

DEPARTMENT OF MINING ENGINEERING

Course Book

as per

NEP 2020

Bachelor of Technology (B.Tech) in Mining Engineering

For

ACADEMIC YEAR

2022– 2023 onwards



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

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.

Keeping in view the implementation of new National Education Policy-2020 (NEP 2020), the syllabus along with the credit scheme has been thoroughly revised as per the NEP and Institute guidelines.

Objectives of the B.Tech Program:

1. To train students to acquire knowledge in the areas of mining engineering processes, systems and technologies.
2. To develop curriculum and instructional programs in mining engineering in tune with need of the time.
3. To generate new knowledge through research and development and to disseminate it.
4. To modernise laboratories and to establish research facilities in the emerging areas.
5. To promote faculty and staff development for updating and acquiring new knowledge and improving professional competence.
6. To provide technical services to the mining industry.
7. 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

	Name	Area of Specialization
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)
(2022 Batch Onwards)

TOTAL CREDIT REQUIREMENT: 170

OVERALL CREDIT STRUCTURE

SN	Category of Courses			B.Tech	
				Existing Credit Scheme	Proposed Credit Scheme
1	Basic Sciences	First Year	BS	18	16
2	Engineering Art and Sciences (ES) & Vocational Courses (VC-Workshop)		ES	20	16
			VC		2
3	Humanities		HU	5	6
4	Energy & Environment		EV	-	3
5	Department Core	L & P-Type Courses	DC	73-76	67
		D-Type Courses		6	12
6	Department Electives		DE	33-48	36-48
7	Humanities & Management		HM	0-6	0-12
8	Open Courses		OC	0-6	
9	Other Department Courses		OD	0	
Total Credit Requirement				170	170
	Minor Courses (Additional Credit)		MN	-	15

REVISED B.TECH.SCHEME**Third Semester**

Course Code	Course Name	DC/DE	Structure	Credits
MNL209	Principle and Concepts of Mining Technology	DC	3-0-0	3
MNL210	Mine Transportation Machinery	DC	3-1-0	4
MNP210	Mine Transportation Machinery	DC	0-0-2	1
MNL211	Rock Mechanics	DC	3-1-0	4
MNP211	Rock Mechanics	DC	0-0-2	1
CEL284	Mining Geology	DC	3-0-0	3
CEP284	Mining Geology	DC	0-0-2	1
SUBTOTAL DC				17
Elective/OC/HM (ANY 2)				
MAL404	Probability and Statistics	DE	3-0-0	3
MML291	Mineral Processing	DE	3-0-0	3
	Open/HM Courses	OC	3-0-0	3
SUBTOTAL DE				6
GRAND TOTAL CREDITS				23

Fourth Semester

Course Code	Course Name	DC/DE	Structure	Credits
MNL212	Underground Coal Mining Methods	DC	3-0-0	3
MNL213	Surface Mining Methods	DC	3-0-0	3
MNL214	Underground Metalliferous Mining Methods	DC	3-0-0	3
MNL202	Mine Surveying	DC	3-1-0	4
MNP202	Mine Surveying	DC	0-0-2	1
MNL205	Mine Ventilation & Climate Engineering	DC	3-1-0	4
MNP205	Mine Ventilation & Climate Engineering	DC	0-0-2	1
SUBTOTAL DC				19
ELECTIVE/OC/HM (ANY 1)				
MNL428	Mine Management Information System	DE	3-0-0	3
MNL453	Introductory Safety Engineering	DE	3-0-0	3
	Open/HM Courses	OC	3-0-0	3
SUBTOTAL DE				3
GRAND TOTAL CREDITS				22

Fifth Semester

Course Code	Course Name	DC/DE	Structure	Credits
MNL315	Mine Excavation Machinery	DC	3-0-0	3
MNL316	Mine Hazards and Pollution	DC	3-0-0	3
MNP316	Mine Hazards and Pollution	DC	0-0-2	1
MNL405	Computer Applications in Mining	DC	3-0-0	3
MNP405	Computer Applications in Mining	DC	0-0-2	1
MNL403	Mine Management	DC	3-0-0	3
MNL404	Mine Planning	DC	3-1-0	4
MNP314	Survey Camp	DC	0-0-2	1
SUBTOTAL DC				19
Elective/OC/HM (ANY 1)				
CEL384	Advanced Mining Geology	DE	3-0-0	3
MNL454	Risk Assessment and Management	DE	3-0-0	3
MNL317	Smart & Clean Mining Technologies	DE	3-0-0	3
	Open/HM Courses	OC	3-0-0	3
SUBTOTAL DE				3
GRAND TOTAL CREDITS				22

Sixth Semester

Course Code	Course Name	DC/DE	Structure	Credits
MNL322	Ground Control and Instrumentation	DC	3-0-0	3
MNP322	Ground Control and Instrumentation	DC	0-0-2	1
MNL401	Mine Legislation and Safety	DC	3-0-0	3
MNL429	Blasting Technology for Mining & Construction	DC	3-0-0	3
MNP318	Mine Visits & Training	DC	0-0-2	2
MND319	Mini Project	DC	0-0-3	3
SUBTOTAL DC				15
Elective/OC/HM (Any 3)				
MNL425	Mass Production Technology for Underground Coal	DE	3-0-0	3
MNL320	Advanced Surveying & Remote Sensing	DE	3-0-0	3
MNL426	Underground Space Technology	DE	3-0-0	3
MNL321	Artificial Intelligence and IoT in Mineral Industry	DE	3-0-0	3
MNL455	Ergonomics in Safety	DE	3-0-0	3
	Open/HM Courses	OC	3-0-0	3
SUBTOTAL DE				9
GRAND TOTAL CREDITS				24

Seventh Semester

Course Code	Course Name	DC/DE	Structure	Credits
MND456	Major Project Phase - 1	DC	0-0-3	3
SUBTOTAL DC				03
ELECTIVE/OC/HM Courses (ANY 5)				
MNL421	Mine System Engineering	DE	3-0-0	3
MNL402	Surface Mine Environment	DE	3-0-0	3
MNL430	Rock Slope Engineering	DE	3-0-0	3
MNL457	Disaster and Emergency Management	DE	3-0-0	3
MNL458	Instrumentation & Non-destructive Testing	DE	3-0-0	3
MNL459	Reliability Engineering	DE	3-0-0	3
MNL406	Mining Economics	DE	3-0-0	3
MNL422	Rock Excavation Engineering	DE	3-0-0	3
SUBTOTAL DE				15
GRAND TOTAL CREDITS				18

Eight Semester

Course Code	Course Name	DC/DE	Structure	Credits
MND460	Major Project Phase - 2	DC	0-0-6	6
SUBTOTAL DC				06
ELECTIVE/OC/HM Courses (ANY 4)				
MNL434	Advanced UG Metal Mining & Design	DE	3-0-0	3
MNL433	Advanced Surface Mining & Design	DE	3-0-0	3
MNL423	Geostatistics	DE	3-0-0	3
MNL431	Novel Mining Methods	DE	3-0-0	3
MNL432	Mine Automation	DE	3-0-0	3
MNL461	Drilling Technology	DE	3-0-0	3
MNL462	Mine Waste Management	DE	3-0-0	3
MNL463	Industrial Safety Audit & Training	DE	3-0-0	3
MNL464	Project Management and Evaluation	DE	3-0-0	3
SUBTOTAL DE				12
GRAND TOTALCREDITS				18

***Two Months Training / Internship in OC and UG Mines**

Total Credits

SN	Type		SEMESTER								Total
			I	II	III	IV	V	VI	VII	VIII	
1	DC	L & P- Type Course	43		17	19	19	12	-	-	67
		D-Type Course			-	-	-	03	03	06	12
2	DE/OC/HM				6	3	3	09	15	12	48
					23	22	22	24	18	18	170

LIST OF CORE COURSES (DC)

(First Year Courses are not included)

Course Code	Course Name	L-T-P-	Credits	Conducted in Semester	Pre-requisites
MNL209	Principle and Concepts of Mining Technology	3-0-0	3	3	
MNL210	Mine Transportation Machinery	0-0-2	1	3	
MNP210	Mine Transportation Machinery	0-0-2	1	3	
MNL211	Rock Mechanics	3-1-0	4	3	
MNP211	Rock Mechanics	0-0-2	1	3	
CEL284	Mining Geology	3-0-0	3	3	
CEP284	Mining Geology	0-0-2	1	3	
MNL212	Underground Coal Mining Methods	3-0-0	3	4	
MNL213	Surface Mining Methods	3-0-0	3	4	
MNL214	Underground Metalliferous Mining Methods	3-0-0	3	4	
MNL202	Mine Surveying	3-1-0	4	4	
MNP202	Mine Surveying	3-1-0	4	4	
MNL205	Mine Ventilation & Climate Engineering	3-1-0	4	4	
MNP205	Mine Ventilation & Climate Engineering	0-0-2	1	4	
MNL315	Mine Excavation Machinery	3-0-0	3	5	
MNL316	Mine Hazards and Pollution	3-0-0	3	5	
MNP316	Mine Hazards and Pollution	0-0-2	1	5	
MNL405	Computer Applications in Mining	3-0-0	3	5	
MNP405	Computer Applications in Mining	0-0-2	1	5	
MNL403	Mine Management	3-0-0	3	5	
MNL404	Mine Planning	3-1-0	4	5	
MNP314	Survey Camp	0-0-2	1	5	
MNL322	Ground Control and Instrumentation	3-0-0	3	6	
MNP322	Ground Control and Instrumentation	0-0-2	1	6	
MNL401	Mine Legislation and Safety	3-0-0	3	6	
MNL429	Blasting Technology for Mining & Construction	3-0-0	3	6	
MNP318	Mine Visits & Training	0-0-2	2	6	
SUBTOTAL L & P- TYPE COURSES			67		
MND319	Mini Project	0-0-3	3	6	
MND456	Major Project Phase - 1	0-0-3	3	7	
MND460	Major Project Phase - 2	0-0-6	6	8	
SUBTOTAL D- TYPE COURSES			12		

LIST OF ELECTIVECOURSES (DE)

Course Code	Course Name	L-T-P-	Credits	Conducted in Semester	Pre-requisites
MAL404	Probability and Statistics	3-0-0	3	3	
MML291	Mineral Processing	3-0-0	3	3	
MNL428	Mine Management Information System	3-0-0	3	4	
MNL453	Introductory Safety Engineering	3-0-0	3	4	
CEL384	Advanced Mining Geology	3-0-0	3	5	
MNL454	Risk Assessment and Management	3-0-0	3	5	
MNL317	Smart & Clean Mining Technologies	3-0-0	3	5	
MNL425	Mass Production Technology for Underground Coal	3-0-0	3	6	
MNL320	Advanced Surveying & Remote Sensing	3-0-0	3	6	
MNL426	Underground Space Technology	3-0-0	3	6	
MNL455	Ergonomics in Safety	3-0-0	3	6	
MNL321	Artificial Intelligence and IoT in Mining	3-0-0	3	6	
MNL421	Mine System Engineering	3-0-0	3	7	
MNL402	Surface Mine Environment	3-0-0	3	7	
MNL430	Rock Slope Engineering	3-0-0	3	7	
MNL457	Disaster and Emergency Management	3-0-0	3	7	
MNL458	Instrumentation & Non-destructive Testing	3-0-0	3	7	
MNL459	Reliability Engineering	3-0-0	3	7	
MNL406	Mining Economics	3-0-0	3	7	
MNL422	Rock Excavation Engineering	3-0-0	3	8	
MNL434	Advanced UG Metal Mining & Design	3-0-0	3	8	
MNL433	Advanced Surface Mining & Design	3-0-0	3	8	
MNL423	Geostatistics	3-0-0	3	8	
MNL431	Novel Mining Methods	3-0-0	3	8	
MNL432	Mine Automation	3-0-0	3	8	
MNL461	Drilling Technology	3-0-0	3	8	
MNL462	Mine Waste Management	3-0-0	3	8	
MNL463	Industrial Safety Audit & Training	3-0-0	3	8	
MNL464	Project Management and Evaluation	3-0-0	3	8	
SUBTOTAL DE COURSES			48/87		

DETAILS OF MINOR DEGREE

MINOR NAME: SAFETY ENGINEERING

Need:

Industrial Safety Engineering is concerned with the development of novel engineering and managerial solutions to safety problems so that the consequences of accidents can be minimised in human, environmental and financial terms. The development and application of emerging technologies within the often contradictory constraints of safety, economy and the law is addressed within this course.

Students will gain a thorough grasp of the fundamentals of Safety Engineering; practical experience in the use of state-of-the-art techniques for the development of safety engineering systems.

To get understanding of the necessary scientific, engineering and technological principles, will enable them to make sound engineering judgments during the design, management and decommissioning of engineering projects.

SN	Course Code	Course Name	Structure L-T-P-Cr	Conducted in sem (3/4/5/6/7/8)
1	MNL453	Introductory Safety Engineering	3-0-0-3	4
2	MNL454	Risk Assessment and Management	3-0-0-3	5
3	MNL455	Ergonomics in Safety	3-0-0-3	6
4	MNL457	Disaster and Emergency Management	3-0-0-3	7
5	MNL436	Industrial Safety Audit and Training	3-0-0-3	8

**SYLLABUS
OF
DEPARTMENT CORE (DC)
COURSES**

Course Name: Principle and Concepts of Mining Technology
Course Code: MNL209
Course Type: Departmental Core
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

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

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: 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; drilage work in varying ground conditions using conventional methods – drilling, blasting, mucking, transportation, supports, services and cycle of operations
Mechanical methods of drilage 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;

Blasting: Brief introduction to blasting accessories, exploders; blasting practices in opencast and underground mines,

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 explosives and their use in mines

Course Name: Mine Transportation Machinery
Course Code: MNL210
Course Type: Departmental Core
Credits (L-T-P): 3-1-2
Pre-Requisite: Nil

Course Objective:

This course will introduce the student to the state-of-the-art tools available for mine transportation. Additionally, concepts of material properties such as strength and its enhancement for metals will be covered for better assimilation. Students will also be introduced to new concepts emerging in the field of bulk material and personnel transportation such as electric vehicles and unmanned automated vehicles.

Course Assessment:

Theory:

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

* students assignments, class performance (attendance, tutorials)

Practical:

	Sessional 1	Sessional 2	Upto End Semester	End Semester
Marks	40	40	20	100
% Syllabus	40	40	20	100

Course contents:

- Engineering Metals and their uses:** Steel and other ferrous alloys; Non-ferrous alloys; Application and Uses of alloys; Heat treatment and strength enhancement; Definitions and manufacturing techniques involved with wire ropes; Constructions and types of wire ropes; Measurements and testing of wire ropes; Rope deterioration; Wire Rope terminations and capping.
- Track Haulage Systems:** Introduction to track haulage –rope and locomotive haulage; Construction, installation and selection of haulage units; Minimum gradient and Power Requirement; Safety devices and features; Track laying and maintenance protocols; Mine tubs/cars
- Conveyors:** Type of conveyors; Construction, installation and operation of conveyors; Capacity and power computations; Mobile conveyors and emerging trends in conveyors
- Surface & Shaft Plant:** Pit-top and Pit-Bottom Circuits; Stacking, blending and reclaiming of materials; Design of storage system: Silos, bins and bunkers; Rapid loading system; Type and choice of headframe; Shaft fittings and guides; Safety devices; Keps, tilting platforms, receivers and roofing; Suspension gear; Cages & Skips
- Winding:** Types, functioning and limitations of drum and friction winding; Duty cycle and torque-time computation; Winding capacity and production; Multi-level and deep winding; Drives and brakes for winding; Speed controllers, depth indicators and safety devices for winding
- Manriding Systems:** Types of Manriding systems; Construction and installation of such systems; Safety devices and case studies
- Other mine transportation solutions:** Railveyor system; Aerial Ropeway; Tube Transportation; Emerging vehicles for bulk, personnel and material transportation in mines.

Reference Texts:

- S. C. Walker, Mine Winding and Transport. Elsevier, 2012.
- M. A. Ramlu, Mine hoisting, White Falcon, 1996
- SME Mining Engineer's Handbook: Hustrulid
- Underground Mining Methods Handbook: Hustrulid

Course Outcomes:

A student will be able to:

- To understand the working and applicability of different mine transport system
- To design the capacity of of different mine transport system
- To select an appropriate mine transportation system based on existing geominig scenario.

Course Name: Rock Mechanics
Course Code: MNL211
Course Type: Departmental Core
Credits (L-T-P): 3-1-2
Pre-Requisite:

Course Objective:

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:

Theory:

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

* students assignments, class performance (attendance, tutorials)

Practical

	Sessional 1	Sessional 2	Upto End Semester	End Semester
Marks	40	40	20	100
% Syllabus	40	40	20	100

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.

Course Name: Mining Geology
Course Code: CEL284
Course Type: Departmental Core
Credits (L-T-P): 3-0-2
Pre-Requisite: Nil

Course Objective:

Students will be introduced to concepts of geology in general and mining in particular

Course Assessment:

Theory:

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

* students assignments, class performance (attendance, tutorials)

Practical:

	Sessional 1	Sessional 2	Upto End Semester	End Semester
Marks	40	40	20	100
% Syllabus	40	40	20	100

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.

Course Name: Underground Coal Mining Methods
Course Code: MNL212
Course Type: Departmental Core
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

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:

Theory:

	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

Course Name: Surface Mining Methods
Course Code: MNL213
Course Type: Departmental Core
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

Surface Mining is the most economical and safe means of mining mineral reserves. Students will understand the viability of surface mining. Students will be familiarized to 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 and reclamation will be covered

Course Assessment:

Theory:

	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:

Role of surface mining in mineral production in India, elements of surface mine planning- height, width, and slope of benches, overall and ultimate pit slopes, stripping ratio, cut off grade, different mining costs and preliminary evaluation of surface mining prospects

Types of surface mining systems — applicability, limitations, advantages and disadvantages

Opening up of Deposits – different systems of opening of deposits, site preparation, box cut, formation of benches, and haul roads. Layouts using different combinations of main excavation, loading and transportation systems.

Blasting: Blasting practices and blast design in surface mines

Extraction Methods: Extraction of subsurface deposits - bedded deposits, massive deposits, pipe type, cap type and vein type deposits; mining of beach sands, placer mining, dimensional stone mining. Layouts with In-pit crushing and conveying, surface miners.

Surface mining of coal seams developed by underground methods, surface mining over underground workings, mining in fiery strata, deep mining problems

Dump Formation: Types of waste dump - internal and external; dump formation methods and equipment.

Reclamation methods by using different combination of equipment

Books:

1. Bulk Handling in Open Pit Mines & Quarries: Reinhard H.Wohlbier
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.

Course Name: Underground Metalliferous Mining Methods
Course Code: MNL214
Course Type: Departmental Core
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

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:

Theory:

	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:

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 geominig parameters

Course Name: Mine Surveying
Course Code: MNL202
Course Type: Departmental Core
Credits (L-T-P): 3-1-2
Pre-Requisite:

Course Objective:

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

Course Assessment:

Theory:

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

* students assignments, class performance (attendance, tutorials)

Practical:

	Sessional 1	Sessional 2	Upto End Semester	End Semester
Marks	40	40	20	100
% Syllabus	40	40	20	100

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.

Course Name: Mine Ventilation and Climate Engineering
Course Code: MNL205
Course Type: Departmental Core
Credits (L-T-P): 3-1-2
Pre-Requisite:

Course Objective:

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:

Theory:

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

* students assignments, class performance (attendance, tutorials)

Practical

	Sessional 1	Sessional 2	Upto End Semester	End Semester
Marks	40	40	20	100
% Syllabus	40	40	20	100

Course Content:

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

1. Mine Ventilation: G. B. Mishra
2. Sub-surface mine ventilation: Macperson
3. Mine ventilation and air-conditioning in mines: Hartman
4. Introductory Mining Engineering: Howard L. Hartman
5. 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.

Course Name: Mine Excavation Machinery
Course Code: MNL315
Course Type: Departmental Core
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

Minerals 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:

Theory:

	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:

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

Power Transmission in Machines: Gear, V-Belt, Friction Belts, etc.

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.

Course Name: Mine Hazards and Pollution
Course Code: MNL316
Course Type: Departmental Core
Credits (L-T-P): 3-0-2
Pre-Requisite:

Course Objective:

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:

Theory:

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

* students assignments, class performance (attendance, tutorials)

Practical

	Sessional 1	Sessional 2	Upto End Semester	End Semester
Marks	40	40	20	100
% Syllabus	40	40	20	100

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-borne dust

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

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

Books:

1. Mine Fires, Inundation and Rescue: M.A.Ramulu, 1991
2. Mine Illumination by Trotter
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.

Course Name: Computer Applications In Mining

Course Code: MNL405

Course Type: Departmental Core

Credits (L-T-P): 3-0-2

Pre-Requisite:

Course Objective:

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:

Theory:

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

* students assignments, class performance (attendance, tutorials)

Practical

	Sessional 1	Sessional 2	Upto End Semester	End Semester
Marks	40	40	20	100
% Syllabus	40	40	20	100

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

Course Name: Mine Management
Course Code: MNL403
Course Type: Departmental Core
Credits (L-T-P): 3-0-0
Pre-Requisite:

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:

Theory:

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

Personnel Management: Selection, training and development of human resource; job evaluation and performance appraisal, and incentives, standard of performance. Manpower planning for mines. Communication: types and its importance, two way personal communications; transmission of facts and feelings; directing and disciplining Leadership: study of traditional leader behaviors - autocratic, democratic and Laissez-Faire behavior; Behavioral

Sciences for Management: Human needs, theory of motivation and organization design; conflicts in organization, sources of conflicts, dealing with conflicts, organizing for conflict resolution, conflict and growth; individual motivation;; behavioral view of controlling; Group and individual behavior.

Industrial Psychology Industrial Relations: Definitions, objectives and applications; 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.

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 optimization, Office management:

Financial Management: Forms of business organization, private public, aquasition and merger, Mine Finance and capital s, shares, debentures, costing, Import export .

Cost of mining, Capital and operating costs, method of estimation standard costing forecasting, budget and budgetary control.

Books

1. Business Administration and Management, S.C. Saxsena, Sahitya Bhavan Agra, 1995
2. Management Theory and Practices, B.S. Moshal, GPC publication New Delhi
3. Personnel Management and Industrial Psychology, Verma and Agarwal, Educational Publishers, New Delhi
4. Principles of Management by Kulkarni and Chopde
5. Finance for Mine Management by Sloan
6. Production Management by William Stevenson, Richard publication, 1982
7. Industrial Engineering and Production Management, M. Mahajan, Dhanpat Rai company.

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

Course Name: Mine Planning
Course Code: MNL404
Course Type: Departmental Core
Credits (L-T-P): 3-1-0
Pre-Requisite:

Course Objective:

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:

Theory:

	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:

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

Course Name: Survey Camp
Course Code: MNP314
Course Type: Departmental Core
Credits (L-T-P): 0-0-2
Pre-Requisite:

Course Objective:

To make students conversant practical aspects and integration of several concepts of surveying through field and site work.

Course Assessment:

Assessment will be based on the survey camp log book and survey sheet prepared during field work, and Viva-Voce.

Course Name: Ground Control and Instrumentation
Course Code: MNL322
Course Type: Departmental Core
Credits (L-T-P): 3-0-2
Pre-Requisite:

Course Objective:

To makes 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
Marks	15	15	10	60
% Syllabus	35	35	-	100

* students assignments, class performance (attendance, tutorials)

Practical

	Sessional 1	Sessional 2	Upto End Semester	End Semester
Marks	40	40	20	100
% Syllabus	40	40	20	100

Course Content:

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

Course Name: Mine Legislation and Safety
Course Code: MNL401
Course Type: Departmental Core
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

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

Course Assessment:

Theory:

	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: 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.

Course Name: Blasting Technology for Mining and Construction

Course Code: MNL429

Course Type: Departmental Core

Credits (L-T-P): 3-0-0

Pre-Requisite:

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:

Theory:

	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:

History and use of explosives: blasting and its applicability to mining and construction industry.

Characteristics and constituents of explosives, Basics of explosives and their classifications as low explosives, high explosives and blasting agents, Bulk explosive, Explosive for special application, Indian classification of explosives. Properties of explosives for their selection, Laboratory and field testing of explosives, Provisions in Explosives Act and legal aspects of explosives including storage and handling of explosives.

Blasting accessories: Safety fuse, Detonating cord, Cord relays, Nonel, Detonator: plain, electric, electronic, Sequential blasting machine, Underground blasting accessories, Preparation of priming cartridges, testing of blasting accessories.

Blast design: Various Pattern of holes for drives and drift, roadways, underground storage and tunnels, pattern of holes for surface & underground excavation, Initiation system and firing sequences. Blasting operation in surface and underground coal mines, metal mines, drifts, shaft, tunnels and caverns. Safety precautions before and during blasting operation, Empirical approaches to blast design.

Mechanics of rock breakage by blasting, Rock explosive interaction, various rock fragmentation theories.

Role of rock parameters, Controllable and non-controllable parameters,

Evaluation of blasting results, Use of various software for blasting, Environmental ill effects of 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. Blast Economics, blasting costs and role of fragmentation with blasting costs, cost optimization,

Books:

1. Langefors, U. and Kihlström, B., 1963. The modern technique of rock blasting (Vol. 405). New York: Wiley.
2. Drilling and Blasting of Rocks, By C. Lopez Jimeno, E. Lopez Jimeno, Francisco Javier Ayala CarcedoHustrulid
3. Konya, C.J. and Walter, E.J., 1991. Rock blasting and overbreak control (No. FHWA-HI-92-001; NHI-13211). United States. Federal Highway Administration.
4. Engineering rock blasting operations: S. Bhandari, A. A. Balkema Pulb

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

Course Name: Mine Visits and Training

Course Code: MNP318

Course Type: Departmental Core

Credits (L-T-P): 0-0-2

Pre-Requisite:

Course Objective:

The students will be assigned field visits to surface/underground coal/metal mining sites to familiarize themselves with various concepts of mining operation that have been covered in the previous semesters.

Course Assessment:

Assessment will be based on the progress reports of mine visits and training.

Course Name: Mini Project
Course Code: MND319
Course Type: Departmental Core
Credits (L-T-P): 0-0-3
Pre-Requisite:

Course Objective:

The students will be assigned mini projects based on the curriculum studied so far

Course Assessment:

Assessment will be continuous in nature comprising of mid-term and end-term evaluation along with submission of a project report and presentation.

Course Name: Major Project Phase -1
Course Code: MND456
Course Type: Departmental Core
Credits (L-T-P): 0-0-3
Pre-Requisite:

Course Objective:

The students will be assigned a dissertation topic based on his/her area of interest within mining domain.

Course Assessment:

Assessment will be continuous in nature comprising of mid-term and end-term evaluation along with presentation.

Course Name: Major Project Phase -2
Course Code: MND460
Course Type: Departmental Core
Credits (L-T-P): 0-0-6
Pre-Requisite:

Course Objective:

The students will be assessed on the progress made on assigned dissertation topic .

Course Assessment:

Assessment will be continuous in nature comprising of mid-term and end-term evaluation along with submission of a project dissertation and presentation.

**SYLLABUS
OF
DEPARTMENT ELECTIVE (DE)
COURSES**

Course Name: Probability and Statistics
Course Code: MAL404
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

COURSE SHALL BE COORDINATED BY THE DEPARTMENT OF MATHEMATICS.

Course Name: Mineral Processing
Course Code: MML291
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Assessment:

Theory:

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

* students assignments, class performance (attendance, tutorials)

Contents

Mineral beneficiation and its role in mineral exploration and conservation with special reference to Indian economic minerals

Theory and practice of crushing and grinding, conventional units and their performance and choice

Laboratory techniques, interpretation and plotting of data, industrial screens and classifiers, dry and wet processes

Importance of sampling and methods used in mills

Picking, washing and classification

Theory and applications of sinks and float, jigging and flowing film concentration-methods and equipment used.

Physico-chemical principles, flotation reagents, flotation machines and circuits, application to common sulfide, oxide and oxidized minerals

Principles, operation and field of application.

Dewatering and drying: thickening, filtration and drying.

Methods of coal washing, washability curves

Simplified flowsheets for the beneficiation of coal and typical ores of copper, lead, zinc, iron and manganese with special reference to Indian deposits

Brief description of leaching methods.

Course Outcomes:

The students will be able to

1. Understand the working principle and mechanism of Crushing and Grinding Operations
2. Understand the basic principles of separation of minerals by Jigging, Tabling and Heavy media separation
3. Understand froth flotation operation for up gradation of ores/minerals, Electrostatic/Magnetic separation operations

Course Name: Mine Management Information System
Course Code: MNL428
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

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

Course Assessment:

Theory:

	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:

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 managers, 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

Course Name: Introductory Safety Engineering
Course Code: MNL453
Course Type: Departmental Elective / MINOR 1
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

To make student familiarize with the basic concept of hazards, safety and management. To provide the knowledge of occurrence of accidents and its causes.

Course Assessment:

Theory:

	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:

Safety management concept and systems in industry;
Engineering aspects of safety management, Occupational safety and health
Industry wise hazards and its classification and identification and hazards communication HazCom
Common industrial accidents, Accident causes and accidents causation theories
Accident prevention and control techniques, Zero Accidents Potential (ZAP)
Safety Information system for industry, accidents statistics,
Safety performance measurement:
Costs of accidents and its calculations
Safety legislations for various industries, Safety Inspection Procedures:

Books:

1. The Handbook of Safety Engineering: Principles and Applications , Frank R. Spellman and Nancy E. Whiting, Government Institutes Inc.,U.S. ISBN-10 : 1605906719, ISBN-13 : 978-1605906713
2. Industrial Safety Management, L M Deshmukh, McGraw-Hill Education LLC., 2005

Course Outcomes:

1. Students understand the methodology of safety management
2. Students can apply safety engineering principles to their industry

Course Name: Advanced Mining Geology
Course Code: CEL384
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

To know prospecting and subsurface exploration methods. To know the engineering properties of rocks in context with geology. To understand the general arrangement of Indian stratigraphy. To understand the hydrological condition of the Earth. To know the Indian mineral deposits and their formation. To understand the concept of Remote Sensing & GIS techniques

Course Assessment:

Theory:

	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:

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

Course Name: Risk Assessment and Management
Course Code: MNL454
Course Type: Departmental Elective / MINOR 2
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

To make student aware of risk management in Industry. To train the students for risk assessment methods

Course Assessment:

Theory:

	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:

Basic concept of risk, reliability and hazard potential;

Elements of risk assessment; statistical methods; control charts;

Qualitative and quantitative risk assessment and analysis, Probabilistic Risk Assessment Hazards and Risk Management

Advanced risk assessment techniques - Fault Tree Analysis, HAZOP, failure mode and effect analysis, fuzzy model for risk assessment, job hazard and safety analysis

Risk Management and control methods, Risk assessment and management software

Risk assessment and management industrial cases

Books:

1. The Essentials of Risk Management by Michel Crouhy Dan Galai, Robert Mark
2. Risk Analysis: A Quantitative Guide, 3rd Edition David Vose

Course Outcomes:

1. Student can determine the risk for operations and jobs with respect to hazards
2. Can apply the risk management and mitigation techniques

Course Name: Smart and Clean Mining Technologies
Course Code: MNL317
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Need of the course:

Mining involves earth work through the various process like drilling, cutting, blasting transportation of debris, dumping of waste which needs to smart in terms of efficiency and having minimum environmental impact. Smart and clean mining is defined as technologies and mine processes that uses information, autonomy, and technology to obtain enhanced safety, reduce operational costs, and gain better productivity for a mine site and are implemented as a means to reduce the environmental impacts associated with the extraction and processing of metals and minerals and it should be sustainable which should not leave any scar on the earth. This course will make students aware with regards to best practices of eco-friendly efficient mining.

Course Objectives:

Students will get the knowledge about productive smart, efficient and intelligent mining. Students will understand the significance of green and eco-friendly mining

Course Assessment:

Theory:

	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:

Remote Mining Techniques, Automated mining:

- Autonomous vehicles, automated equipment includes excavators, load haul dump, drillers & breakers, robotic trucks, and other automated equipment
- remote-controlled drilling rigs, unmanned drone inspection and smart ventilation control,
- Modern Instrumentation in HEMM for Safety and Productivity Enhancement Advances in Instrumentation and monitoring of Mining Machinery
- Instrumentation for intelligent mines, Smart actuators and Smart controllers for monitoring of large movements in underground and open pit mines
- Real-time condition monitoring, measuring bearing vibration and temperature, wireless machine monitoring, detecting, condition monitoring systems beyond preventive maintenance and predictive maintenance.
- Borehole remote mining, underground remotely operated continuous mining machines other continuous mining processes
- The Industrial Internet of Things (IIOT) applications to mining and digital mines
- Automated sensors, RFID tags, intelligent systems, and data transfer mechanism
- Cellular technology of networking, wireless data transfer and control of machines.

Eco-friendly clean mining:

- Environmentally friendly mining processes
- Reevaluating Cut-off Grades, conservation of minerals
- Coal washing and covered transportation
- Mill tailing management
- Water regime management in mines, water recycling, water treatment
- Toxic waste treatment, contamination control
- Wet mining, water sprinkling, wet drilling, wet cutting, modern dust control and treatment techniques
- Innovative synchronization of mine site restoration and reclamation techniques
- Zero-emission mining

Course Outcome:

Upon completion of this course:

1. Students will get the knowledge about productive smart and efficient mining
2. Students can Identify and asses the recent developments in intelligent and prognostic maintenance that could be useful for their work sites and how to introduce them
3. Can realize the importance of clean and sustainable mining

Course Name: Mass Production Technology for Underground Coal

Course Code: MNL425

Course Type: Departmental Elective

Credits (L-T-P): 3-0-0

Pre-Requisite:

Course Objective:

To provide knowledge of advanced techniques of underground coal mining. To develop concept of system engineering and design approaches of advance techniques of underground coal mining

Course Assessment:

Theory:

	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:

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

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

Course Name: Advanced Surveying & Remote Sensing
Course Code: MNL320
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

To disseminate knowledge to student about modern surveying and methods for precision survey in mining

Course Assessment:

Theory:

	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:

National Grid: Map Projections; transformation of coordinates,

Geodesy: Geoid, spheroid and ellipsoid, Geocentric, Geodetic and Astronomical Coordinates,

GIS: Components, Raster data, Vector data, Data acquisition, Data preprocessing & Georeferencing, Query based analysis, GIS software, GIS application in mining

Photogrammetry: Types, Principle of photogrammetry, Photographs types, Scale of photograph, Relief displacement, Ground coordinates, Overlaps, Stereoscope, Flight design

GNSS: Various navigation satellite system, Regional systems principle, operation, application to mine survey-

EDM, Total survey station, principle and application to mine survey,

Gyro-theodolite, principle, application to mine survey

LiDAR, Laser profilers, principle, application to mine survey, and application of laser

Drone: principle, application to mine survey

Remote sensing: Components, Sources of EM radiation, EM Radiation interaction with atmosphere with earth's surface, atmospheric windows, spectral signature, Remote Sensors and platforms, Image resolution, Satellites orbits, Image processing, IRS & INSAT system, Remote sensing software. Application of remote sensing in mining

Books:

1. Burrough, P.A. and Mc Donnel, R.A.(1998), "Principles of Geographic Information System"
2. Kang-tsung Chang. (2002), "Introduction to Geographic Information System"
3. John A. Richards (2012), Remote Sensing and Digital Image Analysis
4. Thomas L., Ralph W. Kiefer, and Jonathan C. (2015), Remote Sensing and Image Interpretation
5. Lu, Zhiping, Qu, Yunying, Qiao, Shubo (2014) "Geodesy: Introduction to Geodetic Datum and Geodetic Systems"

Course Outcomes:

CO1: The students are expected to have detail idea about the advanced surveying techniques.

CO2: Students will be able to use various advanced survey instruments

Course Name: Underground Space Technology
Course Code: MNL426
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

To make students conversant with aspects underground space development. To develop skill of excavation for underground space development

Course Assessment:

Theory:

	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:

Need and importance of underground space creation, types of underground excavations- tunnels, caverns, shafts.

Applications of underground excavations: storage, transport, military etc.

Equipment: Roadheading machines, their selection, operation for underground excavation

Shaft Boring machine and Tunnel Boring Machine: construction and operation

Drill for underground excavations: drill jumbos

Site investigation, various shapes and sizes, selection of method of excavation

Excavation by drilling and blasting: Tunnels, caverns, shafts, Method of excavation and design of blasting round, cycle of operation

Excavation by mechanical means: excavation in soft ground and hard rock by TBM and cutting methods, their layouts

Hazards in underground excavations

Parameters for design of underground excavations, Design and selection of support and reinforcement for underground excavation, Consideration for swelling and squeezing rock conditions, rock burst prone zones, seismic zone and soft ground

Environmental problems in rock excavations, causes and preventions, ventilation and illumination in excavations.

Reference Books

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

Course Outcomes:

The students will be able to

1. Understand the need and importance of underground space technology
2. Understand the applicability of various types of underground excavating machines and drilling patterns
3. Understand the hazards of underground excavations and environmental problems
4. Select and design the underground support for different mining conditions

Course Name: Ergonomics in Safety
Course Code: MNL455
Course Type: Departmental Elective / MINOR 3
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

To provide the basic knowledge about ergonomics with respect to safety. To make students conversant with ergonomics in industrial operations and machines

Course Assessment:

Theory:

	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:

Principles of ergonomics

Designing work stations and tools to reduce work- related musculoskeletal disorders (MSDs)

Physical Ergonomics, man-machine- environment interaction, ergonomically design machines

Cognitive Ergonomics, Organizational Ergonomics

Ergonomics in workplace, workshops etc. and its design

Ergonomics in Construction

Importance of Ergonomics for the Safety Professional

Safety practices in various operations

Reference Books

1. Introduction to Human Factors and Ergonomics by BRIDGER
2. Health, Safety and Ergonomics, Editors: Andrew S. Nicholson, John E. Ridd eBook ISBN: 9781483192314, Elsevier

Course Outcomes:

1. Student can use ergonomics principles to the machines operations
2. Can apply safe ergonomical practices

Course Name: Artificial Intelligence and IoT in Mining
Course Code: MNL321
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

This course will introduce novel concepts of artificial intelligence techniques and Internet of Things and their application in mining domain.

Course Assessment:

Theory:

	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 contents:

Introduction: Brief review of AI history, artificial intelligence and its applications in data sciences Basics of problem solving, problem representation; Search Techniques: Problem size, complexity; Uninformed search techniques- Depth, Breadth, Uniform Cost, Depth Limited .

Informed search techniques: Heuristic Based Search, Greedy Based First Search, A* Search; Local Search algorithms: Hill-climbing, Simulated Annealing, Genetic Algorithms.

Conceptual introduction to Machine Learning: Linear Regression, Logistic Regression, Inductive Classification, Supervised, Unsupervised, and Semi-Supervised Learning, Deep Learning, Reinforcement Learning, k-means partitional clustering. Expectation maximization (EM) for soft clustering.

Introduction to Neural Networks: Artificial Neural Networks, Neurons and biological motivation. Linear threshold units. Perceptrons: representational limitation and gradient descent training. Multilayer networks and back propagation. Hidden layers and constructing intermediate, distributed representations. Overfitting, learning network structure, recurrent networks.

Internet of Things and application of AI, ML and IOT in Mining Industry: Overview of IoT, Design Principles for Connected Devices; Internet Principles, Industry 4.0, embedded devices, overview of Communication in the IoT, data handling, data conversions and cloud computing in IoT, security in IoT, Mining application case studies of AI, ML and IoT

Text Book:

1. Rich and Knight "Artificial Intelligence" MGH Publication, 2018
2. A. McEwen and H. Cassimally, Designing the Internet of Things, 1st edition, Wiley, 2013, ISBN-10: 111843062X.
3. Richard I. Levin and David S. Rubin, Statistics for Management, 7th Edition, Pearson, 1998
4. Tom Mitchell "Machine Learning" McGraw Hill, 1997.
5. Stuart Russel and Peter Norvig; Artificial Intelligence: A Modern Approach; Third Edition; Pearson Education, 2009
6. Adrian McEwen, Hakim Cassimally - Designing the Internet of Thing Wiley Publications, 2012.

Reference Books:

1. Ethem Alpaydin; Introduction to machine Learning, Third Edition
2. Arshdeep Bahga, Vijay Madisetti - Internet of Things: A Hands-On Approach, Universities Press, 2014.

Course Outcomes:

The students will be able to:

1. Understand AI, perform problem solving
2. Carry out data analysis and use informed search techniques
3. Carry out data analysis and understand ML concepts
4. Effective use of Neural networks
5. Understand and practice IoT, Machine learning approaches and Artificial Intelligence and its application in mining industry

Course Name: Mine System Engineering
Course Code: MNL421
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

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

Course Assessment:

Theory:

	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 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

Course Name: Surface Mine Environment
Course Code: MNL402
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

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:

Theory:

	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: 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

Course Name: Rock Slope Engineering
Course Code: MNL430
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

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:

Theory:

	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:

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

Course Name: Disaster and Emergency Management
Course Code: MNL457
Course Type: Departmental Elective / MINOR 4
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

To make aware the students about various disasters. To train the students for disaster management methodologies

Course Assessment:

Theory:

	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:

Accidents, Disaster and Catastrophes

Introduction on Disaster Different Types of Disaster:

- Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etc
- Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures (Building and Bridge), War & Terrorism etc. Causes, effects and practical examples for all disasters.

Disaster Management, Preparedness and Response

- Disaster Preparedness: Concept and Nature, Disaster Preparedness Plan, Prediction, Early Warnings and Safety Measures of Disaster, Role of Information, Education, Communication, and Training,
- Role of Government, International and NGO Bodies, Role of IT in Disaster Preparedness Role of Engineers on Disaster Management.
- Disaster Response: Introduction, Disaster Response Plan, Communication, Participation, and Activation of Emergency Preparedness Plan,
- Rescue, Search, Evacuation and Logistic Management, Role of Government, International and NGO Bodies
- Psychological Response and Management (Trauma, Stress, Rumor and Panic)
- Relief and Recovery. Medical Health Response to Different Disasters

Disaster Planning: Theoretical approaches; the emergency situation and responses; emergency/disaster control agencies; worksite considerations - evaluations, treatment, access, public awareness, shutdown procedures.

Books:

1. Disaster Management Handbook, Jack Pinkowski
2. Industrial Disaster Management and Emergency Response U. K. Chakrabarty

Course Outcomes:

Student can use disaster management and emergency management techniques to reduce the severity
Can prepare the disaster management plans

Course Name: Instrumentation & Non-Destructive Testing
Course Code: MNL458
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Need of the course:

Modern mining operations rely on safe and secure operation to achieve targeted efficiency. This can be ensured by employing a suite of state-of-the-art and novel instrumentation systems that help in generating live data that serves as an early-warning system for faults and calamities.

Course Objective:

In this course, students will be introduced to an array of monitoring systems that are used in the field for measuring various phenomenon ranging from deformation, loads, temperature, pressure and velocity. Further, students will also be familiarized to various laboratory testing systems including non-destructive testing that help characterize rocks and other engineering materials.

Course Assessment:

Theory:

	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 contents:

1. **Rockmass Monitoring:** Need of rockmass monitoring; Introduction to Geotechnical instrumentation systems; Design of Geotechnical measurement systems
2. **In-situ stress, deformation and temperature monitoring systems:** Convergence indicators and recorders; Extensometers; Deformation gauges; Bore hole camera and image analysis; Pressure, Load and Stress Cells; Flat Jacks.
3. **Laboratory stress, deformation and temperature monitoring:** Strain gauges and Displacement transducers; Load cells; Data Loggers and data analysis; thermocouples and infra-red temperature sensors; Application of Transducers for measurement of Displacement, Force, Strain, Pressure, Flow, Temperature and other non-electrical quantities
4. **Seismic and micro-seismic monitoring systems:** Blasting and blast performance instrumentation, Image and Data analysis
5. **Mine Environment Monitoring:** Monitoring of mine gases, temperature, humidity and air velocity; Continuous & live monitoring methods; Data transmission and Tracking; Leaky feeder and Fibre optic based systems.
6. **Non destructive testing & methods:** Principle and methodology of different NDT methods; Ultrasonic Testing, Radiographic, magnetic and Optical Testing methods; Measurement of hardness – fracture toughness; Acoustic Emission; Analytical Techniques: XRD, SEM, DTA

Reference Texts:

1. Hencher, S., 2015. Practical rock mechanics. CRC Press.
2. Jeremic, M.L., 2020. Strata mechanics in coal mining. CRC Press.
3. Anderson, G.L. and Hadden, D.M., 1999. The gas monitoring handbook. Avocet Press Inc.
4. Morris, A.S., 1993. Principles of measurement and instrumentation. Prentice Hall.

Course Outcomes:

The course will familiarize the student to:

1. State-of-the-art instrumentation systems for monitoring rockmass with respect to underground and surface mines
2. State-of-the-art instrumentation systems for laboratory rock characterisation
3. Instrumentation techniques available to monitor the mine environment with regards to safety and environment control
4. Non-destructive techniques to measure various features with rocks and other materials used in mining operation.

Course Name: Reliability Engineering
Course Code: MNL459
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

To make student conversant with concepts of reliability engineering and its applications.

Course Assessment:

Theory:

	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: definition of reliability, the relationship between reliability, quality, and performance. Reliability as a Relative Measure, Reliability and the System Life Cycle, The consequences of having an unreliable product, that is, a product that fails supplier–customer reliability objectives and responsibilities, various stakeholders in product reliability.

Basic concepts of Reliability: Introduction, reliability and quality, failure and failure modes, causes of failure and reliability, maintainability and availability, history of reliability, reliability literature. Hazard Rate, Percentiles Product Life, terms and definitions in reliability, application areas

Reliability mathematics: Introduction, random experiment, probability, random variables, distribution functions, Discrete distributions: Binomial Distribution, Poisson Distribution and Other Discrete distributions; Continuous distributions: Weibull, Exponential, The Normal (Gaussian) Distribution, The Lognormal Distribution, Gamma Distribution, Probability Plots

System Reliability: Reliability Block Diagram - Series, Parallel & combined series parallel configurations; redundant-active and passive types, Failure Mode, Effects and Criticality Analysis (FMECA), Failure Reporting, Analysis and Corrective Action System (FRACAS), Fault Tree Analysis (FTA), System state analysis-Markov Model, Availability, Downtime.

Reliability Testing: Failures and types of failures; Intrinsic & extrinsic failures; Failure cascade; Failure mode; Failure rate, MTTF, MTBF, Accelerated life testing (ALT) - Qualitative ALT, Quantitative ALT & its types, AF, Samples

Reliability Applications: Reliability centered maintenance, Equipment reliability, system reliability, Reliability Management, Reliability culture, and human factors in reliability, reliability software applications

Text Books:

1. Kailash C. Kapur, Michael Pecht, Reliability Engineering, John Wiley & Sons, 2014
2. Reliability and Maintainability Engineering – Charles E. Ebeling, Tata McGraw Hill Edition.
3. Maintenance Engineering – Er Sushilkumar Srivastava, S Chand Publications 1998

Reference Books

1. Reliability Engineering- L. S. Srinath affiliated East- west Press Private Limited
2. Reliability Engineering – E. Balagurusamy Tata McGraw Hill Publications

Course Outcomes:

At the end of this course the student will demonstrate ability to

1. Understand concepts and terminology in reliability.
2. Understand the mathematics of reliability.
3. Understand the applications of constant failure model and estimation of system reliability.
4. Understand failure analysis and construct fault tree diagram
5. Applications of reliability engineering

Course Name: Mining Economics
Course Code: MNL406
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

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

Course Assessment:

Theory:

	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: 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

Course Name: Rock Excavation Engineering
Course Code: MNL422
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

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

Course Assessment:

Theory:

	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: 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

Course Name: Advanced UG Metal Mining & Design
Course Code: MNL434
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

To give knowledge of advanced techniques of underground metal mining and its design

Course Assessment:

Theory:

	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:

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

Reference Books:

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 (SME York, 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

Course Name: Advanced Surface Mining & Design
Course Code: MNL433
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

To make students conversant advanced aspects of surface mining. To develop skill in planning and design of surface mines

Course Assessment:

Theory:

	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:

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, Crosplit 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
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.

Course Name: Geostatistics
Course Code: MNL423
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

Students are made conversant with basic statistical and geostatistical methods. Application of these tools are made with reference to mineral grade calculations

Course Assessment:

Theory:

	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:

Classical statistics, random distributions, normal and lognormal theory. Concept of geostatistics and its application to mining

Spatial statistics, Covariogram, definitions, estimation, fitting

Variogram, semi-variogram, definition, estimation, experimental variogram, fitting; application, uses of variogram.

Various model of variograms: random model, spherical model, exponential model, gaussian model,

Linear model, logarithmic or de Wijsian model, parabolic model

Nugget effect, its implication on model, anisotropies

Numerical calculation of variogram, and graphs for one, two and three dimensions

Krigging method for grade and reserve estimation.

Krigging estimator, krigging error, point krigging, block krigging, optimal valuation

Use for geostatistical software for various application

Case studies of grade estimation

Books:

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

Course Outcomes:

The students will be able to understand the

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

Course Name: Novel Mining Methods
Course Code: MNL431
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

Students are made conversant with non-conventional mining methods

Course Assessment:

Theory:

	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:

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

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

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

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

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

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

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

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

Books:

1. Underground Mining Methods by SME publication Hustrilid
2. Introductory Mining Engineering: Hartman 2nd Edition
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 gassification
2. Technology for hydraulic mining and deep sea mining.
3. Latest Mining methods such as Nuclear fragmentation, Mining in space dimensional mining etc.

Course Name: Mine Automation
Course Code: MNL432
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

To make students conversant with aspects of automation and control applied to mines

Course Assessment:

Theory:

	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:

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 systemsData 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.

Course Name: Drilling Technology
Course Code: MNL461
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Need of the Course:

Mining operations require drilling at every stage from exploration to production and safety. Therefore, it is imperative to study drilling along with its various features and characteristics.

Course Objective:

In this course, the student will be introduced to state-of-the-art technologies used in exploratory, production and rock breakage drilling operations. Further, performance parameters of drilling such as drillability, drill-bit wear and bit consumption will also be introduced to enable students to choose an appropriate drilling system based on the existing geomining scenario.

Course Assessment:

Theory:

	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 contents:

1. Rock Drilling methods: Introduction; Types of drilling operations used in rock breakage; Applicability and limitations of different drilling methods vis-à-vis rock types and hole diameter.
2. Percussive & Rotary percussive drilling: Introduction; Fundamentals of percussive & rotary percussive drilling; Top hammer drilling; Down the hole hammer drilling; Advance systems; Drilling parameters and their estimation.
3. Rotary drilling: Introduction; Fundamentals of rotary drilling; Drilling parameters and their estimation. Special drilling methods: Introduction; Jet piercing; Water-jet drilling.
4. Exploration Drilling: Boring for exploration; Various types of exploratory drills and their applicability – Auger, Cable-tool, Odex, Core Drills; Core recovery: single and double tube core barrels, wire line core barrel;
5. Production Drilling: Blasthole drills – types, classification, applicability and limitations; Underground Drills - types, classification, applicability and limitations; Mechanics of drilling; Performance parameters; Drilling cost; Selection of drilling systems, drilling errors, organization of drilling.
6. Characteristics of Drilling: Mechanics of drilling; Factors influencing drilling performance; Economics of drilling; Rate of drilling and Drillability; Wear in rock drilling tools: tool material; factors influencing wear; wear mechanism and methods of estimating/predicting tool wear.

Reference Texts:

1. Bourgoyne, A.T., Millheim, K.K., Chenevert, M.E. and Young, F.S., 1986. Applied drilling engineering (Vol. 2, p. 514). Richardson: Society of Petroleum Engineers.
2. Mitchell, R. and Miska, S., 2011. Fundamentals of drilling engineering. Society of Petroleum Engineers.
3. Turner, A. 2016. Drilling Technology Handbook
4. Tatiya, R.R., 2005. Surface and underground excavations: methods, techniques and equipment. CRC Press.

Course Outcomes:

The course will familiarize the student to:

1. The various types of drilling systems in mining operation such as exploration, rock breakage, production and support.
2. The state-of-the-art technologies of drilling used in mining industry.
3. Intricacies of exploratory and production drilling systems
4. Methods of analysing a drilling operation from the perspective of mechanics, performance and economics

Course Name: Mine Waste Management
Course Code: MNL462
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

In this course, the student will be introduced to state-of-the-art technologies used in handling, safe disposal and use of different types of waste arising out of mining operations.

Course Assessment:

Theory:

	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 contents:

Types of Mine Waste

ROCK OR SOLID MINE WASTE

Types of solid waste: Overburden rock, Gangue Material and Mill Tailings

Construction of internal and external dumps, design of dumps, mitigation of environmental problems

Disposal of Gangue, construction and design of stock piles, Environmental issues of gangue materials and their management

Tailing Management: design and construction of tailing dams, Environmental issues of tailing and their management

LIQUID MINE WASTE

Mine Water

Mine water management: Sump design, treatment of water, disposal of mine water, Environmental issues of mine water and their management

Sludge

Mine sludge management: Handling and Disposal of mine sludge, Environmental issues of mine sludge and their management

MINE WASTE RECYCLE AND UTILISATION

Recycling and utilisation of Mine waste, Environmental issues recycling and utilisation and their management

ENVIRONMENTAL ASPECTS OF WASTE MANAGEMENT

Books:

1. Environmental Impact of Mining; C G Down & J Stocks, Applied Science Publishers Ltd, London
2. Environmental Aspects of Mining Areas, Bulletin No.27, Indian Bureau of Mines, Nagpur
3. <https://eddyump.com/education/mine-waste-disposal-methods/>
4. <http://canadianminingmagazine.com/understanding-mining-waste-management-and-disposal-methods/>

Course Outcomes:

Student will have knowledge of Mine Waste Management and Waste utilisation

Course Name: Industrial Safety Audit and Training
Course Code: MNL463
Course Type: Departmental Elective / MINOR 5
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

To provide the knowledge about safety monitoring and control methods. To train the student with safety audit methods.

Course Assessment:

Theory:

	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 contents:

Monitoring for Safety, Occupational Health and Safety Management System, ILO and EPA Standards.
Safety measurement and control: Frequency rate, incidence rate, severity rate, mean duration rate, duration rate; monitoring accident rates
Safety Audit: Objectives, Internal and external audit; third party audit.
Audit procedures, duration, report preparation,
Safety inspection, safety organisation for supervision
Accident Investigation and Reporting: safety record management
Accident report preparation
Industrial training
Element of training cycle, Assessment of needs. Techniques of training, design and development of training programs.
Training methods and strategies types of training. Induction training, operators training, refreshers training, on job, off-job training, modern methods of training, training simulators, virtual training.
Evaluation and review of training programs

Books:

1. Environmental Health and Safety Audits by Lawrence B. Cahill
2. Guidelines for Auditing Process Safety Management Systems by John Wiley

Course Outcomes:

Student can apply safety audit techniques for the industry
Student can understand the significance of training in industrial workers for safety

Course Name: Project Management & Evaluation
Course Code: MNL464
Course Type: Departmental Elective
Credits (L-T-P): 3-0-0
Pre-Requisite:

Course Objective:

This course will enable students to evaluate and manage projects of various scales using engineering decision.

Course Assessment:

Theory:

	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 contents:

Introduction: Concepts of Project Management, Project Management Life Cycle, unique attributes of a project, importance of project management, difference between project, program and portfolio

Establishing the Project: Project Planning, Constraints of a project, Project Priority Matrix, Scope, Time, Cost and Performance Goals of project, Project Scope Management, COS, POS, RBS and WBS.

Project implementation phase and its sub stages, different project implementations approaches.

Project Human Resource Management: Organizing Human Resources and Contracting, Organizing systems and Procedures for Project implementation, unique requirements of project organisation,

Project Control: Project Estimation techniques, characteristics of a project estimate, Project Direction, Coordination and Control, Brief about Project Quality and Risk Management.

Project Evaluation: Benefits and Limitations of Project evaluation, Methods of Project evaluation. Project Management Performance. Management Information System, Project Evaluation Tools. Project audit report, Components of project monitoring systems

Text Books:

1. Project Management: David Cleland, Lewis Ireland, Tata McGraw Hill
2. Guide to Project Management: Harold Kerzner, Tata McGraw Hill.
3. Project Management: The Managerial Process, Erik W. Larson, Clifford F. Gray,
4. Project Management: Jack Gido, James Clements, Cengage Learning

Reference Books:

Project Management Body of Knowledge, Book by Project Management Institute

Course Outcomes:

1. Students will be able to understand project and its properties.
2. Students will be able to plan & schedule the project activities
3. Students will demonstrate the ability to understand the use of human resources.
4. Students will be able understand project estimation and control processes
5. Students will be able to evaluate project