DEPARTMENT OF MINING ENGINEERING

Revised NEP Course Book for

Bachelor of Technology (B.Tech) in Mining Engineering

For
Students admitted from 2023 onwards.

VISVESVARAYA NATIONAL INSTITUTE OF TECHNOLOGY,

NAGPUR – 440 010

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 was established in the year 1982-83. The Department offers the undergraduate degree of Bachelor of Technology (B.Tech) in Mining Engineering. The course has been accredited by National Board of Accreditation (NBA) earlier in 1996, 2001, 2008 and 2016 and was granted Grade "A". Recently in 2022, both the UG and PG courses have been accredited by NBA for 3 years up to 2025. In its 41 years of existence 37 UG batches have passed out with over 700 students graduating. The performance of present and past students is comparable with that of international standards. The undergraduate degree is a 4-year course conducted on a semester pattern. The degree is offered if a student fulfils a minimum credit requirement of 170. The course is regularly upgraded, and presently relative grading is in operation. Female candidates have been permitted get admitted in B.Tech (Mining). The Department also offers a postgraduate degree of Master of Technology (M.Tech) in Excavation Engineering and doctoral degree (PhD). 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 m^2 area. The Department has implemented several 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. Department enjoys an excellent rapport with the industry and offers variety of testing and consultancy services to them. Faculty members of the Department 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 had been revised initially in 2022. Further guidelines on the inclusion of Internship, have led to revision of the NEP syllabus as presented herein.

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 counselling 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, analyse 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.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

At the end of the program B. Tech Mining Engineering,

1. Students will possess specialized knowledge and skills to be industry-ready personnel for the further development of mining industry.
2. Students will acquire technical & managerial skills and know-how of modern design and planning tools to address present and future complex mining problems.
3. Students will develop capacity by handling live mining industry case studies through the industrial oriented projects.
4. Students will develop the perspective towards eco-friendly, sustainable, and safe mining to address the economical & social issues.

LIST OF FACULTY MEMBERS

SN	Name	Area of Specialization
1	**Dr. R. R. Yerpude**	Mine Planning, System Engineering, Mine Safety Engineering, Computer applications, Mine Economics
2	**Dr. N. R. Thote**	Rock Blasting and Rock Mechanics, Opencast Mining, Mine Environment
3	**Dr. A. K. Agarwal**	Mine system Engineering, Slope and dump design, Water pollution
4	**Dr. R. D. Lokhande**	Ground control, Design of underground mine working, Slope and dump design, Instrumentation & Monitoring, Subsidence
5	**Dr. S. Panchal**	Rock Mechanics, Underground Coal Mining, Mine Back filling, Mine Surveying
6	**Dr. N. N. Sirdesai**	Geomechanics, Novel Mining Methods, Tunnelling
7	**Dr. A. A. Kher**	Safety in mines, Mine ventilation Planning
8	**Dr. S. Mohanto**	Geomechanics, Underground Metal Mining, Blasting, Soft Computing
9	**Dr. N. V. Bhagade**	Excavation Engineering, Blast Dynamics. Fragmentation Enhancement, Excavation Damage Zone, Surface Mining

CREDIT SYSTEM AT VNIT

Education at the Institute is organized around the semester-based credit system of study. The prominent features of the credit system are a process of continuous evaluation of a student's performance / progress and flexibility to allow a student to progress at an optimum pace suited to his/her ability or convenience, subject to fulfilling minimum requirements for continuation. A student's performance/progress is measured by the number of credits he/she has earned, i.e. completed satisfactorily. Based on the course credits and grades obtained by the student, grade point average is calculated. A minimum number of credits and a minimum grade point average must be acquired by a student in order to qualify for the degree.

COURSE CREDITS ASSIGNMENT

Each course, except a few special courses, has certain number of credits assigned to it depending on lecture, tutorial, and laboratory contact hours in a week.

For Lectures and Tutorials: One lecture hour per week per semester is assigned one credit and

For Practical/ Laboratory/ Studio: One hour per week per semester is assigned half credit.

Example: Course XXXXXX with (3-0-2) as (L-T-P) structure, i.e., 3 hr. Lectures + 0 hr. Tutorial + 2 hr. Practical per week, will have $(3 \times 1) + (0 \times 1) + (2 \times 0.5) = 4$ credits.

GRADING SYSTEM

The grading reflects a student's own proficiency in the course. While relative standing of the student is clearly indicated by his/her grades, the process of awarding grades is based on fitting performance of the class to some statistical distribution. The course coordinator and associated faculty members for a course formulate appropriate procedure to award grades. These grades are reflective of the student's performance vis-à-vis instructor's expectation. If a student is declared pass in a subject, then he/she gets the credits associated with that subject.

For example, in (3-0-2) type of subjects, in order to pass the subject, a student will have to score marks above threshold set by the faculty in theory part and laboratory part separately. If student scores less than the threshold in any part, then he/she will be given FF grade with one mark less than the passing grade cut-off. Student will have to appear for both theory and practical exam again if failed.

Depending on marks scored in a subject, a student is given a Grade. Each grade has got certain grade points as follows:

Grade	**Grade points**	**Description**
AA	10	Outstanding
AB	9	Excellent
BB	8	Very good
BC	7	Good
CC	6	Average
CD	5	Below average
DD	4	Marginal (Pass Grade)
FF	0	Poor (Fail) /Unsatisfactory / Absence from end-semester exam
NP	-	Audit pass
NF	-	Audit fail
SS	-	Satisfactory performance in zero credit core course
ZZ	-	Unsatisfactory performance in zero credit core course
W	-	Insufficient attendance

PERFORMANCE EVALUATION

The performance of a student is evaluated in terms of two indices, viz, the Semester Grade Point Average (SGPA) which is the Grade Point Average for a semester and Cumulative Grade Point Average (CGPA) which is the Grade Point Average for all the completed semesters at any point in time. CGPA is rounded up to second decimal.

The Earned Credits (ECR) are defined as the sum of course credits for courses in which students have been awarded grades between AA to DD. Grades obtained in the audit courses are not counted for computation of grade point average.

Earned Grade Points in a semester (EGP) = $\sum(\textbf{Course credits} \times \textbf{Grade point})$ for courses in which AA-DD grade has been obtained.

Semester Grade Point Average (SGPA) = $\sum \frac{\textbf{EGP}}{\textbf{Course } \boldsymbol{Credits}}$ for courses registered in a semester in which AA-FF grades are awarded.

Cumulative Grade Point Average (CGPA) = $\sum \frac{\textbf{EGP}}{\textbf{Course } \boldsymbol{Credits}}$ for courses passed in all completed semesters in which AA- DD grades are awarded.

ATTENDANCE RULES

1. All students must attend every class, and 100% attendance is expected from the students. However, in consideration of the constraints/ unavoidable circumstances, the attendance can be relaxed by course coordinator only to the extent of not more than 25%.
2. Every student must attend minimum of 75% of the classes held for that course.
3. A student with less than 75% attendance in a course during the semester will be awarded **W Grade**. Such a student will not be eligible to appear for the end semester and re-examination of that course. Even if such a student happens to appear for these examinations, then, answer books of such students will not be evaluated.
4. A student with **W grade** is not eligible to appear for end semester examination, re-examination & summer term.

Overall Credits Requirement for Award of B.Tech in Mining Engineering

Students admitted from 2023 onwards.

Total Credit Requirement: 170

Courses to Register in First Year B.Tech

I Semester					
S. No	**Code**	**Course Title/ Name**	**Type**	**L-T-P**	**Credits**
Core Courses					
		Please refer Scheme of Basic Sciences	–	–	–

II Semester					
S. No	**Code**	**Course Title/ Name**	**Type**	**L-T-P**	**Credits**
Core Courses					
		Please refer Scheme of Basic Sciences	–	–	–

Semester-wise credit structure

1. For Students without Internship

SN	Type		Semester								Total
			I	II	III	IV	V	VI	VII	VIII	
1	DC	L & P- Type	43		13	17	18	22	-	-	70
		D-Type			-	-	-	03	03	03	09
2	Minimum Credits to be Earned from DE/OC/HM				06	03	07	03	13	16	48
Minimum Credits to be Earned Per Semester			43		19	20	25	28	16	19	170

2. For Students with One Semester (7th Semester) Internship**

SN	Type		Semester								Total
			I	II	III	IV	V	VI	VII	VIII	
1	DC	L & P- Type	43		13	17	18	22	-	-	70
		D-Type			-	-	-	03	03	03	09
2	Minimum Credits to be Earned from DE/OC/HM				06	07	07	03	-	13	36
3	Additional Credits Earned Through	DE Course	-		03	03	-	-	-	-	06
		Internship			-	-	-	-	06	-	06
Minimum Credits to be Earned Per Semester			43		22	27	25	28	09	16	170

3. For Students with One Semester (8th Semester) Internship**

SN	Type		Semester								Total
			I	II	III	IV	V	VI	VII	VIII	
1	DC	L & P- Type	43		13	17	18	22	-	-	70
		D-Type			-	-	-	03	03	03	09
2	Minimum Credits to be Earned from DE/OC/HM				06	07	07	03	13	-	36
3	Additional Credits Earned Through	DE Course	-		03	03	-	-	-	-	06
		Internship			-	-	-	-	-	06	06
Minimum Credits to be Earned Per Semester			43		22	27	25	28	16	09	170

4. For Students with One Year (7th and 8th Semester) Internship**

SN	Type		Semester								Total
			I	II	III	IV	V	VI	VII	VIII	
1	DC	L & P- Type	43		13	17	18	22	-	-	70
		D-Type			-	-	-	03	03	03	09
2	Minimum Credits to be Earned from DE/OC/HM				06	07	07	03	-	-	23
3	Additional Credits Earned Through	DE Course	-		03	03	04	03	-	-	13
		Internship			-	-	-	-	06	06	12
Minimum Credits to be Earned Per Semester			43		22	27	29	31	09	09	170

** Students opting for semester-long or year-long internship will be offered MOOC courses to complete their credit requirement (if required). List of MOOC courses will be approved by the competent authority before the start of semester. A student can earn a **maximum of 6 credits** from the MOOC courses and these credits will be counted as DE.

III Semester			
Course Code	**Course Name**	**Structure**	**Credits**
Core Courses			
MNL209	Principle and Concepts of Mining Technology	3-1-0	**4**
MNL210	Mine Transportation Machinery	3-1-0	**4**
MNP210	Mine Transportation Machinery	0-0-2	**1**
CEL284	Mining Geology	3-0-0	**3**
CEP284	Mining Geology	0-0-2	**1**
Elective Basket for III Semester			
MAL404	Probability and Statistics	3-0-0	**3**
MML291	Mineral Processing	3-0-0	**3**
MNL461	Drilling Technology	3-0-0	**3**
MNL453	Introductory Safety Engineering ***(Minor 1)*** *	3-1-0	**4**
-	OC/HM	3-0-0	**3**

- ✓ **Students must undergo one (1) mine visit (Study Tour) during 3rd Semester.**
- * **Departmental students can choose this course as a Departmental Elective (DE).**

IV Semester			
Course Code	**Course Name**	**Structure**	**Credits**
Core Courses			
MNL212	Underground Coal Mining Methods	3-1-0	**4**
MNL213	Surface Mining Methods	3-1-0	**4**
MNL214	Underground Metalliferous Mining Methods	3-1-0	**4**
MNL202	Mine Surveying	3-1-0	**4**
MNP202	Mine Surveying	0-0-2	**1**
Elective Basket for IV Semester			
MNL428	Mine Management Information System	3-1-0	**4**
CEL384	Advanced Mining Geology	3-0-0	**3**
MNL454	Risk Assessment and Management ***(Minor 2)*** *	3-1-0	**4**
-	OC/HM	3-0-0	**3**

- ✓ **Students must undergo one (1) month of training in mines during summer break after the 4th semester.**
- * **Departmental students can choose this course as a Departmental Elective (DE).**

V Semester			
Course Code	**Course Name**	**Structure**	**Credits**
Core Courses			
MNL205	Mine Ventilation & Climate Engineering	3-1-0	**4**
MNP205	Mine Ventilation & Climate Engineering	0-0-2	**1**
MNL211	Rock Mechanics	3-1-0	**4**
MNP211	Rock Mechanics	0-0-2	**1**
MNL315	Mine Excavation Machinery	3-1-0	**4**
MNL429	Blasting Technology for Mining & Construction	3-1-0	**4**
Elective Basket for V Semester			
MNL434	Advanced UG Metal Mining & Design	3-1-0	**4**
MNL425	Mass Production Technology for Underground Coal	3-1-0	**4**
MNL426	Underground Space Technology	3-1-0	**4**
MNL455	Ergonomics and Training in Safety ***(Minor 3)*** *	3-1-0	**4**
	OC/HM	3-0-0	**3**

- ✓ **Students must undergo one (1) mine visit (Study Tour) during 5th Semester.**
- * **Departmental students can choose this course as a Departmental Elective (DE).**

VI Semester			
Course Code	**Course Name**	**Structure**	**Credits**
Core Courses			
MNL322	Ground Control and Instrumentation	3-1-0	**4**
MNP322	Ground Control and Instrumentation	0-0-2	**1**
MNL316	Mine Hazards and Pollution	3-1-0	**4**
MNP316	Mine Hazards and Pollution	0-0-2	**1**
MNL401	Mine Legislation and Safety	3-1-0	**4**
MNL404	Mine Planning	3-1-0	**4**
MNP314	Mine Training, Survey Camp and Study Tours	0-0-8	**4**
MND319	Mini Project	0-0-6	**3**
Elective Basket for VI Semester			
MNL320	Advanced Surveying & Remote Sensing	3-1-0	**4**
MNL431	Novel Mining Methods	3-1-0	**4**
MNL423	Geostatistics	3-0-0	**3**
MNL457	Emergency Management and Safety Audit ***(Minor 4)*** *	3-1-0	**4**
	OC/HM	3-0-0	**3**

- ✓ **Students must undergo one (1) mine visit (Study Tour) during 6th Semester.**
- * **Departmental students can choose this course as a Departmental Elective (DE).**

VII Semester			
Course Code	**Course Name**	**Structure**	**Credits**
Core Courses			
MND456	Major Project Phase - 1	0-0-6	**3**
Elective Basket for VII Semester			
MNL421	Mine System Engineering	3-1-0	**4**
MNL402	Surface Mine Environment	3-1-0	**4**
MNL430	Rock Slope Engineering	3-1-0	**4**
MNL432	Mine Automation	3-0-0	**3**
MNL458	Instrumentation & Non-destructive Testing	3-1-0	**4**
MNL459	Reliability Engineering	3-1-0	**4**
MNL406	Mining Economics	3-0-0	**3**
MNL321	Artificial Intelligence and IoT in Mining	3-1-0	**4**
	OC/HM	3-0-0	**3**

VIII Semester			
Course Code	**Course Name**	**Structure**	**Credits**
Core Courses			
MND460	Major Project Phase - 2	0-0-6	**3**
Elective Basket for VIII Semester			
MNL317	Smart & Clean Mining Technologies	3-1-0	**4**
MNL433	Advanced Surface Mining & Design	3-1-0	**4**
MNL462	Mine Waste Management	3-1-0	**4**
MNL464	Project Management and Evaluation	3-1-0	**4**
MNL422	Rock Excavation Engineering	3-1-0	**4**
MNL405	Computer Application in Mining	3-1-0	**4**
MNL403	Mine Management	3-1-0	**4**
	OC/HM	3-0-0	**3**

DETAILS OF MINOR DEGREE

MINOR NAME: **SAFETY ENGINEERING**

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 are addressed within this course.

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

To get an 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	L-T-P	Credits	Semester
1	MNL453	Introductory Safety Engineering	3-1-0	4	3
2	MNL454	Risk Assessment and Management	3-1-0	4	4
3	MNL455	Ergonomics and Training in Safety	3-1-0	4	5
4	MNL457	Emergency Management and Safety Audit	3-1-0	4	6

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): 3-1-0

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

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 Mining: Opening of deposits; mode of entry: adit, shaft, decline, and combined model; their applicability and comparison.
Drifting: Small and medium size tunnelling and drifting; drivage work in varying ground conditions using conventional methods – drilling, blasting, mucking, transportation, supports, services and cycle of operations
Mechanical methods of drivage of roadways and tunnels
Shaft sinking: Site selection, shaft sinking preparatory arrangements, drilling and blasting, mucking, hoisting, ventilation, pumping, lighting, supporting of sides, complete cycle of operations, special methods of sinking to be used in difficult ground conditions, deepening, and widening of shafts, modern techniques of shaft sinking.
Drilling for production of minerals from surface and underground mines, rotary, percussive and rotary-percussive drilling, short and long hole drilling equipment, mechanism of drilling, different types of bits, bit wear, drilling performance
Explosives: types of explosives- their composition and properties.
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 study of different concepts of mining.
2. Various phases of underground and open cast mining.
3. Various operations involved in drifting and shaft sinking.
4. Various types of explosives and its application in mines.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	0	3	3	0	2	0	2	3	0	0	3	3	2	2	1
CO2	2	0	3	2	0	3	0	2	2	0	0	3	2	2	2	1
CO3	3	0	2	3	0	2	0	2	3	0	0	3	3	3	3	1
CO4	3	0	3	2	0	2	0	2	2	0	0	3	2	1	3	1

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

Course Objective:
This course will introduce the student to the state-of-the-art tools available for transportation in mines. Additionally, concepts of material properties such as strength and its enhancement for metals will be briefly 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 contents:
1. **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.
2. **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.
3. **Conveyors:** Type of conveyors; Construction, installation and operation of conveyors; Capacity and power computations; Mobile conveyors and emerging trends in conveyors
4. **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
5. **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
6. **Man-riding Systems:** Types of Man-riding systems; Construction and installation of such systems; Safety devices and case studies.
7. **Other mine transportation solutions:** Railveyor system; Aerial Ropeway; Tube Transportation; Emerging vehicles for bulk, personnel and material transportation in mines.

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

Course Outcomes:
A student will be able to:
1. Understand the working and applicability of different mine transport system.
2. Design the capacity of different mine transport system.
3. Select an appropriate mine transportation system based on existing geo-mining scenario.
4. Understand the safety features and limitations of various mine transport systems.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	0	0	3	3	0	2	3	3	2	2	3	1	2	2	2
CO2	2	0	0	2	2	0	2	2	2	2	3	2	2	3	2	1
CO3	3	0	0	3	2	0	3	3	3	3	2	3	3	3	3	1
CO4	1	0	0	1	3	0	2	2	3	2	3	2	2	1	3	2

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

Course Objective:
Students will be introduced to concepts of geology in general and mining in particular.

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, Isostacy, 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.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	2	3	1	2	2	2	0	0	3	3	2	2	1
CO2	2	3	3	3	2	2	2	2	3	0	0	3	2	2	2	2
CO3	3	3	2	2	2	3	3	2	1	0	0	3	3	3	3	1
CO4	3	3	3	2	3	2	2	2	2	0	0	3	2	1	3	2

Course Name: Underground Coal Mining Methods
Course Code: MNL212
Course Type: Departmental Core
Credits (L-T-P): 3-1-0

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 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:
1. To know coal grading system, coal mining conditions and selection methods for coal mining in India.
2. To learn various operations involved in development of Bord and Pillar mining.
3. To learn various operations involved in depillaring of Bord and Pillar mining and Longwall mining.
4. To understand special coal mining methods.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	0	2	0	3	2	3	3	2	2	3
CO2	2	2	3	2	2	2	0	2	0	3	3	3	2	2	2	2
CO3	3	3	2	3	2	3	0	2	0	2	2	3	3	3	3	3
CO4	2	1	3	3	2	2	0	2	0	1	2	3	2	2	2	1

Course Name: Surface Mining Methods
Course Code: MNL213
Course Type: Departmental Core
Credits (L-T-P): 3-1-0

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 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, advantages, and disadvantages of Surface mining,
2. Elements of surface mining and aspects related to mine geometry. Opening of deposits under various conditions and haul road design
3. 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.
4. Conversion of underground developed to surface mines. Mine Dumps and Reclamation and with real life problems.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	3	3	0	2	0	3	2	2	3	2	2	3
CO2	2	3	3	3	2	2	0	2	0	3	3	3	2	2	2	2
CO3	3	3	2	3	2	3	0	3	0	2	2	3	3	3	3	2
CO4	3	1	3	2	3	3	0	2	0	3	2	2	3	2	2	1

Course Name: Underground Metalliferous Mining Methods
Course Code: MNL214
Course Type: Departmental Core
Credits (L-T-P): 3-1-0

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 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 -groundbreaking, mucking, ventilation and support; modern methods of raising - Alimak and long-hole 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. Metalliferrious mining of ores by Borosov et.al.
4. SME Mining Engineering Handbook, Edited by H.L.Hartman SME publication

Course Outcomes:
Students will learn be able to understand the:
1. Theories on the formation of metallic ore deposits, their shapes, and spatial and economic distribution.
2. The terminologies related to underground metal mining and the choice of developmental openings.
3. Parameters required for the selection of an optimum mining method.
4. Various methods used for mining different kinds of underground metalliferous deposits.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	0	2	0	3	2	3	3	2	2	1
CO2	2	2	3	2	2	2	0	2	0	3	3	3	2	2	2	3
CO3	3	3	2	3	2	3	0	2	0	2	2	3	3	3	3	1
CO4	2	1	3	2	2	2	0	2	0	3	3	3	2	2	2	2

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

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

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

Course Outcomes:
The students will be able to understand the
1. Basic terminology of Surveying.
2. Various types of levelling.
3. Various types of terrestrial field surveying and curve setting.
4. Correlation survey, stope survey and development survey.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	3	0	0	2	2	3	2	3	3	2	2	1
CO2	2	1	3	3	2	0	0	2	3	3	3	1	2	2	2	3
CO3	3	3	2	3	2	0	0	2	3	2	2	3	3	3	3	1
CO4	2	3	3	1	2	0	0	2	3	3	3	2	2	2	2	2

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

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 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.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	3	3	3	2	2	0	0	3	2	2	2	3	2
CO2	2	3	2	2	2	3	2	2	0	0	1	2	2	2	2	1
CO3	3	2	3	3	2	2	3	3	0	0	2	1	2	3	2	3
CO4	3	2	2	3	1	1	3	3	0	0	2	3	3	1	2	2
CO5	2	2	3	3	2	3	2	3	0	0	3	2	3	3	3	1

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

Course Objective:
Mining structures are made in the rock hence rock characterization and support design become 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 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: In situ 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 micro-seismic 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.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	2	3	0	0	2	2	3	2	2	3	2	2	1
CO2	2	1	3	3	2	0	0	2	3	3	3	3	1	2	2	2
CO3	3	2	2	2	2	0	0	1	2	2	2	2	3	3	3	1
CO4	2	3	3	2	3	0	0	3	3	2	3	3	2	1	3	3

Course Name: Mine Excavation Machinery
Course Code: MNL315
Course Type: Departmental Core
Credits (L-T-P): 3-1-0

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 Content:
Coal cutting machines: shearers, coal ploughs, lump breakers, road headers, TBMs, raise and shaft borers, continuous miners, highwall 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 used in underground and open cast excavations.
2. Understand the necessity, construction, applications, and selection of various loading machines used in underground and open cast excavations.
3. Understand the necessity, construction, applications, and selection of various drilling machines in underground & surface excavation along with.
4. Understand the necessity, construction, applications, and selection of various ancillary equipment and pumps used in underground and open cast excavations.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	0	0	3	3	0	2	2	3	2	2	2	1	2	2	1
CO2	2	0	0	2	2	0	2	2	2	2	3	3	2	2	2	2
CO3	3	0	0	3	1	0	3	3	3	3	2	3	3	3	3	1
CO4	1	0	0	2	3	0	2	2	3	2	3	1	2	1	3	1

Course Name: Blasting Technology for Mining & Construction
Course Code: MNL429
Course Type: Departmental Core
Credits (L-T-P): 3-1-0

Course Objective:
The students are made conversant with rock fragmentation by using explosives. They will learn blast design in surface and underground mines

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 Carcedo Hustrulid.
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 know various types, characteristics, testing and legal aspects of explosives.
2. To understand blasting accessories, initiation system, drilling pattern and blast design.
3. To learn rock breakage mechanism, blast evaluation techniques and blasting software.
4. To understand the environmental effects of blasting, controlled blasting and special blasting techniques.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	1	1	3	2	3	2	3	2	2	2	2	3
CO2	1	3	2	1	2	3	3	3	3	3	3	2	2	2	3	2
CO3	2	1	1	1	2	3	1	2	3	2	3	2	3	3	3	3
CO4	2	2	2	2	2	2	2	2	3	3	3	2	2	2	1	2

Course Name: Ground Control and Instrumentation
Course Code: MNL322
Course Type: Departmental Core
Credits (L-T-P): 3-1-2

Course Objective:
To makes students conversant with aspects of mine support application and design. To make student conversant with slope stability problems

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.
Insitu 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 rockbrusts; 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.
Instrumentation: Study of various instruments related to convergence, stress and load monitoring.

Books:
1. Peng S S, Ground Control in Mines, John Wiely 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. Understand the concepts of different rock-mass classifications and their application in support design.
2. Predict and control the subsidence, rock-burst and coal-bumps.
3. Understand the concepts of stability of slopes.
4. Understand the concepts of instrumentation and monitoring of underground behaviour.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	0	0	2	0	3	2	3	3	2	2	1
CO2	2	3	3	2	2	0	0	2	0	3	3	3	2	2	2	1
CO3	3	3	2	3	2	0	0	2	0	2	2	3	3	3	3	1
CO4	3	3	3	3	3	0	0	2	0	2	3	3	2	1	3	1

Course Name: Mine Hazards and Pollution
Course Code: MNL316
Course Type: Departmental Core
Credits (L-T-P): 3-1-2

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 detail 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 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- 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 mines
Airborne respirable dust in underground mines - generation, dispersion, measurement, and control.; classification, physiological effects, dust measurement, sampling of air-bone 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.Ramlu, 1991
2. Mine Illumination by Trotller.
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 analysing complex engineering problems associated with hazards.
4. To be competent in designing components and processes dealing with hazards.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	0	3	2	2	2	0	3	2	0	3	2	2	1
CO2	2	3	3	0	2	1	2	2	0	3	3	0	2	2	2	1
CO3	3	3	2	0	2	3	3	2	0	2	2	0	3	3	3	1
CO4	3	3	3	0	3	1	2	2	0	2	3	0	2	1	3	1

Course Name: Mine Legislation and Safety
Course Code: MNL401
Course Type: Departmental Core
Credits (L-T-P): 3-1-0

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

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.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	0	2	0	0	3	2	3	0	0	0	0	2	2	2	2
CO2	1	0	3	0	0	3	3	3	0	0	0	0	3	3	3	2
CO3	2	0	2	0	0	2	2	2	0	0	0	0	2	2	2	3
CO4	3	0	3	0	0	3	3	2	0	0	0	0	3	3	3	3

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

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 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.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	2	2	3	3	2	3	3	2	2	1
CO2	2	3	3	2	2	2	2	2	2	3	3	3	2	2	2	1
CO3	3	3	2	3	2	3	3	2	3	2	2	3	3	3	3	1
CO4	2	3	3	2	2	2	2	2	2	3	3	3	2	3	2	2

Course Name: Mine Training, Survey Camp and Study Tours
Course Code: MNP314
Course Type: Departmental Core
Credits (L-T-P): 0-0-8

Course Objective:
1. Students must undergo one (1) month training in mines during summer break after 4th semester.
2. Students must undertake survey camp to become conversant with practical aspects and integration of several concepts of surveying through field and site work.
3. Students must visit the various mines through study tours undertaken during 3rd, 5th, and 6th semesters.

Course Assessment:
Assessment will be based on the detailed training and tour report, survey camp data log-books, survey camp sheets and viva-voce related to survey camp, training, and visits.

Course Outcomes:
1. To learn the detailed practical applications of various mining concepts.
2. To learn the practical application of various surveying concepts.
3. To learn various basic practical mining concepts.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	0	3	0	0	1	2	3	3	3	2	0	2	2	3	2
CO2	2	0	0	0	3	2	3	3	3	3	3	0	3	1	3	3
CO3	3	0	3	0	0	1	2	3	3	3	2	0	2	2	3	2

Course Name: Mini Project
Course Code: MND319
Course Type: Departmental Core
Credits (L-T-P): 0-0-6

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 Outcomes:
1. To exhibit the knowledge about the methodology to carry out research.
2. To prepare and present research report.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	2	1	2	2	2	2	3	2	2	2	2	3	1
CO2	3	2	2	2	2	3	2	3	2	2	3	2	2	2	2	2

Course Name: Major Project Phase -1
Course Code: MND456
Course Type: Departmental Core
Credits (L-T-P): 0-0-6

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 Outcomes:
1. To identify the area of work and scope of work.
2. To exhibit the knowledge about the methodology to carry out research.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	3	1	2	2	3	2	3	2	2	2	2	3	1
CO2	3	2	3	2	2	3	2	3	2	2	3	3	2	2	2	2

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

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.

Course Outcomes:
1. To execute the methodology by various tools
2. To prepare and present research report.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	3	1	2	2	3	2	3	2	2	2	2	3	1
CO2	3	2	3	2	2	3	2	3	2	2	3	3	2	2	2	2

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

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

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

Course Outcomes:
The students will be able to
1. Understand the working principle and mechanism of Crushing and Grinding Operations
2. Understand the basic principles of separation of minerals by Jigging, Tabling and Heavy media separation
3. Understand froth flotation operation for up gradation of ores/minerals, Electrostatic/Magnetic separation operations

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	0	3	0	2	2	0	3	2	3	3	2	2	1
CO2	2	3	3	2	2	2	2	2	2	0	0	2	2	2	2	1
CO3	3	3	2	3	2	3	3	2	2	0	0	2	3	3	3	1

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

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 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

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	2	3	3	2	2	2	3	2	3	1	2	3	1
CO2	2	2	3	2	2	2	2	2	2	2	3	2	2	2	2	3
CO3	2	3	2	3	2	3	3	2	2	2	3	2	3	3	3	1
CO4	3	2	2	3	3	3	1	2	2	2	3	2	1	3	3	2

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

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 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.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	0	2	3	0	0	2	3	3	2	3	1	2	3	1
CO2	3	2	0	3	3	0	0	2	2	2	3	2	1	3	3	2

Course Name: Mine Management Information System
Course Code: MNL428
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

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

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

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.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	0	2	3	0	0	2	2	3	2	3	3	2	2	1
CO2	2	3	0	3	2	0	0	2	3	3	3	3	2	2	2	2
CO3	3	3	0	2	2	0	0	2	2	2	2	3	3	3	1	3

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

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 there formation. To understand the concept of Remote Sensing & GIS techniques

Course Content:
Principles of Prospecting and Exploration: Geophysical methods; Electrical, Seismic, Magnetic and Radar ethods 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. Influents 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. The prospecting and subsurface exploration methods
5. And generate the sub surface profiles from geological maps and plotting structures.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	3	1	2	2	2	0	0	3	2	2	2	2
CO2	2	3	3	3	2	2	2	2	3	0	0	2	2	2	1	1
CO3	3	3	2	2	2	3	3	2	1	0	0	1	3	3	3	3
CO4	2	2	2	2	3	3	2	3	2	0	0	2	2	3	2	1
CO5	1	3	2	1	2	2	3	1	3	0	0	3	3	2	1	2

Course Name: Risk Assessment and Management
Course Code: MNL454
Course Type: Departmental Elective / MINOR 2
Credits (L-T-P): 3-1-0

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

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.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	0	2	3	0	0	2	3	3	2	3	1	2	3	2
CO2	2	2	0	3	2	0	0	2	2	2	3	2	3	3	3	1

Course Name: Advanced UG Metal Mining & Design
Course Code: MNL434
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

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

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,
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.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	0	2	0	3	2	3	3	2	2	1
CO2	2	3	3	2	2	2	0	2	0	3	3	3	2	2	2	1
CO3	3	3	2	3	2	3	0	2	0	2	2	3	3	3	3	1

Course Name: Mass Production Technology for Underground Coal
Course Code: MNL425
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

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 Content:
Status of coal mining in India and abroad, Need for mass production technology for Indian coal.
Continuous Mining Technique: applicability, design, equipment required and their selection, cutting mechanism, rock tool interaction, cutting capacity, cutting performance, operational and technical parameters, cycle of operation, various layout, panel development, pillar extraction methods, design of pillars, strata control and monitoring, support system, cut-out distance, case studies, shortwall mining.
Longwall Mining Technique: applicability, design of panel, face layouts, gateroadway development, Shearer: sumping and cutting methods, rock tool interaction, design of cutting drums, performance, power requirement, haulage speed, cutting capacity, drum loading capacity and efficiency, carrying capacity of AFC, design of chain pillar and barrier pillar, strata mechanics, ground control, design and performance of shield power supports, cycle of operation, ventilation pattern, case studies, thick seam mining.
Filling of goaf: filling material and their properties, methods of filling, filling arrangement, preparation, transportation and placement of fill material.

Books:
1. SME Mining Engineers' Handbook, W A Hustrulid, SME, USA
2. Underground Mining Method Handbook, W A Hustrulid, SME, USA
3. Longwall Mining, S.S. Peng, John Wiley
4. Coal Mine Ground Control, S.S. Peng, John Wiley
5. Advances in Coal Mine Ground Control, S.S. Peng, Woodhead Publishing

Course Outcomes:
1. To understand basics and designing of continuous mining technology.
2. To get detailed knowledge of operations involved in development and depillaring by continuous miner.
3. To learn basics and designing of longwall mining technology.
4. To get in-depth knowledge of operations involved in development and coal extraction in longwall mining.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	3	2	3	3	0	2	0	3	2	3	3	2	2	1
CO2	3	3	3	2	2	2	0	3	0	3	3	2	2	2	2	1
CO3	2	2	2	3	2	3	0	2	0	2	2	3	3	3	3	1
CO4	3	3	3	3	3	3	0	3	0	2	3	2	2	1	3	1

Course Name: Underground Space Technology
Course Code: MNL426
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

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

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 Tunnelling and Underground space technology, Elsevier

Course Outcomes:
The students will be able to understand:
1. Need for and importance of underground space.
2. Importance of site-investigation and its various features for the creation of underground space.
3. Conventional methods of developing underground spaces.
4. Modern Methods of developing underground spaces.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	0	2	0	3	2	3	3	2	2	1
CO2	2	3	3	2	2	2	0	2	0	3	3	3	2	2	2	1
CO3	3	3	2	3	2	3	0	2	0	2	2	3	3	3	3	1
CO4	3	3	3	3	3	3	0	2	0	2	3	3	2	1	3	1

Course Name: Ergonomics and Training in Safety
Course Code: MNL455
Course Type: Departmental Elective / MINOR 3
Credits (L-T-P): 3-1-0

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 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
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

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

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

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	0	3	2	0	0	3	2	2	3	3	3	3	3	3
CO2	3	3	0	3	3	0	0	2	1	2	3	2	1	3	2	2

Course Name: Advanced Surveying & Remote Sensing
Course Code: MNL320
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

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

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 prepressing & 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:
1. To learn various map projection system, earth datum and coordinate systems.
2. To comprehend working principle and application of advanced survey instruments in mines.
3. To learn working principle and application of photogrammetry and drone in mines.
4. To understand working principle and application of remote sensing system and GIS in mines.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	3	0	0	2	2	3	2	3	3	2	2	1
CO2	2	3	3	3	2	0	0	2	3	3	3	3	2	2	2	1
CO3	3	3	2	3	2	0	0	2	3	2	2	3	3	3	3	1
CO4	3	3	3	2	3	0	0	2	2	2	3	3	2	1	3	1

Course Name: Novel Mining Methods
Course Code: MNL431
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

Course Objective:
Students are made conversant with non-conventional mining methods

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 CO_2 minimisation.
Hydraulic mining: Introduction, Process of hydraulic mining, hydro monitors, water jets, surface and underground layouts, merits and impacts
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. Single and multi-hole Borehole mining techniques
2. Hydraulic Mining and Leaching Technologies.
3. Recent advances in deep-sea mining and extra-terrestrial mining.
4. Recent advances in coal-bed methane drainage and underground coal gasification.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	3	3	2	2	2	3	2	0	3	2	2	1
CO2	2	3	3	1	2	2	2	2	2	3	3	0	2	2	2	1
CO3	3	3	2	3	2	1	3	2	3	2	2	0	3	3	3	1
CO4	2	3	1	2	3	3	2	2	2	1	2	0	3	2	2	1

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

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

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

Course Outcomes:
The students will be able to understand the
1. Statistical distributions – random, normal and lognormal and its importance in mining environment.
2. Characteristics and Various models of variogram
3. Semi variogram calculations
4. Krigging method for grade and reserve estimation

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	0	2	1	0	0	0	0	2	3	0	3	2	2	1
CO2	1	3	0	1	2	0	0	0	0	3	3	0	2	2	1	2
CO3	2	1	0	1	2	0	0	0	0	2	3	0	3	3	2	1
CO4	2	2	0	2	2	0	0	0	0	3	3	0	2	2	1	2

Course Name: Emergency Management and Safety Audit
Course Code: MNL457
Course Type: Departmental Elective / MINOR 4
Credits (L-T-P): 3-1-0

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

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 and Emergency 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.
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

Books:

1. Disaster Management Handbook, Jack Pinkowski
2. Industrial Disaster Management and Emergency Response U. K. Chakrabarty
3. Environmental Health and Safety Audits by Lawrence B. Cahill
4. Guidelines for Auditing Process Safety Management Systems by John Wiley

Course Outcomes:

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

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	0	3	2	0	0	2	3	1	2	3	3	2	3	2
CO2	2	2	0	2	2	0	0	2	2	2	3	2	2	2	2	3

Course Name: Mine System Engineering
Course Code: MNL421
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

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 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.
4. Students will acquire knowledge about simulation technique.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	0	2	3	0	0	2	2	3	2	3	3	2	2	1
CO2	2	3	0	3	2	0	0	2	3	3	3	3	2	2	2	3
CO3	3	3	0	2	2	0	0	2	2	2	2	3	3	3	3	1
CO4	2	2	0	3	3	0	0	2	1	2	2	3	3	2	3	2

Course Name: Surface Mine Environment
Course Code: MNL402
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

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 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

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	3	1	3	2	2	3	3	2	1	2	3	2	2
CO2	3	3	3	2	2	2	2	3	2	3	3	3	3	2	1	3
CO3	2	3	2	3	2	3	3	1	3	2	2	3	3	3	3	2
CO4	3	2	3	1	3	3	2	2	3	2	3	2	3	2	1	1

Course Name: Rock Slope Engineering
Course Code: MNL430
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

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 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

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	3	2	2	2	2	2	2	3	2	2	2	2	2	2
CO2	3	3	3	2	2	3	2	3	3	3	3	3	3	2	2	3
CO3	2	3	2	3	2	2	3	2	2	2	2	3	1	3	3	1
CO4	3	3	2	3	3	3	2	1	3	2	3	2	2	1	3	2

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

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

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.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	0	3	0	2	2	0	3	2	3	3	2	2	1
CO2	2	3	3	0	2	0	2	2	0	3	3	3	2	2	2	1
CO3	3	3	2	0	2	0	3	2	0	2	2	3	3	3	3	1

Course Name: Instrumentation & Non-Destructive Testing
Course Code: MNL458
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

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 form 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 contents:
Rockmass Monitoring: Need of rockmass monitoring; Introduction to Geotechnical instrumentation systems; Design of Geotechnical measurement systems
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.
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
Seismic and micro-seismic monitoring systems: Blasting and blast performance instrumentation, Image and Data analysis
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.
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 avaliable 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.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	0	2	3	0	0	0	1	3	2	3	1	2	3	2
CO2	3	2	0	3	2	0	0	0	2	2	3	2	2	2	2	3
CO3	2	3	0	3	2	0	0	0	2	2	2	2	3	3	3	1
CO4	3	2	0	3	3	0	0	0	2	2	3	2	1	3	3	2

Course Name: Reliability Engineering
Course Code: MNL459
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

Course Objective:
To make student conversant with concepts of reliability engineering and its applications.
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 cantered 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

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	0	2	1	0	0	2	3	3	2	3	1	2	3	2
CO2	2	3	0	2	2	0	0	2	2	2	3	2	2	2	2	3
CO3	3	3	0	1	2	0	0	2	2	1	2	2	3	3	3	2
CO4	2	2	0	3	3	0	0	2	2	2	3	2	3	2	3	2
CO5	2	1	0	2	3	0	0	2	3	3	2	3	2	2	3	3

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

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

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 aspects of mining economics.
2. Students will have knowledge about various inventory of minerals, ore sampling and ore reserve estimation.
3. Students will develop skill in financial management in mining industry.
4. Students will develop skill in mine valuation and feasibility.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	0	0	3	2	3	3	2	2	2	3	2	3	3	2	2	3
CO2	0	0	3	3	2	2	2	2	3	2	3	3	2	3	2	2
CO3	0	0	2	1	3	3	2	2	2	3	2	3	3	2	3	1
CO4	0	0	3	3	2	1	2	2	3	2	3	3	2	2	2	1

Course Name: Artificial Intelligence and IoT in Mining
Course Code: MNL321
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

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

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, \
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;Pearson Education, 2009
6. Adrian McEwen, Hakim Cassimally - Designing the Internet of Thing Wiley Publications, 2012.
7. Ethem Alpaydin; Introduction to machine Learning, Third Edition
8. 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

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	0	2	1	0	0	2	3	3	2	3	1	2	3	1
CO2	2	3	0	2	2	0	0	3	2	2	3	2	2	2	2	3
CO3	3	3	0	1	2	0	0	2	2	1	2	2	3	3	2	2
CO4	2	2	0	3	3	0	0	3	2	2	3	2	3	2	3	3
CO5	3	2	0	2	3	0	0	2	3	3	2	3	2	2	2	3

Course Name: Smart & Clean Mining Technologies
Course Code: MNL317
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

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 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

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	1	3	2	0	0	0	2	3	1	2	3	2
CO2	2	2	3	2	2	2	2	0	0	0	3	2	3	2	2	3
CO3	3	3	2	2	2	3	3	0	0	0	3	2	3	1	3	1

Course Name: Advanced Surface Mining & Design
Course Code: MNL433
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

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

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, Crospit Conveyors, Skip Transportation etc), Application and design of Truck Dispatch System,Application of GPS in surface mining
Design of Waste Dumps and Tailing Ponds, Design of Haul roads, Design of Drainage System. Monsoon preparation in surface mines
Design of large scale bench blasting: coal and non coal: cast blasting, coyote blasting, chamber blasting, Estimation of Mining Cost for surface mines

Books:
Fundamentals of Open Pit Mine Planning & Design: Hustrulid, W. and Kuchta, M.
Surface Mining – 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 equipment – their technical combination based on output capacity.
4. Design of waste dumps, haul roads, drainage system.
5. Design of various blasting practices need based.

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	3	3	0	2	0	3	2	2	3	2	2	3
CO2	2	3	3	3	2	2	0	2	0	3	3	3	2	2	2	2
CO3	3	3	2	3	2	3	0	3	0	2	2	3	3	3	3	2
CO4	3	1	3	2	3	3	0	2	0	3	2	2	3	2	2	1
CO5	2	3	3	3	2	2	0	2	0	3	3	3	2	2	3	1

Course Name: Mine Waste Management
Course Code: MNL462
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

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 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://eddypump.com/education/mine-waste-disposal-methods/
4. http://canadianminingmagazine.com/understanding-mining-waste-management-and-disposal-methods/

Course Outcomes:
1. Student will have knowledge of Solid Mine Waste Management
2. Student will have knowledge of Liquid Mine Waste Management
3. Student will have understanding of Mine Waste recycle and utilisation

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	1	3	3	0	0	0	3	2	2	2	1	3
CO2	2	2	3	2	1	3	2	0	0	0	2	1	2	3	2	1
CO3	3	3	1	2	2	3	3	0	0	0	2	3	2	1	1	2

Course Name: Project Management and Evaluation
Course Code: MNL464
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

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

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

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	0	2	3	0	0	2	3	2	2	3	1	2	3	2
CO2	1	3	0	2	2	0	0	3	2	2	3	2	2	2	2	3
CO3	3	2	0	1	2	0	0	2	2	1	2	2	2	3	2	1
CO4	1	2	0	3	1	0	0	2	2	2	3	2	3	2	3	2
CO5	2	2	0	2	3	0	0	1	3	3	2	3	2	2	3	2

Course Name: Rock Excavation Engineering
Course Code: MNL422
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

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 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 Excavation Engineering, Understanding of Rock and its importance in Characterization in Excavations
2. Excavatibility of Rock and its components like Cuttability, Drillability, Rippability etc.
3. Theories of rock tool interaction in all the excavation methods (Drilling, Blasting, Cutting etc)
4. Design principles of Drilling, Cutting Ripping Machines, Wear Mechanisms

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	2	2	2	2	3	2	3	3	2	1	1
CO2	2	3	3	2	2	3	2	2	3	3	3	3	2	2	2	1
CO3	3	3	2	3	2	2	3	2	2	2	2	3	3	2	1	2
CO4	2	2	3	1	2	3	2	2	3	3	3	3	3	2	2	3

Course Name: Computer Application in Mining
Course Code: MNL405
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

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 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

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	1	0	3	0	3	3	3	2	3	2	2	3
CO2	1	3	2	1	2	3	3	3	3	3	3	2	2	2	2	2

Course Name: Mine Management
Course Code: MNL403
Course Type: Departmental Elective
Credits (L-T-P): 3-1-0

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

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, 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

Mapping of COs with POs & PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	0	0	0	0	0	0	0	2	3	2	3	2	3	2	2	1
CO2	0	0	0	0	0	0	0	3	3	3	3	2	2	2	3	2
CO3	0	0	0	0	0	0	0	2	3	2	2	2	3	3	2	3
CO4	0	0	0	0	0	0	0	2	3	1	3	3	2	2	3	1