DEPARTMENT OF MINING ENGINEERING

Course Book for

Bachelor of Technology (B.Tech) in Mining Engineering

For

ACADEMIC YEAR
2020 – 2021

Visvesvaraya National Institute of Technology
Nagpur – 440 010 (Maharashtra)
**Institute Vision Statement**

To contribute effectively to the National and International endeavour of producing quality human resource of world class standard by developing a sustainable technical education system to meet the changing technological needs of the Country and the World incorporating relevant social concerns and to build an environment to create and propagate innovative technologies for the economic development of the Nation.

**Institute Mission Statement**

The mission of VNIT is to achieve high standards of excellence in generating and propagating knowledge in engineering and allied disciplines. VNIT is committed to providing an education that combines rigorous academics with joy of discovery. The Institute encourages its community to engage in a dialogue with society to be able to effectively contribute for the betterment of humankind.

**Department Vision Statement**

To create an environment conducive for attaining professional competence in the field of Mining Engineering and to provide specialized training for developing need-based human resource, while fostering within students and staff committed to academic, social and professional development.

**Department Mission Statement**

To maintain the standard of mining education and commitment for basic research and applied research in the diverse fields of mining, excavation engineering and other interdisciplinary areas and continuously striving to be recognized internationally for education, research and service to the mining and allied industry.
Brief about Mining Department

General Information

The department of Mining Engineering is established in the year 1982-83. It offers Bachelor of Technology in Mining Engineering course. The course has been accredited by National Board of Accreditation earlier in 1996, 2001, 2008 and 2016 and was granted Grade “A”.

In its 38 years of existence 34 batches of students have passed out with about 600 students graduating. The performance of present and past students is comparable with that of International standards.

The B Tech in Mining Engineering is a 4 year course run on semester pattern. A weightage of 40% of contact time is given for practical and 60% for theory. Assessment is based on sessional examinations, practical tests, final written examination, internal viva-voce examination, Home assignments, quality of field work, field reports, seminars and project work. Assessment is 100% internal in case of theory and practicals. The course is regularly upgraded and presently relative grading is in operation. Female candidates have been permitted to take up admission B Tech(Mining) Course. The department also offers M.Tech in Excavation Engineering and Ph.D.

The department is housed in an independent building housing classrooms, laboratories, workshop, seminar and audio-visual rooms, office, stores and other facilities in about 1600 sq.meter area. The department has implemented a number of growth programmes funded by various National and International agencies and has acquired good laboratory and computational facilities. A central library caters to the needs of the department.

The core faculty comprises of 3 Professor, and 5 Assistant Professor. The core faculty is supported by 4 faculty members from other departments and 3 adjunct faculty members as experts from field. The faculty is supported by 7 non-teaching staff.

The department enjoys an excellent rapport with the industry and offers variety of testing and consultancy services to them. The faculty is actively involved in student activities, curriculum development, departmental and institutional planning, development and administrative activities, service to industry and society, implementation of growth programs research and development and in creating an enriching work culture.

The department aspires to create an internationally competitive teaching and research environment through faculty development, creation of advanced research facilities, acquiring collaborative projects and attracting scholars, increasing liaison with industry and maintaining a creative work culture.
Objectives of the B.Tech Program:

- To train students to acquire knowledge in the areas of mining engineering processes, systems and technologies.
- To develop curriculum and instructional programs in mining engineering in tune with need of the time.
- To generate new knowledge through research and development and to disseminate it.
- To modernise laboratories and to establish research facilities in the emerging areas.
- To promote faculty and staff development for updating and acquiring new knowledge and improving professional competence.
- To provide technical services to the mining industry.
- To provide guidance and counseling to students and to establish fruitful linkage with alumni.

Programme Educational Objectives (PEOs)

1. Demonstrate the knowledge in the areas of mining engineering processes, systems and technologies looking into industry and research needs by exposing them to the latest technology.
2. Understand the practical aspects of the mining industry and an appreciation for mining as a profession with regards to safety, technology, blasting and environment looking into economics and production.
3. Apply knowledge in the application of engineering principles pertaining to mine planning, decision making and systems and invoke the desire for continuing education, research, intellectual and professional development and creativity.
Programme Outcomes (POs)

At the end of the program B. Tech Mining Engineering, the student will be able to;
1. Exhibit knowledge of mining engineering and allied with basic sciences.
2. Identify, formulate, analyze and optimize mining engineering problems of various domains.
3. Plan Design and solve various mining engineering components with environmental, social and safety considerations.
4. Comprehend and solve interdisciplinary engineering problems through system approach.
5. Select and apply modern and virtual engineering tool, Design and analysis software and state of art equipment to solve mining engineering problems.
6. Demonstrate the understanding of social, cultural, environmental, land usages and legal issues in professional activities.
7. Exhibit the knowledge of contemporary issues such as effect of technology on environment and importance of sustainable development.
8. Integrate the knowledge of values and professional values and ethics in their activities.
9. Demonstrate the ability to work as individual and participatory learning through group work and working in group as a member or leader to accomplish target for industrial project.
10. Prepare reports to present and communicate technical information effectively by way of seminars.
11. Adopt and adapt technological changes through skill up gradation for lifelong learning.
12. Plan, organize and manage mining engineering projects for feasibility and effective use of financial and human resources.
## List of Faculty Members

<table>
<thead>
<tr>
<th></th>
<th>Name</th>
<th>Area of Specialization</th>
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<tbody>
<tr>
<td>1</td>
<td>Dr. Rajendra Yerpude</td>
<td>Mine Planning, System engg, Mine Safety Engg., Computer applications, Mine Economics</td>
</tr>
<tr>
<td>2</td>
<td>Dr. N. R. Thote</td>
<td>Rock Blasting and Rock Mechanics, Opencast Mining, Mine Environment</td>
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<tr>
<td>3</td>
<td>Dr. I. L. Muthreja</td>
<td>Mine Planning, Mine Environment, Strata Control, Slope Stability</td>
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<td>4</td>
<td>Dr. A. K. Agarwal</td>
<td>Mine system Engineering, Slope and dump design, Water pollution</td>
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<td>5</td>
<td>Dr. R. D. Lokhande</td>
<td>Ground control, Design of underground mine working, Slope and dump design</td>
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<tr>
<td>6</td>
<td>Dr. Sandeep Panchal</td>
<td>Rock Mechanics, Underground Coal Mining, Mine Back filling, Mine Surveying</td>
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<td>7</td>
<td>Dr. N. N. Sirdesai</td>
<td>Geomechanics, Novel Mining Methods, Tunnelling</td>
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<td>8</td>
<td>Dr. A. A. Kher</td>
<td>Safety in mines, Mine ventilation Planning</td>
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CREDIT REQUIREMENTS FOR B.TECH (MINING)
2015 Batch Onwards

TOTAL CREDIT REQUIREMENT: 170

OVERALL CREDIT STRUCTURE

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<th>Category</th>
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<td><strong>Total</strong></td>
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Grand Total PC +PE 170

REVISED 1ST YEAR B. TECH. SCHEME

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Second Semester

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## Third Semester

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### Elective/OC

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**TOTAL CREDITS 23**

## Fourth Semester

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<td>MNL208</td>
<td>Surface Mining</td>
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<tr>
<td>MNL203</td>
<td>Underground Metalliferous Mining</td>
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### Electives (Any Three)

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<td>CEL384</td>
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<td>EEL285</td>
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**TOTAL CREDITS 18**

## Fifth Semester

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<tr>
<td>MNL205</td>
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<tr>
<td>MNL206</td>
<td>Rock Engineering</td>
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<td>MNL301</td>
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<td>Mine Ventilation &amp; Climate Engineering</td>
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<td>MNP206</td>
<td>Rock Engineering</td>
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### Electives (Any Three)

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<tbody>
<tr>
<td>MML291</td>
<td>Mineral Processing / Dressing</td>
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<td>3-0-0</td>
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<tr>
<td>MNL425</td>
<td>Mass Production Technology for Underground Coal</td>
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<tr>
<td>MNL434</td>
<td>Advanced UG Metal Mining &amp; Design</td>
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<td>MNL424</td>
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**TOTAL CREDITS 22**
## Sixth Semester

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<tr>
<td>MNL302</td>
<td>Mine Hazards and Rescue</td>
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<tr>
<td>MNP302</td>
<td>Mine Hazards and Rescue</td>
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<td>MNL303</td>
<td>Ground Control In Mines</td>
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<tr>
<td>MNP303</td>
<td>Ground Control In Mines</td>
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<tr>
<td>MNP314</td>
<td>Survey Camp (Sessional)</td>
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<tr>
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<td>Mine Management Information System</td>
<td>DE</td>
<td>3-0-0</td>
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<td>MNL423</td>
<td>Geostatistics</td>
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<td>MNL429</td>
<td>Blasting Technology for mining &amp; Const.</td>
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<tr>
<td>MNL431</td>
<td>Novel Mining Methods</td>
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<td>MNL426</td>
<td>Underground Space Technology</td>
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**TOTAL CREDITS 21**

## Seventh Semester

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<td>MNP402</td>
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<td>MNL405</td>
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<td>MNL406</td>
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<td>MNL422</td>
<td>Rock Excavation Engineering</td>
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<td>Rock Slope Engineering</td>
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<td>MNL433</td>
<td>Advanced Surface Mining &amp; Design</td>
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**TOTAL CREDITS 24**

*Three mine visits during the course.*
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**Elective (Any One)**

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TOTAL CREDITS 19

** Three trainings of one month duration each in opencast, underground coal and underground metal mines during the course.

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* Three mine visits during the course

** Three trainings of one month duration each in opencast, underground coal and underground metal mines
MINING DEPARTMENT
AS PER SCHEME IMPLEMENTED WITH EFFECT FROM ADMISSION BATCH 2020
B.TECH. MINING ENGINEERING: Syllabus

CEL2** Mining Geology L-T-P: 3-0-0

Content


Mineralogy: Definition and classification of Minerals. Silicate structures. Structure, chemical and physical properties of following mineral groups; Silica, Felspar, Pyroxene, Amphibole, Mica and Clay minerals.


Stratigraphy: Principles of stratigraphic Correlation, Stratigraphic units and Geological Time Scale. Principles of Prospecting and Exploration, Geophysical and geochemical prospecting

Economic Geology, Study of important metallic and non-metallic deposits of India. Introduction to geology of Indian Coalfields

Text Reference Books
1. Engineering Geology : B.S.S. Narayanswamy
4. Structural Geology : M.P. Billings
4. Principles of Stratigraphy : Ravindra Kumar
6. Courses in Mining : RNP Arogyaswamy

Course Outcomes:
The students will be able to
1. Understand the Internal structure of earth and structural geology
2. Know about the rocks and minerals and their properties.
3. Understand various geological structures and impacts on mining
4. Generate the sub surface profiles from geological maps and plotting structures.
MNL 201 Introduction to Mining Technology (Departmental Core)L-T-P:3-0-0
Pre-requisite: Nil

Course Objectives: Students will be made aware about the rudimentary aspects of mining engineering.

Course Assessment:

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* students assignments, class performance (attendance, tutorials)

Course Content:

**Introduction:** Important mineral resources, Importance of Mining and its consequences.

**Basic terminology:** Surface Mining, Underground coal and metal such as Mine, Mining, surface mining, underground mining, mineral, rock, ore, mineral deposit, beds, coal seam, veins, strike and dip, hanging wall, footwall, bench, haul road, bench slope, pit slope, overburden, dump, stripping ratio, shaft, adit, incline, tunnel, cross cut, drift, level, winze, raise, stope, dip and rise, level, face, panel, pillar, gallery, roadway.

**Phases of mining:** Prospecting to reclamation, Brief description of elements of an opencast mine; ramp, haul roads, benches, production cycle, dumping of overburden and backfilling. Brief description of Board and Pillar development, and Longwall (advancing and retreating) methods of coal mining.

**Introduction to underground metal mining methods:** Brief description of underhand, overhand, cut and fill, and sub level stoping methods of metal mining.

**Introduction to Oil Mining:** Opening up of deposits; mode of entry; adit, shaft, decline, and combined model; their applicability and comparison.

**Drifting:** Small and medium size tunneling and drifting; drivage work in varying ground conditions using conventional methods – drilling, blasting, mucking, transportation, supports, services and cycle of operations.

**Mechanical methods of drivage of roadways and tunnels**

**Shaft sinking:** site selection, shaft sinking preparatory arrangements, drilling and blasting, mucking, hoisting, ventilation, pumping, lighting, supporting of sides, complete cycle of operations, special methods of sinking to be used in difficult ground conditions, deepening and widening of shafts, modern techniques of shaft sinking.

Drilling for production of minerals from surface and underground mines, rotary, percussive and rotary-percussive drilling, short and long hole drilling equipment, mechanism of drilling, different types of bits, bit wear, drilling performance.

**Explosives:** types of explosives - their composition and properties; selection of explosives; manufacture, transport, storage and handling of explosives; testing of explosives, destruction of explosives.

**Blasting:** Mechanism of rock fragmentation by blasting; blasting accessories, exploders; blasting practices in opencast and underground mines, compaction and strength.

Books:
1. Introductory Mining Engineering: H L Hartman
2. Coal Mining Methods: S K Das
3. SME Mining Engineer’s Handbook: Hustrulid

Course Outcomes:
The students will be able to understand the
1. Basic terminology of mining and mechanics of blasting
2. Various phases of underground and open cast mining
3. Various operations involved in drifting and shaft sinking
4. Various types of explosive and their use in mines
Contents

Power Transmission: General Principles; Power transmission by belts [flat and V], ropes, chains and gears. Ratio of tensions, centrifugal tension, slip and creep in belts [explanation of terms only.] Power transmitted by belts. [When C.F. tension is neglected] and chain drives; power transmitted by chains, simple problems; Belt and rope materials, power transmitted by gears, type of gears.

Brakes and Dynamometers: Band brake, block brake, band and block brake, single and multiple disc clutches, transmission and absorption type dynamometers.

Bearings and Couplings: Main types of bearings and couplings, anti friction bearings.


Thermodynamics: Laws of thermodynamics, concept of entropy, methods of heating and expansion of gases, internal energy, external work done, total heat of gas, change of entropy during different methods, representation on PV and TQ diagram.

Air Standard Cycles: Carnot, Otto, Diesel and Joule’s cycles. Air Standard efficiencies, and mean effective pressure, representation of PV and TQ diagram.

Internal Combustion Engines: Classification based on types of fuel and working cycles, working of four stroke and two-strokes cycles. IC Engines; Their merits and demerits, study of parts of petrol and diesel Engine viz. fuel pump, injector and carburetor, Brief description of ignition system, cooling system, and lubrication system of IC Engines. Study of multi-cylinder engines. PV diagram, testing of IC engines, and thermal efficiencies, simple problems. Air Compressors: Reciprocating and Rotary compressors single and multistage compressors, inter cooler, after cooler, receiver clearance volume and volumetric efficiency. Refrigeration and air conditioning: Bale – Coleman refrigerators, vapor compression and absorption refrigerators, psychrometry charts, introduction to comfort air-conditioning.

Reference Books
1. Theory of Machines : S.S.Ratan
2. Theory of Machines : Shigley
3. Engineering Thermodynamics : P.K.Nag
5. Thermal Engineering: V.M.Domkundwar
6. Theory of Machines : R.S.Uhurmi

Course Outcomes:

The students will be able to understand the

1. General Principles of Power Transmission
2. Concepts of Thermodynamics and Internal Combustion Engines
3. Air Standard Cycles and Air Compressors
Mine Surveying (Departmental Core)L-T-P:3-0-2

Pre-requisite: Nil

Course Objective: Students will be given the basic idea of principles of surveying and mine surveying.

Course Assessment:

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* students assignments, class performance (attendance, tutorials)

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Course contents:

Surveying: Definition, objective, classification and principles of surveying. Linear measurement: Instruments for measuring distances, ranging survey lines. EDM: Principle of measurement; types; corrections; selection of equipment; total station.

Miner’s Instrument: Miners’ Dial, Abney level, Clinometers, Suspension Compass, and Gyro-theodolite; Angular measurement; Prismatic compass - principle and construction; bearing of lines; local attraction; magnetic declination.

Theodolite: Essentials of the transit and modern micro-optic theodolite; measurement of horizontal and vertical angles; theodolite traversing, traverse calculations, adjustment of the traverse; computation of co-ordinates; temporary and permanent adjustments.

Leveling: Definition of leveling terms; leveling instruments; different types of leveling; booking and reduction methods; differential, profile, cross-sectional and reciprocal leveling; underground leveling; shaft depth measurement.

Contours: Characteristics, methods of contouring and uses of contours; problem solving.

Control Surveys: Tacheometry- Principle and classification of tachometry; stadia tachometry; distance and elevation formulae.

Triangulation: classification, reconnaissance, measurement, procedures for angles and base-line; GPS and its application in mine surveying.

Theory of errors, Calculation of most probable values, adjustment of observations.

U/G Surveying: - Correlation - direct traversing in inclined shaft, correlation in vertical, single and two shafts. Stope Surveying: Purpose, methods of survey in moderately and steeply inclined ore bodies, flat and vertical ore bodies/seams.

Curve setting: Elements, laying of simple circular curves on surface and belowground. Transition curve and super elevation. Development surveys; Setting a point of known coordinate, control of direction and gradient in drifts, tunnels, raises and winzes; application of lasers; Problems of underground traversing. Legal requirements as to mine plans in India, preparation and preservation of plans and sections, representation of geological and other features on mine plans and sections.

Books:
1. Surveying Vols. I, II, III Dr. B.C.Punmia
2. Surveying Vol I and II Dr T.P.Kanetkar
3. Metalliferous Mine Surveying Winniberg

Course Outcomes:

The students will be able to understand the
1. Basic terminology of Surveying
2. Various types of levelling
3. Various operations involved field surveying and curve setting.
MNL203 Underground Metalliferous Mining (Departmental Core) L-T-P: 3-0-0

Pre-requisite: Introduction to Mining Technology

Course Objectives:
- Gives understanding of metal mining methods with respect to development and extraction
- Provides methodology for selection of metal mining methods, methods of driving underground openings
- To appraise the special mining techniques and problems

Course Assessment:

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* students assignments, class performance (attendance, tutorials)

Course Content:
Present status of Indian metal mining industry, scope and limitations of underground mining; classification and choice of stoping methods
Choice of level interval and block length- shape, size, position; excavation and equipping of shaft station, grizzly, ore/waste bin, main ore pass system, underground crushing and loading stations, underground chambers, sump and other subsidiary excavations; arrangements for dumping into main ore pass
Cross-cuts, drifts, and declines — their shape, size and position
Raises and winzes - their shape, size and position; excavation process - ground breaking, mucking, ventilation and support; modern methods of raising - Alimak and longhole method including vertical crater retreat method of raising, raise boring - systems and their details; modern methods of winzing;
Secondary breaking at grizzly - conventional and mechanized methods
Open stoping – room and pillar, sublevel, large diameter blast hole/DTH, shrinkage and vertical crater retreat methods - their applicability, stope layouts, stope preparation, ground breaking, mucking, ventilation and supporting, haulage and dumping
Supported stoping – post and pillar, square set, longwall, cut and fill- their applicability, stope layouts, stope preparation, ground breaking, mucking, ventilation and supporting, haulage and dumping
Caving stoping – top slicing, sublevel caving, and block caving; their applicability, stope layouts, stope preparation, ground breaking, mucking, ventilation and supporting, haulage and dumping
Mining of parallel and superimposed veins
Pillar recovery
Dilution, loss and recovery in stoping
Specialised methods: Solution mining, in-situ leaching, borehole mining, underground retorting
Problems of deep mining and their remedial measures, design and layout of stopes in rock burst prone areas

Books:
1. Introductory mining engg by H.L.Hartman
2. Underground mining methods handbook, by Hustrulid SME publication
3. Metalliferrous mining of ores by Borosov et.al.
4. SME Mining Engineering Handbook, Edited by H.L.Hartman SME publication

Course Outcomes:
1. Students will gain the knowledge about various development headings, opening with their shape, locations and its driving technology
2. Students can will learn about the unit operations and stoping parameters through models and visuals
3. Students will develop a skill to select the method of metal mining based on geomining parameters
Course Assessment:

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Course contents:

- **Pit-Top and Pit-Bottom Circuits:** Simple pit-bottom circuits, pit-top circuits, tippers, screening and handling plants, railway sidings.
- **Wire Ropes:** Wire ropes of different types and their construction and selection, space factor, fill factor, bending factor and factor of safety. Rope deterioration, estimation of size of rope, rope capping, recapping and rope splicing.
- **Heat Treatment:** Heat Treatment of steel and steel alloys, properties, uses and application.
- **Locomotives:** Different types ; diesel, electric trolley wire, construction and operation, application and maintenance. Locomotive haulage computations, safety devices. Track laying and maintenance.
- **Manriding systems in underground mines:** Types, construction and safety devices.
- **Conveyors:** Construction and operation of belt, chain and cable belt conveyors. Conveyor computations.
- **Aerial ropeways:** Types, construction, application and operation, safety devices.

**Books:**

1. Mine Winding & Transport : Walker
2. SME Mining Engineer’s Handbook: Hustrulid

**Course Outcomes:**

The students will be able to

1. Understand various surface layouts, wire ropes construction and size selection and its deterioration
2. Transport systems in mines – its various features in detail, safety devices, braking systems and related calculation.
4. Winding systems in mines – friction winder There important features –construction, mechanical & electrical braking, safety features and torque time diagram.
5. Aerial Ropeway – construction, safety features and calculation.
MNL205 Mine Ventilation and Climate Engineering (Departmental Core) L-T-P: 3-0-2

Prerequisite: Nil

Course Objectives:
To understand the basic concepts of ventilation.
Apply various methods used in the subject.
Awareness for practical problems.
Recent developments in the subject.
Solving ventilation problems.

Course Assessment:
It is done through two sessional examinations, assignments and end semester examination.

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Course contents:
Composition of Mine Atmosphere: Mine gases - production, properties, effects and detection; sampling and analysis of mine air; methane content; methane drainage; methane layering; flame safety lamp and its uses; methanometers; radon gas and its daughter products; continuous monitoring of gases
Heat and humidity: Sources of heat in mines; effects of heat and humidity; psychrometry, kata thermometer; heat stress, air-conditioning
Natural ventilation: Seasonal variations, calculation of NVP from air densities and thermodynamic principles
Air Flow through Mine Openings: Laws of air-flow, resistance of air ways, equivalent orifice, distribution of air; flow control devices; automation and remote control of ventilation installations; ventilation surveys; permissible air velocities in different types of workings
Mechanical Ventilation : Types of mine fans; theory, characteristics and suitability of fans; selection, testing and output control; fans in series and parallel; forcing and exhaust configurations; reversal of flow; fan drifts, diffusers, evases
Ventilation planning: Planning of ventilation systems and economic considerations; ventilation layouts for mining of coal and ore deposits; ventilation of workings/stopes using heavy blasting; calculation of air quantity required for ventilating a mine; calculation of total mine head; network analysis principles and computer applications
Booster fans, auxiliary ventilation, recent developments in mine ventilation, venturi blowers; ventilation of deep mines - underground and open pit; standards of ventilation; ventilation cost calculations

Books
- Mine Ventilation: G. B. Mishra
- Sub-surface mine ventilation: Macperson
- Mine ventilation and air-conditioning in mines: Hartman
- Introductory Mining Engineering: Howard L. Hartman
- Elements of Mining Technology - Volume II: D.J.Deshmukh

Course Outcomes:
The students will be able to understand the
1. Various gaseous pollutants including radon gas in metalliferous and coal mines. Their toxic effects, detection and means of their reduction in mine atmosphere. Statutory requirement of ventilation standards to be maintained.
2. Salient features of heat and humidity, their effect on working efficiency of miners, measurement and reducing both to tolerable limits.
3. Natural ventilation and its limitations. Types of Mechanical ventilators, various ventilation devices, selection, installation, working and necessary calculation including expenditure and necessary statute.
4. Live case studies of mine ventilation, quantity & necessary pressure requirement, ventilation planning in underground coal and non-coal mines, auxiliary ventilation devices for improvement in ventilation.
5. Computer application in solving complicated ventilation circuits and special problems associated with deep underground and deep opencast mines.
MNL 206 Rock Engineering (Departmental Core) L-T-P: 3-0-2
Pre-requisite: Nil

Course Objectives:
- Mining structures are made in the rock hence rock characterization and support design becomes immense need of mining graduates. Behaviour of rock is governed by rock properties and structural discontinuities in the rock.
- The students are acquainted with the determination of the strength properties of both absolute and index properties

Course Assessment:
Internal and end sem evaluation for theory and continuous assessment for Practical, final result by grade system and distribution is given below.

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Course Content:
Introduction, Intact rock and Rock mass Properties : Introduction to Rock Mechanics; Concept of stress and strain in rock, Analysis of stress, strain and constitutive relations in isotropic and anisotropic rocks. Introduction to elementary rock mass classifications based on strength, hardness and RQD. Determination of physical properties, strengths, strength indices and static elastic constants; parameters influencing strength; abrasivity and its determination.
Time dependent and Dynamic properties of rock and rock mass, Failure criteria for rock and rock mass :: Propagation of elastic wave in rock media; determination of properties and elastic constants. Creep deformation and strength behaviour, creep test and rheological models. Theories of rock failure; Coulomb, Mohr and Griffith criteria; empirical criteria.

Books:
2. Rock Engineering : John Franklin and Maurice Dusseault, McGraw-Hill Publ. comp
3. Rock Mechanics for hard rock mining : Jumikis

Course Outcomes:
1. To make students conversant with different types of rock mass with regard to design of excavations and methods of designing
2. To acquaint students with various types of supports and reinforcements as well as permanent supports of excavations
3. To make them conversant with ground control and subsidence problems and preventive measures.
4. To understand the knowledge basic of stress analysis, rock modelling and soil mechanics to be applied for design of rock structures.
Mining Machinery-II (Departmental Core) L-T-P:3-0-0

Pre-requisite : Mining Machinery-I

Course Objectives:
- Today, minerals whether coal or non coal are high in demand therefore it involves high capacity mining machines.
- Imparting knowledge of the following: constructional features, working, applications, capacity, calculations and safety features.
- To find out the right combination of various machines and their number required for desired output.

Course Assessment:

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* students assignments, class performance (attendance, tutorials)

Course Content:

Coal cutting machines: shearsers, coal ploughs, lump breakers, road headers, TBMs, raise and shaft borers, continuous miners, stage loaders; their main features and applicability
Loading machines: rocker shovel, SDL, LHD, gathering arm loader, shuttle car, LPDTs, scraper ; their main features, applicability, selection and production capacities
Open cast Machinery: Shovels, draglines, dumpers, wheel loaders; their main features, applicability, selection and production capacities;
Underground coal and rock drills, jumbo drills, rock bolting machines.
Small and large diameter surface blasthole drills, rippers and scrapers, road graders, dozers; their construction, application, selection, and operation
Continuous surface mining equipment: bucket wheel excavators, surface miners, spreaders, dredging equipment; their main features, applicability, selection and production capacities
Pumps: Types of mine pumps, application and related computations.

Books:
1. SME Vol on Underground Mining Methods Handbook Ed. Hustrulid
4. Surface Mining Equipment by JW Martin, TJ Martin, TP Bennett, KM Martin; Publ – Martin Consultants, Inc, Golden Colorado 80402

Course Outcomes:
The students will be able to
1. Understand the necessity, construction, applications and selection of various winning machines in underground excavation including, coal formation and tunnels.
2. Understand the necessity, construction, applications and selection of various loading machines in underground excavation including coal formation and tunnels.
3. Understand the necessity, construction, applications and selection of various drilling machines in underground & surface excavation along with roof bolting machines.
4. Understand the necessity, construction, applications and selection of various surface mining machines.
5. Understand the necessity, construction, applications and selection of various ancillary equipments. Construction and selection of various type of pumps used in underground and opencast mines and calculations.
MINERAL PROCESSING (Departmental Elective) L-T-P: 3-0-0

Contents
Mineral beneficiation and its role in mineral exploration and conservation with special reference to Indian economic minerals
Theory and practice of crushing and grinding, conventional units and their performance and choice
Laboratory techniques, interpretation and plotting of data, industrial screens and classifiers, dry and wet processes
Importance of sampling and methods used in mills
Picking, washing and classification
Theory and applications of sinks and float, jigging and flowing film concentration-methods and equipment used.
Physico-chemical principles, flotation reagents, flotation machines and circuits, application to common sulfide, oxide and oxidized minerals
Principles, operation and field of application.
Dewatering and drying: thickening, filtration and drying.
Methods of coal washing, washability curves
Simplified flowsheets for the beneficiation of coal and typical ores of copper, lead, zinc, iron and manganese with special reference to Indian deposits
Brief description of leaching methods.

Course Outcomes:
The students will be able to

1. Understand the working principle and mechanism of Crushing and Grinding Operations
2. Understand the basic principles of separation of minerals by Jigging, Tabling and Heavy media separation
3. Understand froth flotation operation for up gradation of ores/minerals, Electrostatic/Magnetic separation operations
Students have to undertake mine field visits during the course
MNL302 Mine Hazards and Rescue (Departmental Core) L-T-P: 3-0-2

Pre-requisite: All 3 level courses

Course Objectives:
- to make students conversant with types of hazards viz. Fires, Explosion and Inundation which can take place in underground mines
- to give knowledge in details about the causes and mitigation measures for each of the hazard
- to provide details of rescue operations to be conducted in mines after disasters
- to make students understand problems of mine dust and illumination including the assessment and mitigating measures

Course Assessment:

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Course Content:

Mine Fires: Causes of mine fires; spontaneous combustion - mechanism, susceptibility indices, factors affecting spontaneous combustion; detection and prevention of spontaneous heating; accidental fires – causes and prevention; dealing with mine fires - direct and indirect methods, fire stoppings; fires in quarries, coal stacks and waste dumps.

Mine Explosions: Firedamp and coal dust explosions – mechanisms, causes and prevention; stone-dust and water barriers; investigations after an explosion.

Inundation: Causes and prevention, precautions and techniques of approaching old workings; safety boring apparatus, pattern of holes; design and construction of water dams, shaft dams, emergency bulk heads, strengthening of dams.

Rescue and Recovery: Rescue equipment and their uses, rescue stations and rescue rooms; organization of rescue and recovery areas, re-opening of sealed-off workings.

Illumination in mines- it’s effect on safety, efficiency and health; common types of safety lamps & their uses and limitations, maintenance and examination of lamps, their charging, cleaning, lighting, re-lighting; lamp room design and organization; lighting from mains – different types of illumination devices; illumination of pit bottoms. main roads, faces, pump houses and haulage rooms; standards of illumination in underground and opencast mines.

Airborne respirable dust in underground mines - generation, dispersion, measurement and control.; classification, physiological effects, dust measurement, sampling of air-bone dust.

Books:
2. Mine Illumination by Trotller
3. Spontaneous Combustion: S C Banerjee
4. Mine Fires: L C Kaku
5. Mine Fires: Mitchell
7. Subsurface Ventilation and Environmental Engineering :McPherson

Course Outcomes:
1. To familiarize with the concept of hazards in mines and rescue operations
2. To understand the basic mechanism of hazards
3. To develop the ability of analyzing complex engineering problems associated with hazards
4. To be competent in designing components and processes dealing with hazards.
Course:

Ground Control in Mines (Departmental Core) LTP: 3-0-2
Prerequisites: Rock Engineering

Course Objectives:
- to make students conversant with aspects of mine support application and design
- to make student conversant with slope stability problems

Course Assessment:
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Practical: Continuous assessment and viva-voce exam

Course Contents:
Design and Stability of Structures in Rock: Intact rock and rock mass classification systems; criteria for design and support of underground excavations; energy released by making an underground excavation; design of single and multiple openings in massive, stratified and jointed rock mass; Estimation of support requirement.

Mine pillars and their classification, pillar stresses, pillar design, stability analysis of pillars.

Timber and Steel support: Prop/post, various types of chocks, cross bars, lagging, forepoling; load bearing capacity of timber supports; setting up of timber supports, bulkheads, treatment and preservation of timber. Steel set - rigid and yielding types; shaft tubing, wire mesh, steel lining, screw jacks and ratchet jacks; improvised steel props, friction props, hydraulic props; link bars and chocks, powered supports.

Active Supports: Rock bolts and dowels - different types and uses; mechanics of bolting. Anchored rockbolts Slot and wedge type, expansion shell type, grouted point anchor type. full column anchors, wooden and fiberglass dowels, mechanical full column anchors, split sets/friction rock stabilizers, installation and testing of rock bolts. Cable bolting — its installation and applications.

Instut constructed support

Poured monolithic and reinforced concrete lining; guniting and shotcreting. Materials of backfill and their procurement; sand gathering plant; theoretical aspects of slurry transportation; preparation, transport and placement of hydraulic backfill with and without cement; rock and concrete fills; surface arrangement for storage and mixing; pneumatic and mechanical methods of backfilling.

Subsidence: Causes and impacts of subsidence; mechanics of surface subsidence, discontinuous and continuous subsidence; monitoring, prediction, control and management of subsidence.

Caving of Rockmass: Caving characteristics of rocks; cavability index. Rockburst: Phenomenology of rockbursts; prediction and control of rockbursts; bumps and gas outbursts.

Surface Mine Slope Stability: Types of mine slope; influence of pit slope on mine economics; common modes of slope failure; factors influencing slope stability; slope stability assessment techniques; stability of analysis of slopes; measures to enhance slope stability; protection and monitoring of slopes.

Books:
1. Peng S S, Ground Control in Mines, John Wiely Publication
2. Hoek & Brown, Rock Slope Engineering:
3. Hudson & Harrison: Engineering Rock Mechanics
6. Hoek, Practical Rock Engineering

Course Outcomes:
The students will be able to

1. Classify the rock based on their engineering properties
2. Understand applicability of different types of supports.
3. Understand various phases of stowing and back filling.
4. Predict and control the subsidence, rock burst and bumps
5. Analyze the stability of slopes
MNL207 Underground Coal Mining (Departmental Core) L-T-P:3-0-0

Pre-requisite: Nill

Course Objectives:
- Gives understanding of coal mining methods with respect to development and extraction.
- Provides methodology for selection of coal mining methods, methods of driving underground openings

Course Assessment:

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* students assignments, class performance (attendance, tutorials)

Course Content:

Introduction: status of coal reserves, grade and rank of coals available in India, status of coal mining in India, mining conditions in Indian coalfields; choice of mining methods

Development: Bord and Pillar, and Room and Pillar Mining; design of bord & pillar workings, the panel system, panels and inter-panel barriers, size of pillars and galleries; methods of driving galleries; layouts for different combinations of loading and transport systems including continuous systems

Depillaring: preparatory arrangements for depillaring; sequence and manner of extraction of pillars; mechanized pillar extraction, setting and withdrawal of supports; airblasts; partial extraction

Longwall Mining: Evolutionary development of longwall mining, its application, layouts, development and extraction by conventional and mechanised methods; design of longwall workings - face length and panel length; salvaging of longwall faces.

Thick seam mining: multi-section mining, slicing methods, sublevel caving, integrated sublevel caving, blasting gallery method, thick seam extraction by cable bolting, hydraulic mining

Contiguous seam working: working under surface structures and water bodies, harmonic mining; shaft pillar extraction; horizon mining

Gasification of coal

Books:
1. Introductory Mining Engineering: H L Hartman
2. Coal Mining Methods: S K Das
3. SME Mining Engineer’s Handbook: Hustrulid

Course Outcomes:
The students will be able to understand the

1. Basic technology of coal mining
2. Various operations involved in depillaring
3. Various operations involved in Longwall Mining and Contiguous seam working
Surface Mining (Departmental Core) L-T-P:3-0-0

Pre-requisite: Nil

Course Objectives:
- Surface Mining is the most economical and safe means of mining mineral reserves.
- Understanding viability of surface mining
- Opening of deposits under various conditions and haul road design
- Mining of deposits under various conditions using various equipment combination with layouts including in-pit-crushing technology
- Blast design under various geo-mining conditions
- Conversion of underground coal mines to surface mines
- Construction of external and internal dumps
- Reclamation

Course Assessment:

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* students assignments, class performance (attendance, tutorials)

Role of surface mining in mineral production in India, elements of surface mine planning- height, width, and slope of benches, overall and ultimate pit slopes, stripping ratio, cut off grade, different mining costs and preliminary evaluation of surface mining prospects
Types of surface mining systems — applicability, limitations, advantages and disadvantages
Opening up of Deposits – different systems of opening of deposits, site preparation, box cut, formation of benches, and haul roads. Layouts using different combinations of main excavation, loading and transportation systems.
Blasting: Blasting practices and blast design in surface mines
Extraction Methods: Extraction of subsurface deposits - bedded deposits, massive deposits, pipe type, cap type and vein type deposits; mining of beach sands, placer mining, dimensional stone mining. Layouts with In-pit crushing and conveying, surface miners.
Surface mining of coal seams developed by underground methods, surface mining over underground workings, mining in fiery strata, deep mining problems
Dump Formation: Types of waste dump - internal and external; dump formation methods and equipment.
Reclamation methods by using different combination of equipment

Books:
1. Bulk Handling in Open Pit Mines & Quarries: Reinhard H.Wohlbier
3. Introductory Mining Engineering: Howard L. Hartman
4. Modern Coal Mining Technology: Samir Kumar Das
5. Opencast Mining – Technology and Integrated Mechanization: V.V.Rzhevsky
6. Opencast Mining – Unit Operations: V.V.Rzhevsky
7. SME Hand Books
8. Surface Mining : G.B.Misra
9. Surface Mining Technology : Samir Kumar Das

Course Outcomes:
The students will be able to understand the
1. Importance of surface mining in today’s mineral requirement and world mineral production of various minerals from surface mines.
2. Understanding viability of surface mining and its design aspects.
3. Various systems of surface mining and their applications. Opening of deposits under various conditions and haul road design
4. Mining of deposits under various conditions using various equipment combination with layouts including in-pit-crushing technology. Problem solving of mine design covering – development, production, equipment capacity & strength calculation and layouts.
5. Blast design under various geo-mining conditions with live problem solving.
6. Conversion of underground developed to surface mines – its related problems and design of mines.
7. Construction of external and internal dumps with problems.
8. Reclamation and with real life problems.
MNL 402 Surface Mine Environment (Departmental Core) L-T-P:3-0-2

Pre-requisite: MNL265 Mine Ventilation and Climate Engineering
MNL 380 Mine Hazards and rescue

Course Objectives:
- to make student conversant with prevailing environmental legislation in India
- to provide knowledge in details about various sources of pollution in surface mines and mitigating measures against each source
- to make student conversant with social impacts and aspects of getting approvals and permissions for running mining industry

Course Assessment:

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* students assignments, class performance (attendance, tutorials)

Course Content:
Introduction: Environmental issues in mineral industry — national and global; ambient environment mining complexes; environmental impacts of mineral exploitation - underground and opencast mining and associated activities.

Societal Environment: Societal environment and its management including resettlement and rehabilitation; socio-economic impacts; sustainable development; concept of carrying capacity based planning.

Ecological Environment, Ecological environment and its management including biological reclamation. Land Environment: Visual impacts; landscape analysis; land use; landscape planning; physical reclamation and subsidence management.

Air Pollution: Air pollution - sources, monitoring and control
Water Regime: Availability; water quality; water pollution treatment and water management.
Waste Management: solid wastes - generation, treatment and disposal


Environmental Administration in India: Administration and Management, preparation of Environmental Management Plan. Environmental audit, salient features of Environment Protection Act

Books:
1. Environmental Impact of Mining by Stocks
2. Mining and Environment by B.B.Dhar
3. Mine Environment by Dhar and Thakur

Course Outcomes:
The students will be able to understand the

1. Environmental issues in mineral industry
2. Issues related to air and water pollution
3. Environmental issues related to blasting
4. Management of environment
Course: Computer Applications In Mining (Departmental Core) L-T-P:3-0-2

Pre-requisite: Mine Management Information System

Course Objectives:
- To make students conversant with importance of computers in mining engineering
- To make aware about the various software and its application to mine planning and design
- To demonstrate and impart initial training to use the software

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* students assignments, class performance (attendance, tutorials)

Course Content:
Overview of software for Mine Planning and Design.
CAD and computer graphics applications for preparation of mine plans and sections
Statistical and geostatistical techniques used in mining calculations, ore reserve and ore grade estimation using computer software packages
Analogue and digital simulations, deterministic and stochastic computer simulation models of mining operations.
Computer simulation of mine ventilation systems, haulage and winding calculations
Introduction to the application of robotics in mines, remote controlled and manless mining.
Database systems: Overview of file organization - sequential, direct, indexed, hashed, inverted; introduction to RDBMS; use of DBASE and Microsoft Access. Mine management Information Systems, Inventory management application
Expert systems: concept and applications in mining. Artificial Intelligence Programming
Computer applications to mine environment, computer aided blast applications.
Mine design computer applications based on rock mechanics and ground control like slope stability, pillar design, mine opening design etc.

Books:
1. Surpac Software Manuals
2. Operation Research Application by Kulkarni
3. DBASE Handbook
4. CAD Manuals.

Course outcomes
1. Students will have knowledge about various software application worldwide in the field of mining engineering
2. Students will develop some skill to use the software with cases
Pre-requisite:
- To make students conversant with importance of mineral economics
- To make aware about the various financial aspects of mineral industry

Course Objectives:

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* students assignments, class performance (attendance, tutorials)

Contents

Introduction : Economic importance of the mineral industry; mining economy, risky nature of the mining industry; State and the mining industry; national mineral policy
Mineral price and pricing, price index. Mineral consumption and substitution; market survey and demand analysis.
Conservation of mineral resource - scope and limitations.
Forms of business organization- Private and public enterprises. acquisition and merger. Mine finance :Capital and its importance, sources of finance, shares, debentures and the cost of capital, various forms and formation; Royalty, taxes and duties; imports and exports.
Mine Sampling : Definition, purpose and scope; sampling methods and computations; reliability of mine sampling. Loss of mineral in mining : Classification and incorporation of losses; coefficient of completeness of mineral extraction; dilution and recovery.
Geostatistical application for grade and reserve estimation
Cost of mining - Capital and operating costs; factors affecting operating cost; methods of estimating future costs; standard cost and forecast; budget and budgetary control.
Mine examination and valuation : Examination and valuation of mines/mineral properties; Hoskold and modern concepts, present value computation;
Economic feasibility studies : Need for economic analysis; techno-economic analysis data estimates; methods of investment appraisal; risk analysis; societal versus private interest economic evaluation.

Reference Books
1. Mineral Economics by Chatterjee
3. Valuation and Examination Of mineral Property by Parks
4. Indian Mineral Year Book – Indian Bureau of Mines

Course Outcomes:

1. Students will have knowledge about various inventory of minerals and aspects of mineral economics
2. Students will develop some skill in financial managements of mineral industry
MNL421 Sub-MINE SYSTEMS ENGINEERING(Departmental Elective) L-T-P:3-0-0

Course Objectives:

- To make students aware about the concept of system engineering and its relevance to mining
- To expose the students to various mathematical models for optimization, maximization, & minimization
- To extend the knowledge about project management tools, decision making and simulations applicable to mining

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* students assignments, class performance (attendance, tutorials)

Contents

Introduction to Systems Engineering: Concept of system, components and system environment; classification of systems; systems analysis; creative aspects of planning and design; factors influencing creativity; techniques for generating alternative ideas/solutions

Mathematical Programming Methods: Linear programming - definition/elements, assumptions and limitations of LPP; graphical solution; geometry and algebra of simplex method; interpretation of simplex table; application of linear programming for solution of mining problems related to production, blending, scheduling.

Transportation and Assignment Problems: Mathematical modelling and solution algorithm; application to mining problems.

Project Management with PERT & CPM: Network Models Assumptions of PERT and CPM; art of drawing network; redundancy and identification of redundant jobs; algorithm for calculation of critical path and identification of critical jobs; criticality index; statistics related to PERT; probability of completing a project by a due date; lowest cost schedule; case examples application to mining problems

Decision Analysis: Decision problems; model formulation; decision analysis based on expected monetary value and utility value. Optimisation techniques and queueing theory.

Simulation: Introduction and concept; scope and limitation; system type versus simulation technique; generating input data; Monte-Carlo simulation; deterministic and stochastic simulation of various systems in mines.

Reference Books

1. ORT Applications by Kulkarni

Course Outcomes:

1. Students will acquire knowledge about different modelling techniques for mining and allied applications
2. Students will acquire some simulation knowledge useful for decisions making and management
3. Students will acquire knowledge about Project Management with PERT & CPM
Pre-requisite:

Course Objectives:
- To make students aware about the concept of excavation engineering and its relevance to mining
- To expose the students to various excavation techniques and their design aspects

Contents

Introduction: Scope and importance of rock excavation engineering in mining and construction industries; physico-
mechanical and geotechnical properties of rocks vis-a-vis excavation method; selection of excavation method.

Drilling: Mechanics of rock drilling; design and operating parameters of surface and underground drilling;
evaluation of drill performance; drill ability of rocks; mechanism of bit wear; bit selection; problems of drilling;
economics of drilling.

Blasting: Mechanics of rock fragmentation by explosives; advancement in explosives and blasting technique; their
selection criteria for rock excavation; blast design for surface excavations and optimization;

Advanced blasting techniques; blast performance evaluation; cast blasting; techno-economic and safety aspects of
surface and underground blasting; advances in blast design for underground excavations; control blasting; computer
aided blast designs; review of tunnel blasting techniques, recent advances and novel techniques of blasting

Rock Cutting: Theories of rock tool interaction for surface excavation machinery; design of cutter head - rippers,
dozers, scrapers, BWE. Continuous surface miners, auger drills;

Recent Developments

Theories of rock tool interaction for underground excavation machinery; design of cutter head - ploughs, shearers,
roadheaders, continuous miners and tunnel boring machines: selection criteria for cutting tools; advanced rock
cutting techniques - high pressure water jet assisted cutting. Recent Developments in rock excavation machinery.

Reference Books:
1. Blasting Practices by G.K. Pradhan
2. Explosives and Blasting Practices in Mines by Dr. Sameer Kumar Das
3. Drilling by G. Chugh
4. SME – Mining Engineers Handbook
5. Surface Mining – SME
6. Introduction to Mining by Hartman

Course Outcomes:
The students will be able to understand the

1. Concepts of drilling and Blasting
2. Advanced blasting techniques
3. Theories of rock tool interaction and Rock Cutting
Geostatistics (Departmental Elective) L-T-P: 3-0-0

Pre-requisite: Maths and statistics

Course Objectives:
- Students are made conversant with basic statistical and geostatistical methods
- Application of these tools are made with reference to mineral grade calculations

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* students assignments, class performance (attendance, tutorials)

Course Content:

Classical statistics, random distributions, normal and lognormal theory. Concept of geostatistics and its application to mining
Spatial statistics, Covariogram, definitions, estimation, fitting
Variogram, semi-variogram, definition, estimation, experimental variogram, fitting; application, uses of variogram.
Various model of variograms: random model, spherical model, exponential model, gaussian model,
Linear model, logarithmic or de Wijsian model, parabolic model
Nugget effect, its implication on model, anisotropies
Numerical calculation of variogram, and graphs for one, two and three dimensions
Krigging method for grade and reserve estimation.
Krigging estimator, krigging error, point krigging, block krigging, optimal valuation
Use for geostatistical software for various application
Case studies of grade estimation

Books:
1. Geostatistics – Methods and Applications : Rendu J.M.
2. Open Pit Planning – SME

Course Outcomes:

The students will be able to understand the


2. Variogram, co-variogram calculation. Different models of variogram like random spherical, spherical, exponential, Gaussian, Linear, logarithmic and Parabolic - their application, Nugget effect and its implication on model.

3. Grade and reserve estimation for mineral deposits.
4. Case studies on various geostatistical models, grade estimation
MNL424 Advanced Mine Surveying (Departmental Elective) L-T-P: 3-0-0

Pre-requisite: Mine Surveying

Course Objectives:
Students are made aware about the modern survey equipment and methods for precision survey

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Course Content:
National Grid: Map Projections; Cassini, Lambert's Polyconic, UTM, transformation of coordinates.
Geodesy: Good, spheroid and ellipsoid, geocentric, geodetic and astronomical ordinates, orthometric and dynamic heights.
GPS, principle, operation, application to mine survey and face monitoring.
EDM, Total survey station, principle and application to mine survey,
Laser profilers, opencast mine survey
Survey for construction of excavations, chambers, installation of headgear, haulages, hoisting engine, Substation, pump stations etc.
Gyro-theodolite, principle, application to mine survey
Subsidence survey
Remote sensing, Photogrammetry, satellite imaging, GIS application to mining Computer aided drawings of plans and sections

Books:
1. Mine Surveying by Mason
2. Metalliferous Mine Surveying by Winigerg
4. Surveying & Levelling Vols I & II by Kanetkar and Kulkarni

Course Outcomes:

1. Learn advanced tools for mine surveying
2. Students will be trained in handling the various advanced survey instruments
3. Learn various calculations required for planning
4. Will work with team spirit
Sub code-MND401 Sub-PROJECT PHASE-I

Projects will be allotted to the students
MNL 403 Mine Management (Departmental Core) L-T-P: 3-0-0

Prerequisite: Nil

Course Objective:
The students are made conversant with management, organization, structures, personnel management and managerial behaviors. This would be very much essential for their duties as of manager which they have to perform in future.

Course Assessment:
Internal and end sem evaluation for theory and continuous assessment for Practical, final result by grade system and distribution is given below.

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Course Content:
Introduction : Evolution of management, theory and practice, principles of scientific management; elements of management functions - planning, organization, staffing and controlling organisation; structuring organisation for mining enterprises.

Industrial Psychology : Definitions, objectives and applications; study or individual differences — traits and personality theories; job satisfaction and morale - determining factors, and steps for improvement; study of work groups — characteristics and types; psychological tests and their uses.

Industrial Relations : Industrial disputes - definitions and causes; industrial discipline, grievance — causes, and grievance procedure; trade union movement, trade unions collective bargaining; adjudication - adjudicating authorities and their subject matters: workers' participation in management.


Communication : types and its importance, two way personal communications; transmission of facts and feelings; directing and disciplining

Leadership - study of traditional leader behaviours - autocratic, democratic and Laissez-Faire behaviour;

Production Management : Determination of norms and standards of operations by work study; analysis of mine capacities and capabilities; production planning, scheduling and control - short and long term; productivity - its concept and measurement.

Office management, types of accounts, Financial Management, accounting procedures, book keeping

Behavioural Sciences for Management : Human needs, theory of motivation and organization design; conflicts in organization, sources of conflicts, dealing with conflicts, organising for conflict resolution, conflict and growth; individual motivation;; behavioral view of controlling; eliciting positive response to controls; efficient control process through leadership actions.

Books:
1. Principles of Management by Kulkarni
2. Finance for Mine Management by Sloan

Course Outcomes:
1. To know managerial aspects of mines and its organization and structures,
2. To understand the fundamentals of principles of management
3. Application of management principles in mining industries
4. To study the behaviour science, industrial psychology and motivations etc human aspects
MNL401 MINE LEGISLATION AND SAFETY (Departmental Core) L-T-P: 3-0-0

Prerequisite: all 3 level courses

Course Objective:
The students are made conversant with legal requirements and safety aspects of mining

Course Assessment:
Internal and end sem evaluation for theory and continuous assessment for Practical, final result by grade system and distribution is given below.

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Contents
General provisions of Coal Mines Regulations 1957 and some important by-laws and standing orders for coal mines
General provisions of Metalliferous Mines Regulations 1961 and some important by-laws and standing orders for coal mines
Safety and Health in Mines: Occupational hazards of mining and diseases; accidents and their classification; statistics of fatal and serious accidents; frequency rates and severity rates of accidents; cause-wise analysis; basic causes of accident occurrence; investigations into accidents and accident reports; in-depth study of accidents due to various causes; Cost of Accidents.
Emergency measures and emergency organization, Disaster Management Plans for major disasters of explosions, inundation etc. Measures for improving safety in mines, risk assessment

Reference Books
1. Indian Mining Legislation – A Critical Appraisal by Rakesh & Prasad
2. NIOSH Publications
3. DGMS Circulars by L.C.Kaku
4. Safety in Mines : A survey of accidents, their causes and prevention by Prof. Kejriwal

Course Outcomes:
The students will be able to understand the

1. General principles of Mining Laws and their history
2. Salient features of Mines Act and mines rules
4. Legal aspects of safety and health of Mine workers.
MNL404 Mine Planning (Departmental Core) L-T-P: 3-0-0
Pre-requisite: All 3 level courses

Course Objectives:
- to make students conversant with aspects of mine planning
- to develop skill of planning of mining operations
- to develop expertise in mine design

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Course Content:

- Principles of planning, Features of mine planning, planning for new projects and reconstruction planning, short range and long range planning, phases of mine planning, project implementation and monitoring, types of reserves & their inter-relationship, geological reports, weather, topography, drainage and climate report

- Fixing the mine boundary- surface and underground, size of mine, limited and unlimited reserves, optimum designed capacity, reserve allocation. Dividing mine into various panels, stope, panel dimensions

- Mine entries: types, their application, location, selection shape and size opening.
  Planning for pit top and pit bottom layouts, choice of layout
  Infrastructure planning: CHP/mineral handling plant, workshop, power, water requirement, communication

- Method of mining: factors to be considered, surface v/s underground, selection of various methods of extraction, production estimation, production potential of different panels, fixing the target mine

- Transportation planning: alternatives, choice of men, material and mineral transport systems, essential requirement, and selection
  Ventilation planning: objectives, steps, essential features of ventilation system, different types of ventilation systems, network solutions, economics of ventilation

- Drainage planning: assessment of make of water, drainage layout, design of sumps, selection of pumps and pumping capacity
  Manpower planning,
  Planning for mine closure and post mining land use planning

Books:
1. Coal Mine Planning by S.P. Mathur
2. Underground Mining Methods Handbook by Hustrulid
3. Introductory Mining Technology by Hartman
4. Mine Planning: Jayant Bhattacharya

Course Outcomes:

1. To understand various components of mine planning
2. To learn general planning principles
3. Design of various components of mine system
4. Plan and design an overall mine
MNL426 UNDERGROUND SPACE TECHNOLOGY (Departmental Elective) L-T-P:3-0-0

Pre-requisite: All 3 level courses

Course Objectives:
- to make students conversant with aspects underground space development
- to develop skill of excavation for underground space development

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* students assignments, class performance (attendance, tutorials)

Contents
Need and importance of underground space creation, types of underground excavations- tunnels, caverns, shafts.
Applications of underground excavations: storage, transport, military etc.
Equipment: Roadheading machines, their selection, operation for underground excavation
Shaft Boring machine and Tunnel Boring Machine: construction and operation
Drill for underground excavations: drill jumbos
Site investigation, various shapes and sizes, selection of method of excavation
Excavation by drilling and blasting: Tunnels, caverns, shafts, Method of excavation and design of blasting round, cycle of operation
Excavation by mechanical means: excavation in soft ground and hard rock by TBM and cutting methods, their layouts
Hazards in underground excavations
Parameters for design of underground excavations, Design and selection of support and reinforcement for underground excavation, Consideration for swelling and squeezing rock conditions, rock burst prone zones, seismic zone and soft ground
Environmental problems in rock excavations, causes and preventions, ventilation and illumination in excavations.

Reference Books
1 SME underground mining methods Handbook
2 Storage in excavated rock and caverns
3 Design parameters for underground construction
4 Geo-technical instrumentations in Civil Engg.
5 Tunneling and Underground space technology, Elsevier

Course Outcomes:
The students will be able to
1. Understand the need and importance of underground space technology
2. Understand the applicability of various types of underground excavating machines and drilling patterns
3. Understand the hazards of underground excavations and environmental problems
4. Select and design the underground support for different mining conditions
Course Objectives:

- To make students conversant about significance of safety in industry and safety management
- To provide the training about risk assessment and carrying out safety audit
- To impart knowledge about site specific safety and training

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* students assignments, class performance (attendance, tutorials)

Contents

Safety management systems in Indian mining industry; engineering aspects of safety management. Basic concept of risk, reliability and hazard potential; elements of risk assessment; statistical methods; control charts; appraisal of advanced techniques - fault tree analysis, failure mode and effect analysis, quantitative structure - activity relationship analysis; fuzzy model for risk assessment. Measurement of safety efficiency; safety audit methods; safety records management. Safety legislations, Safety meetings, constitution of safety committees, functions, pit safety committee Ergonomics, Safely practices in various operations, blasting, drilling, equipment and machine handling, site specific safety, ground control, ventilation and gases; safety codes, implementation and monitoring of safety programmes Recent Trends of development of safety engineering approaches. Safety training

Reference Books

1. Mine Safety by Prof. Kejriwal
2. Occupational Safety and Health in Industries and Mines by C.P.Singh
3. Indian Mining Legislation – A Critical Appraisal by Rakesh & Prasad

** Safety in Mines : A survey f accidents, their causes & prevention (1901 to 2000)

Course Outcomes:

1. Students will gain the idea about preparation of safety management plan and risk calculation
2. Students can will learn the various steps of safety audit
3. Students will develop a initial skill to monitor the safety related to mining
Course Objectives:

- To provide knowledge about information and database
- To demonstrate the data base management and MIS
- To give hands on training for database software

For theory:

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* students assignments, class performance (attendance, tutorials)

Content:

Information as a Resource: Introduction to information management, concept of management information system, planning of information resources
Computer based information management systems, information methodologies and tools, system approach to various operations in mines, analysis of systems
Computer fundamentals for information system, database and database management systems, data mining, data ware house, data banks, data storage and handling. Relational and other data bases
Capturing of information, on-line, off line, pre-processing, formatting etc. Forms and layout. Data processing systems; data communication, data loggers etc.
Mine management information system: Production information, human resource information, geological information, geo-technical information, environmental information, survey information, stores and inventory information, Marketing, financial etc.
Decision support systems for mine mangers, reporting, models, expert systems, office automation, network layout of computer nodes and data communication

Reference Books
1. Data base manuals of MS Access and Oracle
2. Management Information System text books

Course Outcomes:

1. Students will get initial knowledge about database and its preparation
2. Students can develop skill handling database software
3. Students will get the idea about database and MIS application to mining
MNL433 ADVANCED SURFACE MINING & DESIGN (Departmental Elective)  L-T-P:3-0-0

Pre-requisite: Surface Mining

Course Objectives:
- to make students conversant advanced aspects of surface mining
- to develop skill in planning and design of surface mines

Course Assessment:

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* students assignments, class performance (attendance, tutorials)

- Openpit Optimisation considering Ultimate pit slope, cutoff grades and stripping ratio. Optimum Production Scheduling
- Planning and Design of Surface coal mines, Planning and design of Open pit Mines, Planning of Hill Mining
- Design of Surface mines Using Inpit Crushing, Surface Miners, Rock Breakers, Design of Highwall Mining
- Advances in Loading, Hauling and transportation equipment (Shovel, Draglines, Dumpers, Crospit Conveyors, Skip Transportation etc), Application and design of Truck Dispatch System, Application of GPS in surface mining
- Design of Waste Dumps and Tailing Ponds, Design of Haul roads, Design of Drainage System. Monsoon preparation in surface mines
- Design of large scale bench blasting: coal and non coal: cast blasting, coyote blasting, chamber blasting, Estimation of Mining Cost for surface mines

Books:
Fundamentals of Open Pit Mine Planning & Design: Hustrulid, W. and Kuchta, M.
Surface Mining Technology, Das, S.K., Lovely Prakashan, Dhanbad, 1994

Course Outcomes:

The students will be able to understand the

1. Cut-off grade, ultimate pit slope angle and break-even-stripping ratio. In the light of this information ultimate pit design they will learn.

2. Planning and design of opencast coal mines, opencast metal mines and hill mining – involves layout, equipment calculation.

3. Different loading and transport equipments – their technical combination based on output capacity.

4. Design of waste dumps, haul roads, drainage system.

5. Design of various blasting practices need based.
NOVEL MINING METHODS (Departmental Elective) L-T-P:3-0-0

Pre-requisite: All 3 level courses

Course Objectives:
- to make students conversant with non-conventional mining methods

Course Assessment:

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* students assignments, class performance (attendance, tutorials)

Content:

Review of various experimental mining procedures, including a critical evaluation of their potential applications. Mining methods covered include deep sea nodule mining, in situ gasification of coal, in situ retorting of oil shale, solution mining of soluble minerals, in situ leaching of metals, geothermal power generation, oil mining, nuclear fragmentation, slope caving, electro-thermal rock penetration and fragmentation.

Borehole mining: Borehole mining of coal, uranium, sulphur Drilling, maintenance services, Jet Cavitations, fracturing, Solution Mining of important minerals, leaching

Coal bed methane: Coal Fundamentals and Geology, Key Coal Properties, Coal Permeability, Measurement of Coal bed Gas Content, Elements of a CBM, Isotherms, and Recovery Factor, Development Considerations, Well Design and Drilling, Gas Recovery & Well Performance

Coal gasification: Introduction to gasification: Chemical reactions, Process technologies: Coal Liquefaction, Underground gasification – principles and potential, Conversion of coal to syngas, Impact of coal properties on gasification, Production of coal for gasification: mining and beneficiation perspective, Conversion of syngas to a variety of chemical products, Conversion of coal to syngas via the Sasol process, Environmental aspects around a gasification plant, relevance of coal gasification and its future potential as an environmentally sound technology in the co-production of energy and chemicals with CO₂ minimisation.

Hydraulic mining: Introduction. Process of hydraulic mining, hydro monitors, water jets, surface and underground layouts, merits and impacts

Dimensional Stone mining: Introduction and stone mining in India, cutting and control blasting technology, damage measurement during mining, marble and granite mining, cobbles and building stone mining

Ocean floor mining: Deep ocean exploration, sea bed mining, ocean floor nodules mining, technology, dredgers and other machines for mining and transport

Mining in the space: lunar mining, asteroid mining, automatic and robotic machines, future of space mining, Impacts

Books:
1. Underground Mining Methods by SME publication Hustrilid
2. Introductory Mining Engineering : Hartman 2nd Edition

Course Outcomes:

The students will be able to understand the

1. Technology for methane drainage and coal gasification
2. Technology for hydraulic mining and deep sea mining.
3. Latest Mining methods such as Nuclear fragmentation, Mining in space dimensional mining etc.
MNL432 MINE AUTOMATION (Departmental Elective) L-T-P:3-0-0
Pre-requisite: All 3 level courses
Course Objectives:
- to make students conversant with aspects automation and control applied to mines

Course Assessment:

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Content:
- scope and role of automation in mining operation and human related factors.
- System engineering approach and use of operational data from mining equipment and its use the mining process.
- data communication and modern computerised control systems
- data formats and IREDES, mine process data, AGV technology
- Basic foundations for automation of mining equipment.
- navigation, surface navigation and GNSS (satellite navigation), mine planning tools, etc
- Automation of drilling and drill rig, drilling process.
- Automation of underground loading and transportation systems.
- Automation in tunnelling projects.
- Automation in monitoring of environments in longwall and continuous mining system
- Automation of transportation system in surface mining.
- Use of robotics in mining for production and disaster management purpose

Books:
Society of Mining Engineering Handbooks –Vol –I and II
Introductory Mining Engineering: Hartman

Course Outcomes:
The students will be able to understand the
1. Scope and role of automation in mining operation
2. Data communication and modern computerised control systems
3. Use of latest techniques used for mine automation.
**CEL3** Advanced Mining Geology (Departmental Elective) L-T-P:3-0-0

**Pre-requisite:** Mining Geology

**Course Objectives:**
1. To know prospecting and subsurface exploration methods
2. To know the engineering properties of rocks in contest to Geology
3. To understand the general revive of Indian Stratigraphy
4. To understand the hydrological condition of the Earth
5. To know the Indian mineral deposits and there formation
6. To understand the concept of Remote Sensing & GIS techniques

**Course Assessment:**

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* students assignments, class performance (attendance, tutorials)

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**Course Content:**

- **Principles of Prospecting and Exploration:** Geophysical methods; Electrical, Seismic, Magnetic and Radar methods of exploration. Geo-Chemical methods; dispersion, mobility, anomaly, pathfinder elements, sampling methods. exploratory drilling, different methods and applicability. Borehole logging, orebody modelling.
- **Stratigraphy:** Physiographic and Tectonic Divisions of India. General review of Stratigraphy of India detailed study including economic potential of Archean, Cuddapah, Vindhyan, Gondwana, Deccan Traps and Tertiary systems of India.
- **Economic Mineral deposits. Processes of Ore genesis; magmatic concentration, Hydrothermal, contact metasomatism, residual concentration etc. Syngenetic and epigenetic deposits. Controls of ore localization. Metallogenic Epochs and provinces.**
- **Remote Sensing and Geographical Information System:** Introduction to remote sensing technology, Analog and digital data products, remote sensing satellites, application of remote sensing for mining operations. Introduction to GIS and its applications.

**Books :**

1. Arogyaswamy RNP: Courses in Mining
2. Fundamentals of Engineering Geology, F.G.Bell, BS Publications
4. Ravindra Kumar : Principles of Stratigraphy
5. Sabins F.A : Remote Sensing
6. Todd D.K. : Groundwater Hydrology

**Course Outcomes:**

The students will be able to understand

1. The Internal structure of earth, fundamental geomorphic and dynamic processes on the Earth
2. The rocks and minerals and their properties.
3. The various geological structures and impacts on mining
4. To Know prospecting and subsurface exploration methods
5. And generate the sub surface profiles from geological maps and plotting structures
MNL434 ADVANCED UG METAL MINING & DESIGN (Departmental Elective) L-T-P: 3-0-0
Pre-requisite: Underground Metalliferous Mining

Course Objectives:
- to give knowledge of advanced techniques of underground metal mining and its design

Course Assessment:

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* students assignments, class performance (attendance, tutorials)

Content:
- Development- size of stope, level interval
- Classification and Selection of stoping methods
- Design and locating the orepass and levels
- Design of stopes: Stope design and production planning, scheduling
- Ring drilling, fan drilling design
- Mechanisation and Selection of equipment
- Methods of extraction of pillars
- Deep mining problems
- Mine fills, pastefill, cemented fills
- Case studies: Indian and mines from other countries
- Mine costing

3. Introductory Mining Engineering: Hartman

Course Outcomes:

1. Students will get ideas about the advancement of metal mining methods with regards to mechanization and automation
2. Students will be trained to select the method of mining based on geo-mining data
3. Student will develop initial skill to stope design
MNL425 Mass Production Technology for Underground Coal (Departmental Elective) LTP:3-0-0

Pre-requisites: Mining Machinery I, Mining Machinery II and Introduction to Mining Engineering

Course Objectives:
- to provide knowledge of advance techniques of underground coal mining
- to develop concept of system engineering and design approaches of advance techniques of underground coal mining

Course Assessment:

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* students assignments, class performance

Course Content:
Status of coal mining in India and abroad, Need for mass production technology for Indian coal
Continuous Mining Technique: Applicability, Layout for development and depillaring, Design, Equipment required and their Selection, System analysis, Cycle of operation, Case studies
Longwall Mining: Applicability, various layouts, System analysis and system design, Equipment and their selection, Types of cut, ground control, cycle of operation, Case studies

Course Outcomes:
- Student will have in-depth knowledge of advance techniques of underground coal mining
- They will be able to design such systems

Books:
1. SME Mining Engineers’ Handbook, W A Hustrulid, SME, USA
2. Underground Mining Method Handbook, W A Hustrulid, SME, USA
3. Longwall Mining, S.S. Peng, John Wiley
4. Ground Control in Mines, S.S. Peng, John Wiley

Course Outcomes:
1. Student will have in-depth knowledge of advanced techniques of underground coal mining
2. They will be able to design such systems
3. Develop technical skill for operation of such systems
4. Will be ready to take up advanced research in coal mining on long term basis
MNL430 Rock Slope Engineering (Departmental Elective) LTP: 3-0-0

Pre-requisites: MNL Rock Engineering, MNL Ground Control in Mines, MNL Surface Mining

Course Objectives:
- to make student conversant with slope stability problems
- to develop skill in slope stability analysis by various methods
- to deal with slope stability problems in mines and in general

Course Assessment:

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* students assignments, class performance (attendance, tutorials)

Course Content:
- Basic Concepts:
  - Engineering issues of Slope stability, Basic terminology, Slope failure causes and process, basic mechanism of slope failure
  - Rock mass properties: various properties, data collection, stereographic projections
  - Ground water: Role of ground water flow, influence of ground water on slope stability, evaluation of ground water conditions in slopes
  - Plane failure: general conditions and failure analysis
  - Wedge failure: general conditions and failure analysis
  - Circular failure: general conditions and failure analysis
  - Toppling failure: general conditions and failure analysis
  - Rock slope stabilization techniques, Geotechnical Instrumentation and Monitoring
  - Aspect of Waste dump stability analysis

Books:
1. Rock Slope Stability: Charles A Kliche (SME publication)
2. Rock Slope Engineering: Hoek & Brown
3. Pit slope manual: Mineral Research Laboratories, Canada

Course Outcomes:
1. Learning basic slope stability in mining operations as well as civil excavation
2. Developing expertise in slope stability analysis
3. Expertise in management of slopes
4. Expertise in Dump Management
MNL 429 Blasting Technology for Mining and Construction (Elective) L-T-P: 3-0-0
Prerequisite: Nil
Course Objective:
The students are made conversant with rock fragmentation by using explosives. They will learn blast design in surface and underground mines.

Course Assessment:
Internal and end sem evaluation for theory and continuous assessment for Practical, final result by grade system and distribution is given below.

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Course contents:
History and use of explosives: blasting and its applicability to mining and construction industry. Role of blasting in production of minerals and in construction industry. Blasting inputs and outputs, Controllable and non controllable parameters. Blast Economics, blasting costs and role of fragmentation with blasting costs, cost optimization, Environmental impact of blasting

Various Pattern of holes for drives and drift, roadways, underground storage and tunnels, pattern of holes for surface excavation, Blasting accessories and tools. Initiation system and firing sequences. Blasting operation in surface and underground coal mines, metal mines, drifts, shaft, tunnels and caverns. Safety precautions during blasting, blasting fumes.
Rock explosive interaction, Various rock fragmentation theories. Role of rock parameters, explosive parameters and blast design parameters on blasting. Evaluation of blasting results, techno economic evaluation of fragmentation, fragmentation Analysis of production blasts, fragmentability and productivity. fragmentation and costs, effect of structural discontinuities on blasting results, Use of various software like wipfrag, wipjoint, Blastware, Blast Information Management Systems etc.
Optimization of blast designs for tunnels, caverns, nuclear waste disposal and other domestic purpose. Blast design for surface workings and opencast mines. Blast design for non coal and coal mines. Ground vibrations, fly rock and noise due to blasting. Minimization of environmental damages due to blasting.

Controlled blasting techniques for surface blasting and underground blasting. Use of innovative techniques in blasting like, air deck, cushion blasting, underwater blasting, blasting near sensitive structures, cast blasting etc. use of blasting techniques for demolition of structures.

Books:
1. Engineering rock blasting operations : S. Bhandari, A. A. Balkema Pulb
2. Explosives and blasting technology by G. K. Pradhan
3. Surface mine blast evaluation by Dr. N. R. Thote and G. K. Pradhan
4. Modern mining technology by Samir Kumar Das

Course Outcomes:
1. to understand the basic characteristics of explosives
2. to know the mechanism of rock breakage utilization of explosives energy.
4. design of optimum blast and control measures
Sub code-MNP314
Sub-SURVEY CAMP (SESSIONAL)

Sub code-MNP452
Sub-TRAINING SEMINAR (SESSIONAL)

Sub code-MND402
Sub-PROJECT PHASE – II