | **03** |
| **Practical** | Applied Rock Mechanics | **03** | **02** |
| | TOTAL | **12** | **11** |

**Eco-friendly Mining
**Safety and Risk Management in Mines
** Reliability Engineering
** Underground Space Technology

| SEMESTER – III | | | |
|---|---|---|---|
| **SUBJECT CODE** | **SUBJECT** | **CONTACT HOURS/ WEEK** | **CREDITS** |
| **THEORY** | | | |
| | **Elective – IV | **03** | **03** |
| | **Elective – V | **03** | **03** |
| | TOTAL | **06** | **06** |

**Rock Fragmentation Engineering
** Rock Slope Engineering
**** Practices of Rock Mechanics Instrumentation
**Subsidence Engineering

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

| SEMESTER – IV | | | |
|---|---|---|---|
| **SUBJECT CODE** | **SUBJECT** | **CONTACT HOURS/ WEEK** | **CREDITS** |
| **THEORY** | | | |
| | **Elective – VI | **03** | **03** |
| | **Elective – VII | **03** | **03** |
| | Seminar | **02** | **02** |
| | TOTAL | **08** | **08** |

****** Rock mass Structures
**Engineering Geology
**Drilling Technology

| SEMESTER – V | | | |
|---|---|---|---|
| **SUBJECT CODE** | **SUBJECT** | **CONTACT HOURS/ WEEK** | **CREDITS** |
| **THEORY** | | | |
| | Seminar on Dissertation Evaluation | **-** | **05** |
| | Dissertation – Interim Evaluation | **-** | **05** |
| | TOTAL | | **10** |

| SEMESTER – VI | | | |
|---|---|---|---|
| **SUBJECT CODE** | **SUBJECT** | **CONTACT HOURS/ WEEK** | **CREDITS** |
| **THEORY** | | | |
| | Seminar on Dissertation Evaluation | **-** | **05** |
| | Dissertation – Interim Evaluation | **-** | **05** |
| | TOTAL | | **10** |

**M.TECH. (MINING ENGINEERING)**

## 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.

## 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 stiching, 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.

## APPLIED ROCK MECHANICS LAB

1 Study of determination of some physical properties of rock - like water absorption, density and specific gravity.
2 Study of determination of porosity and void index of rocks.
3 Study of rock stress determination Insitu using flate jake technique.
4 Study of determination of sonic wave velocity of rock specimen with suitable diagram.
5 Study of determination of UCS and elastic constants.
6 Study of determination of indirect tensile strength by point load and Brazilian tests.
7 Study of the effect of L/D Ratio, strain rate, and saturation of rock specimen on compressive strength.
8 Study of determination of strength anisotropy of rock specimens by direct shear test in single, double, oblique and punch shear.
9 Study of determination of slake durability index of rock samples.
10 Study of Triaxial compression testing of rock specimen.

## PROJECT MANAGEMENT ( 3 Credits)

**Financial Analysis:** Mining costs. Break Even Analysis. Net Present Value (NPV). Internal Rate of Return (IRR). Incorporating risk in the NPV calculation. Sensitivity analysis. Preparation of balance sheets.

**Personnel Management:** Requirement schedule. Qualifications, experience. Press advertisement. Processing of applications. Tests, selection and appointment. Induction and training programmes.

**Work Study:** Time and motion study.

**Inventory Planning and Management Purchasing and Tendering**

Purchase procedures in public sector. Preparation of tender documents.

**Project Monitoring:** Monitoring techniques. Management Information Systems (MIS).

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

**Mine Closure Planning:** Issues in mine closure planning. Different mine closure operations. Role of regulatory authorities and mine operator in mine closure. Post-mining site rehabilitation programme.

**Quality Management:** Concepts, practices and trends.

## ECO-FRIENDLY MINING ( 3 Credits)

**Overview:** Basic concept of eco-friendly mining. Selection of eco-friendly equipment and exploitation operations.

**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:** Waste water management – sources characteristics, techniques of treatment. Acid mine drainage – occurrence, effects and treatment techniques. Solid waste management for mine spoils.

**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.

## 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.

## 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.

## RELIABILITY ENGINEERING ( 3 Credits)

**Basic Concepts of Reliability:** Reliability and quality. Failures and failure modes. Causes of failure and unreliability. Maintainability and availability.

**Design for Reliability:** Mathematical model and numerical evaluation. Designing for higher reliability. Redundancy techniques. Equipment hierarchy. Reliability and cost.

**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:**

Capability and variability of performance. Required performance. Overall reliability functions.

**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.

## 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,

Risk assessment process. Risk reduction.

Safety audits and control.

Human behavioural approach in safety.

## M.TECH. (MINING ENGINEERING)

## 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**

Methods of slope stability analysis. Safety factor. Deterministic and probabilistic approaches. Physical, analytical and numerical analyses of rock and soil slopes.

Field instrumentation and monitoring. Conventional and GPS monitoring. Stabilisation and strengthening of slopes.

**Design of Waste Dumps and Tailings Dams**

## 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.

## ROCK FRAGMENTATION ENGINEERING ( 3 Credits)

### Fragmentation by Blasting

Mechanism of rock fragmentation by blasting. Explosives – trends and selection. Principles and application of explosives. Casting of rocks. Controlled blasting methods. Design of multi-row blast rounds. Design of blast rounds for tunnels and drifts.

### 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.

## 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.

Monitoring and interpretation of the data.

### Soil Mechanics

Instrumentation for shear strength and bearing capacity of soils.

### Applications

Mining and Civil Engineering applications.

## 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.

## 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.

Types of subsidence. Factors affecting subsidence. Methods of prediction of subsidence-empirical, analogue, numerical and physical models. Prediction of subsurface subsidence and subsidence nomograms. Measurement of subsidence. Time dependent component of subsidence.

Special mining layouts to minimize subsidences. Impact of subsidence on structures. Design of shaft and safety pillars.

## ENGINEERING GEOLOGY ( 3 Credits)

Genetic rock structures and their significance.
Effect of tectonic stresses on rock mass deformation. Effect of application of stress on petrographic constituents of rocks. Microfabrics and its relation with strength of rocks. Foliation and lineation in rocks 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.

## DRILLING TECHNOLOGY ( 3 Credits)

### Drilling Methods

Classification, factors affecting drilling of rock – thrust, rotation, flushing, feed, rock type, alignment and deviation. Flushing with air-water. Suction drilling. Basis for the choice of method – diameter, depth and rock type. Drillability of rocks. Ergonomics of drilling.

### 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

## 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

Baseline data. Impact of mining activities on environmental parameters. Mitigating measures, monitoring and control. National and international standards and regulations. ISO principles and series.

### 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.

## 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**

Computation of volume flow using equivalent resistance and direct analysis methods. Application of Kirchhoff's laws to solve ventilation network. Linear graph theory – formation of meshes, Hardy-Cross iteration method, convergence of network analysis algorithm. Concept of compressibility of air in mine ventilation.

**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**

## ENVIRONMENTAL HAZARDS AND DISASTER MANAGEMENT IN MINES ( 3 Credits)

**Mine Fires**

Mechanism of self-heating. Classes of fires. Detection, monitoring and control. Preventive and mitigative measures. Isolation, inertization and flooding. Fire fighting agents and methods.

**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, athelete’s foot, noise induced hearing loss and white finger.

**Disaster Management**

Emergency organization. Developments in rescue, reviving and resuscitating apparatus. Cooling and fire resistant clothings. Location and rescue of trapped miners. Investigation of disaster. Mine rescue rules.

## GLOBAL ENVIRONMENTAL ISSUES ( 3 Credits)

**Environmental Issues**

Sustainable development. Greenhouse effect. Bio-diversity. Global warming and climatic changes. Acid rain.
Sea-level changes. Ozone hole. Radio nucleides. Oil spillage in oceans.

**Environmental Protection Strategies**

Conservation of natural resources. Physical and financial incentives and disincentives. Carbon tax. Protection of ancient monuments.

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.

## CLEAN COAL TECHNOLOGY ( 3 Credits)

**Coal Utilization**

Coal production and utilization trends. Status of coal utilization technology and related operating and environmental problems. Coal qualities and their effect on selection of efficient methods for eco-friendly utilization of coal.

**Pre-Combustion Technology**

Necessity, scope and limitations of pre-combustion coal cleaning technology. Washability characteristics and preparation problems related to coal quality. Principles, operations and selection of processes for coal preparation. Plant performance evaluation and forecasting of cleaning results. Environmental problems and related mitigating measures.

**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.

## 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.