

**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

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

## CREDIT REQUIREMENTS FOR B.TECH (MINING)

2015 Batch Onwards

**TOTAL CREDIT REQUIREMENT: 170**

### OVERALL CREDIT STRUCTURE

<b>Program Core (PC)</b>		<b>Program Elective (PE)</b>	
<b>Category</b>	<b>Credit</b>	<b>Category</b>	<b>Credit</b>
Basic Sciences(BS)	<b>18</b>	Departmental Electives(DE)	33-45
Engineering Sciences(ES)	<b>20</b>	Humanities and Management (HM)	0-6
Humanities(HU)	<b>5</b>	Open Courses (OC)	0-6
Departmental Core(DC)	<b>82</b>		-
<b>Total</b>	<b>125</b>	<b>Total</b>	<b>45</b>
<b>Grand Total PC +PE</b>			<b>170</b>

### REVISED 1ST YEAR B. TECH. SCHEME

#### **First Semester**

<b>Code</b>	<b>Course</b>	<b>L-T-P</b>	<b>Credits</b>
AML 151	Engineering Mechanics	3-1-0	4
AMP151	Engineering Mechanics Laboratory	0-0-2	1
HUL101	Communication Skills	2-0-2	3
MAL101	Mathematics-I	3-1-0	4
MEC101	Engineering Drawing	3-0-2	4
PHL101	Physics	3-1-0	4
PHP101	Physics Laboratory	0-0-2	1
SAC101	Health Information and Sports- Part 1	0-0-2	0
		<b>Total Credits</b>	<b>21</b>

#### **Second Semester**

<b>Code</b>	<b>Course</b>	<b>L-T-P</b>	<b>Credits</b>
CHL101	Chemistry	3-1-0	4
CHP101	Chemistry Laboratory	0-0-2	1
CSL101	Computer Programming	3-0-2	4
EEL101	Electrical Engineering	3-1-0	4
EEL101	Electrical Engineering Laboratory	0-0-2	1
HUL102	Social Science	2-0-0	2
MAL101	Mathematics-II	3-1-0	4
MEP101	Workshop	0-0-4	2
SAC102	Health Information and Sports- Part 2	0-0-2	0
		<b>Total Credits</b>	<b>22</b>

### Third Semester

Course Code	Course Name	DC/DE	Structure	Credits
MNL201	Introduction to Mining Technology	DC	3-0-0	3
MNL291	Mechanical Engineering	DC	3-0-0	3
MNL202	Mine Surveying	DC	3-1-0	4
MNL204	Mining Machinery- I	DC	3-1-0	4
MNP202	Mine Surveying	DC	0-0-2	1
MNP204	Mining Machinery-1	DC	0-0-2	1
CEL284	Mining Geology	DC	3-0-0	3
CEP284	Mining Geology	DC	0-0-2	1
<b>Elective/OC</b>				
	Open/HM Courses	OC	3-0-0	3
<b>TOTAL CREDITS</b>				<b>23</b>

### Fourth Semester

Course Code	Course Name	DC/DE	Structure	Credits
MNL207	Underground Coal Mining	DC	3-0-0	3
MNL208	Surface Mining	DC	3-0-0	3
MNL203	Underground Metalliferous Mining	DC	3-0-0	3
<b>Electives (Any Three)</b>				
MAL404	Probability and Statistics	DE	3-0-0	3
CEL384	Advanced Mining Geology	DE	3-0-0	3
EEL285	Industrial Electrical Engineering	DE	3-0-0	3
	Open/HM Courses	OC	3-0-0	3
<b>TOTAL CREDITS</b>				<b>18</b>

### Fifth Semester

Course Code	Course Name	DC/DE	Structure	Credits
MNL205	Mine Ventilation & Climate Engineering	DC	3-1-0	4
MNL206	Rock Engineering	DC	3-1-0	4
MNL301	Mining Machinery-II	DC	3-0-0	3
MNP205	Mine Ventilation & Climate Engineering	DC	0-0-2	1
MNP206	Rock Engineering	DC	0-0-2	1
<b>Electives (Any Three)</b>				
MML 291	Mineral Processing / Dressing	DE	3-0-0	3
MNL425	Mass Production Technology for Underground Coal	DE	3-0-0	3
MNL434	Advanced UG Metal Mining & Design	DE	3-0-0	3
MNL424	Advanced Mine Surveying	DE	3-0-0	3
	Open/HM Courses	OC	3-0-0	3
<b>TOTAL CREDITS</b>				<b>22</b>

**Sixth Semester**

<b>Course Code</b>	<b>Course Name</b>	<b>DC/DE</b>	<b>Structure</b>	<b>Credits</b>
MNL302	Mine Hazards and Rescue	<b>DC</b>	3-0-0	<b>3</b>
MNP302	Mine Hazards and Rescue	<b>DC</b>	0-0-2	<b>1</b>
MNL303	Ground Control In Mines	<b>DC</b>	3-0-0	<b>3</b>
MNP303	Ground Control In Mines	<b>DC</b>	0-0-2	<b>1</b>
MNP314	Survey Camp (Sessional)	<b>DC</b>	0-0-2	<b>1</b>
<b>Electives (Any Four)</b>				
MNL428	Mine Management Information System	<b>DE</b>	3-0-0	<b>3</b>
MNL423	Geostatistics	<b>DE</b>	3-0-0	<b>3</b>
MNL429	Blasting Technology for mining & Const.	<b>DE</b>	3-0-0	<b>3</b>
MNL431	Novel Mining Methods	<b>DE</b>	3-0-0	<b>3</b>
MNL426	Underground Space Technology	<b>DE</b>	3-0-0	<b>3</b>
	Open/HM Courses	<b>OC</b>	3-0-0	<b>3</b>
<b>TOTAL CREDITS</b>				<b>21</b>

**Seventh Semester**

<b>Course Code</b>	<b>Course Name</b>	<b>DC/DE</b>	<b>Structure</b>	<b>Credits</b>
MNL402	Surface Mine Environment	<b>DC</b>	3-0-0	<b>3</b>
MNP402	Surface Mine Environment	<b>DC</b>	0-0-2	<b>1</b>
MNL405	Computer Applications in Mining	<b>DC</b>	3-1-0	<b>4</b>
MNP405	Computer Applications in Mining	<b>DC</b>	0-0-2	<b>1</b>
MNL406	Mining Economics	<b>DC</b>	3-0-0	<b>3</b>
MND401	Project Phase –I	<b>DC</b>	0-0-2	<b>2</b>
MNP451	Mine Visits (Sessional)*	<b>DC</b>	0-0-2	<b>1</b>
<b>Electives (Any Three)</b>				
MNL421	Mine System Engineering	<b>DE</b>	3-0-0	<b>3</b>
MNL422	Rock Excavation Engineering	<b>DE</b>	3-0-0	<b>3</b>
MNL430	Rock Slope Engineering	<b>DE</b>	3-0-0	<b>3</b>
MNL433	Advanced Surface Mining & Design	<b>DE</b>	3-0-0	<b>3</b>
	Open/HM Courses	<b>OC</b>	3-0-0	<b>3</b>
<b>TOTAL CREDITS</b>				<b>24</b>

**\*Three mine visits during the course.**

### Eight Semester

Course Code	Course Name	DC/ DE	Structure	Credits
MNL401	Mine Legislation and Safety	DC	3-0-0	3
MNL403	Mine Management	DC	3-0-0	3
MNL404	Mine Planning	DC	3-1-0	4
MND402	Project Phase -II	DC	0-0-4	4
MNP452	Training Seminar (Sessional)**	DC	-	2
<b>Elective (Any One)</b>				
MNL427	Mine Safety Engineering	DE	3-0-0	3
MNL432	Mine Automation	DE	3-0-0	3
<b>TOTAL CREDITS</b>				<b>19</b>

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

### Total credits

S. No.	Type	I Sem	II Sem	III Sem	IV Sem	V Sem	VI Sem	VII Sem	VIII Sem	Total
1	DC	21	22	20	9	13	9	15	16	125
2	DE/OC/HM			3	9	9	12	9	3	45
										<b>170</b>

**LIST OF CORE COURSES (DC)**

<b>Course Code</b>	<b>Subject Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Pre-requisites</b>
CEL2**	Mining Geology	3	0	0	3	
CEP3**	Mining Geology	0	0	2	1	
MNL201	Introduction to Mining Technology	3	0	0	3	
MEL291	Mechanical Engineering	3	0	0	3	
MNL202	Mine Surveying	3	1	0	4	
MNP202	Mine Surveying	0	0	2	1	
MNL203	Underground Metalliferous Mining	3	0	0	3	
MNL204	Mining Machinery - I	3	1	0	4	
MNP204	Mining Machinery - I	0	0	2	1	
MNL205	Mine Ventilation and Climate Engineering	3	1	0	4	
MNP205	Mine Ventilation and Climate Engineering	0	0	2	1	
MNL206	Rock Engineering	3	1	0	4	
MNP206	Rock Engineering	0	0	2	1	
MNL301	Mining Machinery II	3	0	0	3	MNL204
MNL302	Mine Hazards and Rescue	3	0	0	3	MNL205
MNP302	Mine Hazards and Rescue	0	0	2	1	MNL205
MNL303	Ground Control In Mines	3	0	0	3	MNL206
MNP303	Ground Control In Mines	0	0	2	1	MNL206
MNL207	Underground Coal Mining	3	0	0	3	
MNL208	Surface Mining	3	0	0	3	MNL201
MNP314	Survey Camp (Sessional)	-	-	2	1	MNL202
MND401	Project Phase -I	-	-	2	2	All 3 level courses
MNP451	Mine Visits (Sessional)*	-	-	2	1	
MNL401	Mine Legislation and Safety	3	0	0	3	All 3 level courses
MNL402	Surface Mine Environment	3	0	0	3	MNL205,MNL302
MNP402	Surface Mine Environment	0	0	2	1	
MNL403	Mine Management	3	0	0	3	
MNL404	Mine Planning	3	1	0	4	All 3 level courses
MNL405	Computer Applications in Mining	3	1	0	4	
MNP405	Computer Applications in Mining	0	0	2	1	
MNP452	Training Seminar (Sessional)**	-	-	-	2	
MNL406	Mining Economics	3	0	0	3	
MND402	Project Phase -II	-	-	4	4	MND451
	<b>Total</b>				<b>82</b>	

**LIST OF ELECTIVE COURSES (DE)**

<b>Course Code</b>	<b>Subject Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Pre-requisites</b>
	Industrial Electrical and Electronics Engg	3	0	0	3	
CEL3***	Advanced Geology	3	0	0	3	
MAL404	Probability and Statistics	3	0	0	3	
MML2**	Mineral Processing/Dressing	3	0	0	3	
MNL421	Mine System Engineering	3	0	0	3	
MNL422	Rock Excavation Engineering	3	0	0	3	
MNL423	Geostatistics	3	0	0	3	
MNL424	Advanced Mine Surveying	3	0	0	3	
MNL425	Mass Production Technology for underground Coal	3	0	0	3	
MNL426	U/G space technology	3	0	0	3	
MNL427	Mine Safety Engineering	3	0	0	3	
MNL428	Mine Management Information System	3	0	0	3	
MNL429	Blasting Technology for mining & Const.	3	0	0	3	
MNL430	Rock Slope Engineering	3	0	0	3	
MNL 431	Novel Mining Methods	3	0	0	3	
MNL432	Mine Automation	3	0	0	3	
MNL 433	Advanced Surface mining & Design	3	0	0	3	
MNL434	Advanced U/G Metal Mining & Design	3	0	0	3	
	<b>TOTAL</b>				<b>54</b>	
* 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**

Introduction to science of Geology; its various branches and its application in mining engineering. Geotectonics: internal structure of earth, Continental Drift theory and Plate Tectonics, Isostasy, Earthquakes, Earthquake and seismic zones in India and Volcanism.

Structural Geology: Mode of rock failure and mechanism of deformation. Attitude of strata, Dip; True and apparent, Strike. Folds : Elements, terminology, descriptive, morphological and genetic classification. Joints : Classification, joint mapping, frequency diagrams. Faults: Mechanism of formation, elements, terminology, geometric and genetic classification.

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.

Petrology : Introduction to Petrology, Rock Cycle, Rock forming Minerals. Igneous petrology; Elementary knowledge of Magma and its consolidation & rock formation. Mode of occurrence, textures, structure, classification of Igneous, Sedimentary and Metamorphic rocks.

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
2. Principles of Engineering Geology :KVGK Gokhale
3. Fundamentals of Engineering Geology : F.G.Bell
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:

	Seesional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>35</b>	<b>35</b>	<b>-</b>	<b>100</b>

\* 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

## MEL291MECHANICAL ENGINEERING L-T-P: 3-0-0

### 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.

Lubrication: Laws of friction for dry and lubricated surfaces, methods of lubrication of 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
4. Thermal Engineering: P.L.Ballaney
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

**MNL202 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:****For theory:**

	Seesional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>35</b>	<b>35</b>	<b>-</b>	<b>100</b>

\* students assignments, class performance (attendance, tutorials)

**For practical :**

	Seesional 1	Sessional 2	Upto End Semester	End Semester
<b>Marks</b>	<b>40</b>	<b>40</b>	<b>20</b>	<b>100</b>
<b>% Syllabus</b>	<b>40</b>	<b>40</b>	<b>20</b>	<b>100</b>

**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:** Methods of 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, IIIDr. 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:**

	Seesional 1	Sessional 2	Teacher's Assessment*	End Semester
Marks	15	15	10	60
% Syllabus	30	30		100

\* 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. Metalliferous 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

**MNL204 Mining Machinery - I (Departmental Core)L-T-P:3-0-2****Pre-requisite:** Nil**Course Assessment:****For theory:**

	Seesional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>35</b>	<b>35</b>	<b>-</b>	<b>100</b>

\* students assignments, class performance (attendance, tutorials)

**For practical :**

	Seesional 1	Sessional 2	Upto End Semester	End Semester
<b>Marks</b>	<b>40</b>	<b>40</b>	<b>20</b>	<b>100</b>
<b>% Syllabus</b>	<b>40</b>	<b>40</b>	<b>20</b>	<b>100</b>

**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.

Rope Haulages: Types of rope haulages, selection, computations, and safety devices. Mine tubs, mine cars, links, clips and rope capel. Application of rope haulages. Track laying and maintenance. 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. High angle conveyors, shiftable conveyors, Head frames; types and fittings. Shaft fittings; signals, guides, Keps, tilting platform, cage receivers, protective roofing. Suspension gear, cages, and skips.

Winding: Drum and friction winding with their variations and limitations, duty cycle, torque time diagrams and computations. Multilevel and deep winding. Drives for winding. Safety devices on winders; emergency braking, over speed control, slow banking, depth indicators, automatic contrivances.

Aerial ropeways: Types, construction, application and operation, safety devices.

**Books:**

1. Mine Winding & Transport : Walker
2. SME Mining Engineer's Handbook: Hustrulid
3. Underground Mining Methods Handbook: Hustrulid
4. Mine Hoisting : M.A.Ramlu, Oxford & IBH, 1996

**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.
3. Winding systems in mines – drum winder. There important features –construction, mechanical & electrical braking, safety features and torque time diagram.
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.

### For Theory

	Seesional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>35</b>	<b>35</b>	<b>-</b>	<b>100</b>

### For Practical

	Seesional 1	Sessional 2	Upto End Semester	End Semester
<b>Marks</b>	<b>25</b>	<b>25</b>	<b>-</b>	<b>50</b>
<b>% Syllabus</b>	<b>35</b>	<b>70</b>	<b>-</b>	<b>100</b>

### 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, evasees

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.

**For Theory**

	Seesional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>35</b>	<b>35</b>	<b>-</b>	<b>100</b>

**For Practical**

	Seesional 1	Sessional 2	Upto End Semester	End Semester
<b>Marks</b>	<b>40</b>	<b>40</b>	<b>20</b>	<b>100</b>
<b>% Syllabus</b>	<b>40</b>	<b>40</b>	<b>20</b>	<b>100</b>

**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.

Stresses in Rock and Rock reinforcement techniques: Insitu stresses, methods of determination including over-coring and hydro-fracturing methods. Terminology used in rock reinforcement, pressure arch theory, support and reinforcement principles and design; classification of mine supports

Distribution of stress patterns around mine openings. Introduction to methods of stress analysis. Predictive methods for mine design, principles of classical stress analysis, closed form solutions for simple excavation.

Monitoring Rockmass Performance : Purpose and nature, monitoring systems including seismic and microseismic methods.

Introduction to computational methods of stress analysis - finite element, boundary element, distinct element methods and hybrid computational schemes.

Physico-mechanical properties of soil : Physical properties including consistency and gradation; classification of engineering soils; engineering properties of soils — compressibility, consolidation, compaction and strength.

**Books:**

1. Manual on Rock Mechanics : Ramamurthy & Sharma, CBIP Publ.
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.

**MNL301 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:**

	Sessional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>35</b>	<b>35</b>	<b>-</b>	<b>100</b>

\* students assignments, class performance (attendance, tutorials)

**Course Content:**

Coal cutting machines: shearers, 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

Opencast 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.

Miscellaneous Mining Equipment: Power pack and Hydraulic System, Truck Despatch System, Stacker Reclaimer, Rock Breakers, Impact Hammers, Slurry Pumps, Equipment used in Shaft Sinking, In-pit Crushers

**Books :**

1. SME Vol on Underground Mining Methods Handbook Ed. Hustrulid
2. E. Lopez Jimeno, C. Lopez Jimeno, Ayala Carcedo : Drilling and Blasting of Rocks, 1995, CRC Press
3. Ratan Raj Tatiya : Surface and Underground Excavations – Methods, Techniques and Equipment, Taylor & Francis (2005)
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.

### **MML3\*\* 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, floatation 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

**Sub code-MNC461Sub-MINE VISITS**

**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:

#### For Theory

	Seesional 1	Sessional 2	acher's Assessment	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>30</b>	<b>30</b>	<b>-</b>	<b>100</b>

\* students assignments, class performance (attendance, tutorials)

#### For Practical

	Seesional 1	Sessional 2	acher's Assessment	End Semester
<b>Marks</b>	<b>40</b>	<b>40</b>	<b>20</b>	<b>100</b>
<b>% Syllabus</b>	<b>30</b>	<b>30</b>	<b>20</b>	<b>100</b>

### 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 :

1. Mine Fires, Inundation and Rescue : M.A.Ramlu, 1991
2. Mine Illumination by Trotler
3. Spontaneous Combustion: S C Banerjee
4. Mine Fires: L C Kaku
5. Mine Fires: Mitchell
6. Mine Ventilation and Air conditioning: Hartman
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.

## MNL303 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:

#### Theory:

	Sessional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>30</b>	<b>30</b>		<b>100</b>

\* students assignments, class performance (attendance, tutorials)

**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 tubbing, 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.

In situ 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 Wiley Publication
2. Hoek & Brown, Rock Slope Engineering:
3. Hudson & Harrison: Engineering Rock Mechanics
4. Brady and Brown: Rock Mechanics for Underground Mines
5. Hoek, E, Kaiser, P.K. and Bawden W.F. entitled Support of Underground Excavations in Hard Rock
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

## MNL207Underground Coal Mining (Departmental Core) L-T-P:3-0-0

**Pre-requisite:** Nil

**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:**

	Sessional 1	Sessional 2	Teacher's Assessment*	End Semester
Marks	15	15	10	60
% Syllabus	35	35	-	100

\* 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

## MNL208Surface 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:

	Seesional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>35</b>	<b>70</b>	<b>-</b>	<b>100</b>

\* 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.Wohlbiel
2. Coal Mines Regulations, 1957 and Metalliferous Mines Regulations, 1961
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:

	Seesional 1	Sessional 2	Teacher's Assessment*	End Semester
Marks	15	15	10	60
% Syllabus	30	30		100

\* 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

Noise and Vibrations : Causes, precautions, measurement, prevention and reduction. Blasting : Environmental aspects of blasting.:

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

## MNL405 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

**Course Assessment:**

	Seesional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>30</b>	<b>30</b>	<b>-</b>	<b>100</b>

\* 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. coal and mineral handling 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

## MNL406Sub-MINING ECONOMICS(Departmental Core)L-T-P:3-0-0

**Pre-requisite: -**

**Course Objectives:**

- To make students conversant with importance of mineral economics
- To make aware about the various financial aspects of mineral industry

**Course Assessment:**

	Seesional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>30</b>	<b>30</b>	<b>-</b>	<b>100</b>

\* 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 resource - concept, classification and estimation. Mineral inventory -concept, characteristic features, composition and economic significance; estimation of life index. Economics of mineral exploration and production

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
2. Mineral Economics by R.T.Deshmukh
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

### For theory:

	Seesional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>35</b>	<b>35</b>	<b>-</b>	<b>100</b>

\* 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

## **MNL422 Sub- ROCK EXCAVATION ENGINEERING(Departmental Elective) L-T-P:3-0-0**

### **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;

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

## MNL423Geostatistics (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

**Course Assessment:**

	Seesional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>35</b>	<b>35</b>	<b>-</b>	<b>100</b>

\* 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, defination, estimation, experimental variogram, fitting; application, uses of variogram.

Various model of variograms: random model, spherical model, expontial 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

1. Statistical distributions – random, normal and lognormal and its importance in mining environment.
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

**Course Assessment:**

**For Theory**

	Seesional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>35</b>	<b>35</b>	<b>-</b>	<b>100</b>

\* students assignments, class performance (attendance, tutorials)

**For Practical**

	Seesional 1	Sessional 2	Upto End Semester	End Semester
<b>Marks</b>	<b>40</b>	<b>40</b>	<b>20</b>	<b>100</b>
<b>% Syllabus</b>	<b>40</b>	<b>40</b>	<b>20</b>	<b>100</b>

**Course Content:**

National Grid: Map Projections; Cassini, Lambert's Polyconic, UTM, transformation of coordinates.

Geodesy: Good, spheroid and ellipsoid, geocentric, geodetic and astronomical oordinates, 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
3. Surveying Vols I, II & III – by Punmiya
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.

**For Theory**

	<b>Seesional 1</b>	<b>Sessional 2</b>	<b>Teacher's Assessment*</b>	<b>End Semester</b>
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>35</b>	<b>35</b>	<b>-</b>	<b>100</b>

**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 of 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.

**Personnel Management :** Selection, training and development of human resource; job evaluation and performance appraisal, and incentives, standard of performance. Manpower Planning in mines.

**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

**Materials Management :** Introduction; purchase and stores management; **Inventory Management :** Introduction; components, scope and limitations; nature of inventory; classical E. O. Q. model; E. O. Q. model with quantity discount; an E. O. Q. problem with safety stock; inventory optimisation

**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

## MNL401MINE 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.

**For Theory**

	<b>Seesional 1</b>	<b>Sessional 2</b>	<b>Teacher's Assessment*</b>	<b>End Semester</b>
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>35</b>	<b>35</b>	<b>-</b>	<b>100</b>

**Contents**

Introduction: General principles of mining laws, development of mining laws in India. Sources of legislations, mining laws of India. General provisions of Mines and Minerals(Regulation and Development Act 1957, Mineral Concession Rules 1960, Mineral Conservation and development Rules 1988

Salient features of Mines Act 1952, Mines Rules 1955, Additional provisions Indian Electricity Rules 1956 applicable to mines, Workman Compensation Act, Mine Chreche Rules, Pit Head Bath Rules, Vocational Training Rules 1966, Mies Rescue Rules 1985

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 accidenbts, 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
3. General provisions of CMR 1961 and MMR 1961
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

### Course Assessment:

	Sessional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>30</b>	<b>30</b>		<b>100</b>

\* students assignments, class performance (attendance, tutorials)

### 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

### Course Assessment:

	Seesional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>30</b>	<b>30</b>		<b>100</b>

\* 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

## MNL427 MINE SAFETY ENGINEERING (Departmental Elective) L-T-P:3-0-0

### 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

### For theory:

	Seesional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>35</b>	<b>35</b>	<b>-</b>	<b>100</b>

\* 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

## MNL428 MINE MANAGEMENT INFORMATION SYSTEM (Departmental Elective) L-T-P:3-0-0

### 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:

	Seesional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>35</b>	<b>35</b>	<b>-</b>	<b>100</b>

\* 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 will 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:

	Seesional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>30</b>	<b>30</b>		<b>100</b>

\* 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, Cropsit 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 – Kennedy, B.A., 2nd Edition, SME, New York, 1990  
Surface Mining Technology, Das, S.K., Lovely Prakashan, Dhanbad, 1994  
SME Mining Engg. Cummings, A.B. and Given, I.V., Hand book Vol.I and II, New York

#### 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.

## MNL431 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:

	Sessional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>30</b>	<b>30</b>		<b>100</b>

\* 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 CO<sub>2</sub> 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 2<sup>nd</sup> Edition
3. Society of Mining Engineering Handbooks –Vol –I and II

### 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:**

	<b>Seesional 1</b>	<b>Sessional 2</b>	<b>Teacher's Assessment*</b>	<b>End Semester</b>
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>30</b>	<b>30</b>		<b>100</b>

\* students assignments, class performance (attendance, tutorials)

**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

Underground Mining Methods Handbook: Hustrulid (SME NY, 1994)

**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 context to Geology
3. To understand the general review of Indian Stratigraphy
4. To understand the hydrological condition of the Earth
5. To know the Indian mineral deposits and their formation
6. To understand the concept of Remote Sensing & GIS techniques

**Course Assessment:**

**For Theory**

	Sessional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>35</b>	<b>35</b>	<b>-</b>	<b>100</b>

\* students assignments, class performance (attendance, tutorials)

**For Practical**

	Sessional 1	Sessional 2	Upto End Semester	End Semester
<b>Marks</b>	<b>40</b>	<b>40</b>	<b>20</b>	<b>100</b>
<b>% Syllabus</b>	<b>40</b>	<b>40</b>	<b>20</b>	<b>100</b>

**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.

Engineering Geology: Engineering properties of rocks in context to geology. Rock discontinuities and their bearing on rock performance and rock mass failures. Geology of natural slopes. Geological characteristics influencing subsidence and rock bursts.

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. Geo-Hydrology: Hydrologic Cycle and equation, Vertical zones of sub-surface water, water table, aquifers, aquicludes, aquifuges and aquitards. Confined and unconfined aquifers. Inflow and effluents, seepage, springs. Hydrologic properties of rocks; porosity, permeability. Occurrence and movement of Groundwater, Darcy's Law, water table maps and their usages, Hydrographs.

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
3. Principles of Engineering Geology, KVGK Gokhale, 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:**

	<b>Seesional 1</b>	<b>Sessional 2</b>	<b>Teacher's Assessment*</b>	<b>End Semester</b>
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>30</b>	<b>30</b>		<b>100</b>

\* 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

1. Techniques in Underground Mining: Selection... by– Richard E. Gertsch et al, SME 1998
2. Underground Mining Methods: Engineering Fundamentals and International Case Studies by A. Hustrulid, 2001
3. Introductory Mining Engineering: Hartman
4. Underground Mining Methods Handbook: Hustrulid (SMEYork, 1994

**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:**

	<b>Seesional 1</b>	<b>Sessional 2</b>	<b>Teacher's Assessment*</b>	<b>End Semester</b>
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>30</b>	<b>30</b>		<b>100</b>

\* 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 Wliey
4. Ground Control in Mines, S.S.Peng, John Wliey

**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:**

	<b>Seesional 1</b>	<b>Sessional 2</b>	<b>Teacher's Assessment*</b>	<b>End Semester</b>
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>30</b>	<b>30</b>		<b>100</b>

\* 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
4. Slope Stability in Surface mining: W A Hustrulid, SME Publication

**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.

#### **For Theory**

	Seesional 1	Sessional 2	Teacher's Assessment*	End Semester
<b>Marks</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>60</b>
<b>% Syllabus</b>	<b>35</b>	<b>35</b>	<b>-</b>	<b>100</b>

#### **For Practical**

	Seesional 1	Sessional 2	Upto End Semester	End Semester
<b>Marks</b>	<b>40</b>	<b>40</b>	<b>20</b>	<b>100</b>
<b>% Syllabus</b>	<b>40</b>	<b>40</b>	<b>20</b>	<b>100</b>

### **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

Characteristics and constituents of explosives, Mechanics of blasting,

Basics of Explosives and their classifications as low explosives, high explosives and blasting agents Indian classification of explosives. Properties of explosives for their selection, Testing of explosives for safety. Standards of storage and handling of explosives, Provisions in Explosives Act and legal aspects of explosives

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.
3. Conduction of blasting operation in mine and its safer aspects.
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**