Curriculum Book

and

Assessment and Evaluation Scheme

Based on

Outcome Based Education (OBE)

and

Choice-Based Credit System (CBCS)

in

Master of Technology

Mining Engineering

2 Years Degree Program

Revised as on 01 August2023Applicablew.e.f.AcademicSession2023-24

AKS University

Satna-485001, Madhya Pradesh, India

Faculty of Engineering and Technology

Department of Mining Engineering

Department of Mining Engineering,
Faculty of Engineering and Technology,
AKS University, Satna, M.P.
Curriculum of M. Tech. Mining Engineering
(Revised as on 01st August 2023)

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Forwarding

I am thrilled to observe the updated curriculum of the Mining Engineering Department for M. Tech. Mining Engineering Program, which seamlessly integrates the most recent technological advancements and adheres to the guidelines set forth by AICTE. The revised curriculum also thoughtfully incorporates the directives of NEP-2020 and the Sustainable Development Goals.

The alignment of course outcomes (COs), Programme Outcome (POs) and Programme specific outcomes (PSOs) has been intricately executed, aligning perfectly with the requisites of NEP-2020 and NAAC standards. I hold the belief that this revised syllabus will significantly enhance the skills and employability of our students.

With immense satisfaction, I hereby present the revised curriculum for the M. Tech. in Mining Engineering program for implementation in the upcoming session.

ER. Anant Soni
Pro Chancellor & Chairman
AKS University, Satna
01 August 2023

Department of Mining Engineering,
Faculty of Engineering and Technology,
AKS University, Satna, M.P.
Curriculum of M. Tech. Mining Engineering
(Revised as on 01st August 2023)

From the Desk of the Vice-chancellor

AKS University is currently undergoing a process to revamp its curriculum into an outcome-based approach, with the aim of enhancing the teaching and learning process. The foundation of quality of quality education lies in the implementation of a curriculum that aligns with both societal and industrial needs, focusing on relevant outcomes. This entails dedicated and inspired Faculty members, as well as impactful industry internships.

Hence, it is of utmost importance to begin this endeavor by crafting an outcome-based curriculum in the guidelines outlined in the National Education Policy (NEP) of 2020, and sustainable goals. Collaboration with academia and industry experts. This curriculum design should be informed by the latest technological advancements, market demands.

I'm delighted to learn that the revised curriculum has been meticulously crafted by the Mining Department, in consultation with an array of experts from the mining industry, research institutes, and academia. This curriculum effectively integrates the principles outlined in the NEP-2020 guidelines, as well as sustainable goals. It also adeptly incorporates the latest advancements in mining engineering.

The curriculum goes beyond theoretical learning and embraces practical applications by incorporating the utilization of industrial and domestic waste in cement production. To enhance students' skills, the curriculum integrates Hands-On Training, industrial visits, and On-Job Training experiences, research and progress. This well-rounded approach ensures that students receive a comprehensive education, fostering their skill development and preparing them for success in the cement and Mining industry.

I am confident that the updated curriculum for Mining engineering will not only enhance students' technical skills but also contribute significantly to their employability. During the process of revising the curriculum, I am pleased to observe that the Mining engineering department has diligently adhered to the guidelines provided by the AICTE. Additionally, they have maintained a total credit requirement of 62 for the M. Tech. Mining engineering program.
It's worth noting that curriculum revision is an ongoing and dynamic process, designed to address the continuous evolution of technological advancements and both local and global concerns. This ensures that the curriculum remains responsive and attuned to the changing landscape of education and industry.

AKS University warmly invites input and suggestions from industry experts and technocrats and Alumni students to enhance the curriculum and make it more student-centered. Your valuable insights will greatly contribute to shaping an education that best serves the needs and aspirations of our students.

Professor B.A. Chopade
Vice-Chancellor
AKS University, Satna
01August2023

Preface

AKS University, Satna, has been imparting M. Tech. in Mining Engineering since 2012. With over 20 qualified and experienced faculty members the department of Mining Engineering draws inspiration from Vice Chancellor of AKSU, Prof. B. A. Chopade. The Department also enjoys full support from the management and Pro Chancellor Er. Anant K. Soni and Prof. G. K. Pradhan, Dean, Faculty of Engineering & Technology.

As part of our commitment to ongoing enhancement, the Department of Mining Engineering consistently reviews and updates its M. Tech. Mining Engineering program curriculum every three years. Through this process, we ensure that the curriculum remains aligned with the latest technological advancements, as well as local and global industrial and social demands.

During this procedure, the existing curriculum for the M. Tech. Mining Engineering Program undergoes evaluation by a panel of technocrats, industry specialists, and academics. Following meticulous scrutiny, the revised curriculum has been formulated and is set to be implemented starting from August 01, 2023. This implementation is contingent upon the endorsement of the curriculum by the University's Board of Studies and Governing Body.

This curriculum closely adheres to the AICTE model syllabus distributed in May 2023. It seamlessly integrates the guidelines set forth by the Ministry of Higher Education, Government of India, through NEP- 2020, as well as the principles of Sustainable Development Goals. In order to foster the holistic skill development of students, a range of practical activities, including Hands-On Training, Industrial Visits, Project planning and execution, Report Writing, Seminars, and Industrial On-Job Training, have been incorporated. Furthermore, in alignment with AICTE's directives, the total credit allocation for the M. Tech. Mining Engineering program is capped at 62 credits. This curriculum is enriched with course components in alignment with AICTE guidelines, encompassing various disciplines such as Engineering Science core: 22 credits, Engineering Science core elective: 09 credits, Open elective 03 credits, Research Projects& Seminar34, Indian Knowledge System: 2 credits, Sustainable Development Goals: 2 credits.

To ensure a comprehensive learning experience, detailed evaluation schemes and rubrics have also been meticulously provided.

For each course, a thorough mapping of Course Outcomes, Program Outcomes, and Programme Specific Outcomes has been undertaken. As the course syllabus is being meticulously developed, various elements such as session outcomes, laboratory instruction, classroom instruction, self-learning activities, assignments, and mini projects are meticulously outlined.

We hold the belief that this dynamic curriculum will undoubtedly enhance independent thinking, skills, and overall employability of the students.

We are pleased to present the revised and updated edition of the approved Syllabus of the M. Tech. (Mining Engineering). This will be implemented wef 2023-24 batch. Since 2012, we have constantly updated the syllabus.

Attempts have been made to incorporate the new Syllabus circulated by DGMS(*) which extends exemption Certificate of Second Class Mine Managers' Certificate of Competency to M. Tech. Mining students after having one year experience and other necessary certificates (like Gas Testing to work in UG mines, First Aid, Experience & Medical certificate).

We acknowledge the efforts of our colleagues. Our thanks are due to the approving authorities of the University and for their guidance.

(*)Ref: The Gazette of India Part II, Section-3 sub-section (i) No. 672 dated 14 Sept 2018 under Regulation 12(1) & 12(4) of CMR 2017 & relevant Notification as under MMR 1961.

Professor B. K. Mishra
Associate Professor and HOD
AKS University
01August2023

Introduction:

AKS University proudly stands as a pioneer for preparing the Mining Engineers to serve the Industry with their Best academic knowledge and great field training during the vacation period while studying. Mining engineering in M. Tech. in Mining engineering started in 2012.

This innovative curriculum has been meticulously crafted to align with the dynamic needs of the present Mining industry and the most current technological advancements. Currently about 200 students are actively engaged in pursuing their M. Tech in Mining Engineering in this department. We have very good laboratories that serve as hubs for immersive hands-on training, enabling students to delve into practical applications of their learning. Every year during summer vacation we are sending our students to mine to have vocational training. To have better experience on field we have planned to send students in different type of mines such as open cast Mines, Underground Coal Mines, and Underground Metal Mines. We prepare our students that after completion of their course they can accept any challenge. We also provide first aid Training followed by first aid certificates to our students which is the integral part of Mining Engineering.

Vision:

To provide best quality education in Mining Engineering at par with National Level Institutions through pertaining need based theoretical and practical learning with specific focus on world acclaimed mining technologies, sustainability framework for mining industry and advancing research orientation.

Mission:

M01: Accomplish academic excellence in Mining Engineering through an innovative teaching-learning process.

M 02: Carry out research and create human resource for developing and adopting appropriate technology towards sustainable development of mineral resources.

M 03: Designing and continual review of the mining engineering programme curriculum in commensuration with the articulated needs of the mining industry, academic institutions and research organizations.

M 04: More focus on individual assignments and project works based on analysis of the learning ability of the students to make all the students employable.

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

PEO -01: Possess a successful career and conduct new research in Mining Engineering and related fields.

PEO-02: With ethical values and social responsibility, provide optimal solutions to complex problems in the mining and energy sectors.

PEO-03: Inculcate in students a mindset for adopting modern state of the art technologies and to implement them into practice.

PEO 04: In their job, demonstrate project management skills and the capacity to operate in collaborative, diverse assignments.

Program Outcome (PO)

The program outcomes are of generic nature that describe what the graduates of any engineering program should perform.

PO 1: Develop the skilled knowledge of communication in verbal and written forms.

PO 2: Apply the complex systems as a part of Research Project.

PO 3: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools.

PO 4: Understand the impact of the professional engineering solutions in societal and environmental contexts.

PO 5: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 6: The ability to engage in self-directed, reflective, and lifelong learning for the benefit of society.

Consistency/Mapping of PEOs with Mission of the Department

PEO	M1	M2	M3	M4
PEO1	2	2	3	3
PEO2	3	2	2	2
PEO3	2	3	2	1
PEO4	3	2	3	3
PEO5	2	2	1	3

1:Slight(Low)2:Moderate(Medium)3:Substantial(High)"-":Nocorrelation

GENERAL COURSE STRUCTURE & THEME

1. Definition of Credit

1Hr.Lecture(L) per week	1 Credit
1Hr.Tutorial(T) per week	1 Credit
2HoursPractical(P) per week	1 Credit

2. Range of Credits:

In the light of the fact that a typical Model Two-year Post Graduate degree program in Engineering has about 62 credits, the total number of credits proposed for the two-year M. Tech. in Mining Engineering is kept as 62 considering NEP-2020 and NAAC guidelines.

3. Structure of PG Program in Mining Engineering:

The structure of PG program in Mining Engineering shall have essentially the following categories of courses with the breakup of credits as given:

Components of the Curriculum

(Program curriculum grouping based on course components)

Sl. No	Course Component	% of total number of credits of the Program	Total number of Credits
1	Program Core (PCC)	17.74	11
2	Program Electives (PEC)	38.71	24
3	Research Project (PROJ)	40.32	25
5	Others	3.23	02
	Total	100.0	62

General Course Structure and Credit Distribution

Curriculum of M. Tech. Mining Engineering

Semester -I		**Semester-II**	
Course Title	Credit	Course Title	Credit
1-Operation Research	3:0:2= 5	1- Underground Space Technology	3:0:0 = 3
2-Applied Rock Mechanics	3:0:0 = 3	2- Rock Fragmentation Engineering	3:0:0 = 3
3-Project management	3:0:0 = 3	3- Subsidence Engineering	3:0:0 = 3
4-Eco friendly Mining & Processing / Safety and Risk Management in Mines Elective – I	3:0:0 = 3	4- Engineering Geology	3:0:0 = 3
5-Geo informatics / Surface Mining operations & equipment Elective -` II	3:0:0 = 3	5- Drilling Technology	3:0:0 = 3
6.- Comprehensive Viva Voce covering Proposed Thesis (Partial Fulfillment**)	0:0:2 = 2	6- Applied Rock Mechanics- Lab	0:0:4 = 2
		7- Seminar	0:0:2 = 1
Total Credit	**19**	**Total Credit**	**18**
Semester-III		**Semester-IV**	
Course Title	Credit	Course Title	Credit
1- Seminar on Dissertation Evaluation	0:0:10 = 5	1- Dissertation (Open Defense)	0:0:10 = 5
2- Dissertation – Interim Evaluation	0:0:10 = 5	2- Dissertation (Evaluation)	0:0:20 = 10
Total Credit	**10**	**Total Credit**	**15**

Course code and definition:

L	=	Lecture
T	=	Tutorial
P	=	Practical
C	=	Credit
BSC	=	Basic Science Courses
ESC	=	Engineering Science Courses
HSMC	=	Humanities and Social Sciences including Management courses
PCC	=	Professional core courses
PEC	=	Professional Elective courses
OEC	=	Open Elective courses
LC	=	Laboratory course
MC	=	Mandatory courses
IKS	=	Indian Knowledge System
SDGs	=	Sustainable Development Goals

Course level coding scheme:

Three-digit number (odd numbers are for the odd semester courses and even numbers are for even semester courses) used as suffix with the Course Code for identifying the level of the course. Digit at hundred' place signifies the year in which course is offered. e.g.
101, 102 … etc. for first year.201, 202….Etc. for second

Category-wise Courses

PROFESSIONAL CORE COURSES [PCC] (Total 11)

Sl.	Code No.	Subject	Semester	Credits
1	19MI101/19MI151-L	Operations Research	I	3:0:4= 5
2	19MI102	Applied Rock Mechanics	I	3:0:0=3
3	19MI103	Project Management	I	3:0:0 = 3
Total Credits:				**11**

PROFESSIONAL ELECTIVE [PEC]

Sl.	Code No.	Subject	Seme	Credits
Elective – I				
1	19MI104-A	Eco-friendly Mining & Processing	I	3:0:0=3
2	19MI104-B	Safety and Risk Management in Mines	I	3:0:0=3
Total Credits:				**03**
Elective – II				
1	19MI105-A	Geo-Informatics	I	3:0:0=3
2	19MI105-B	Surface Mining Operations & Equipment	I	3:0:0=3
Total Credits:				**03**
Total Credits:				**06**

RESEARCH PROJECT

Sl.	Code No.	Subject	Semester	Credits
1	19MI351	Seminar on Dissertation Evaluation	III	0:0:10= 5
2	19MI352	Dissertation – Interim Evaluation	III	0:0:10= 5
3	19MI451	Dissertation (Open Defense)	IV	0:0:10= 5
4	19MI452	Dissertation (Evaluation)	IV	0:0:20=10
Total Credit				**25**

OTHER COURSES

Sl.	Code No.	Subject	Semester	Credits
1	19MI152	Comprehensive Viva Voce covering Proposed Thesis (Partial Fulfillment**)	I	0:0:4=2
Total Credit				**02**

Induction Program

Induction program for students to be offered right at the start of the first year. It is mandatory. AKS University has designed an induction program for 1st year student, details are below:

i. Physical activity
ii. Creative Arts
iii. Universal Human Values
iv. Literary
v. Proficiency Modules
vi. Lectures by Eminent People
vii. Visits to local Areas
viii. Familiarization to Dept./Branch & Innovations

Mandatory Visits/Workshop/Expert Lectures:

i. It is mandatory to arrange one industrial visit every semester for the students.

ii. It is mandatory to conduct a One-week workshop during the winter break after fifth semester on professional/industry/entrepreneurial orientation.

iii. It is mandatory to organize at least one expert lecture per semester for each branch by inviting resource persons from industry.

Evaluation Scheme:

1. **For Theory Courses:**
   i. The weightage of Internal assessment is 50% and
   ii. End Semester Exam is 50%
   The student has to obtain at least 40% marks individually both in internal assessment and end semester exams to pass.
2. **For Practical Courses:**
   i. The weightage of Internal assessment is 50% and
   ii. End Semester Exam is 50%
   The student has to obtain at least 40% marks individually both in internal assessment and end semester exams to pass.
3. **For Summer Internship/Projects/Seminar etc.**
   Evaluation is based on work done, quality of report, performance in viva-voce, presentation etc.

Semester wise Course Structure

Semester wise Brief of total Credits and Teaching Hours

Semester	L	T	P	Total Hour	Total Credit
Semester-I	15	0	08	23	19
Semester-II	15	0	06	21	18
Semester-III	0	0	20	20	10
Semester-IV	0	0	30	30	15
Total	30	0	64	94	62

Details of Semester Wise Course Structure

Semester–I

SN	Category	Code	Course Title	L	T	P	Total Hour	Credit
1	PCC	19MI101/19MI151-L	Operations Research	3	0	4	7	5
2	PCC	19MI102	Applied Rock Mechanics	3	0	0	3	4
3	PCC	19MI103	Project Management	3	0	0	3	3
4	PEC-I	19MI104-A	Eco-friendly Mining & Processing	3	0	0	3	3
		19MI104-B	Safety and Risk Management in Mines					
5	PEC-II	19MI105-A	Geo-Informatics	3	0	0	3	3
		19MI105-B	Surface Mining Operations & Equipment					
6	PROJ	19MI152	Comprehensive Viva Voce covering Proposed Thesis (Partial Fulfillment**)	0	0	4	4	2
Total				15	0	08	23	19

Semester–II

SN	Category	Code	Course Title	L	T	P	Total Hour	Credit
1	PEC	19MI201	Underground Space Technology	3	0	0	3	3
2	PEC	19MI202	Rock Fragmentation Engineering	3	0	0	3	3
3	PEC	19MI203	Subsidence Engineering	3	0	0	3	3
4	PEC	19MI204	Engineering Geology	3	0	0	3	3
5	PEC	19MI205	Drilling Technology	3	0	0	3	3
6	PEC	19MI251	Applied Rock Mechanics- Lab	0	0	4	4	2
7	PEC	19MI252	Seminar	0	0	2	2	1
Total				15	0	6	21	18

Semester–III

SN	Category	Code	Course Title	L	T	P	Total Hour	Credit
1	PROJ	19MI351	Seminar on Dissertation Evaluation	0	0	10	10	5
2	PROJ	19MI352	Dissertation – Interim Evaluation	0	0	10	10	5
		Total		**0**	**0**	**20**	**20**	**10**

Semester–IV

SN	Category	Code	Course Title	L	T	P	Total Hour	Credit
1	PROJ	19MI451	Dissertation (Open Defense)	0	0	10	10	5
2	PROJ	19MI452	Dissertation (Evaluation)	0	0	20	20	10
Total				**0**	**0**	**30**	**30**	**15**

Semester-I

Course Code: 19MI101/19MI151-L

Course Title: Operations Research

Pre-requisite: Student should have the knowledge of computer application, numerical solving and apply in mining industries to solve the problems.

Rationale: The students studying the knowledge of computer application, numerical solving and apply in mining industries to solve the problems. Also students study the various mining solutions which are beneficial for mining industries as per requirement.

Course Outcomes:

19MI101/19MI151-L.1: Describe about the basic concept of operation research.

19MI101/19MI151-L.2: Explain about the importance of linear programming like simplex methods.

19MI101/19MI151-L.3: Discuss about the importance of network analysis like CPM and PERT which is benefitted for mining solutions.

19MI101/19MI151-L.4: Illustrate the study about queue theory and problems solving.

19MI101/19MI151-L.5: Understand the non-linear programming problems.

Scheme of Studies:

CODE	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits(C)
			Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
PCC	19MI101/ 19MI151-L	Operations Research	3	4	1	1	9	5

Legend: **CI:** Class room Instruction (Includes different instructional strategies i.e.Lecture (L)and Tutorial (T) and others),
LI: LaboratoryInstruction(IncludesPracticalperformancesinlaboratoryworkshop,fieldorotherlocation susingdifferentinstructionalstrategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:
Theory

CODE	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment(PRA)						End Semester Assessment ESA)	Total Marks (PRA+ESA)
			Class/HomeAssignment5number 3 marks each (CA)	Class Test2 (2bestout of3) 10 markseach(CT)	Seminar one (SA)	Class Activityanyone (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PCC	19MI101/19MI151-L	Operation Research	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). Asthecourseprogresses,studentsshouldshowcasetheirmasteryofSessionOutcomes(SOs),culminatinginthe overallachievementof Course Outcomes (COs) upon the course's conclusion.

19MI101/19MI151-L.1: Describe about the basic concept of operation research.

Approximate Hours

Item	Appx. Hrs
Cl	09
LI	4
SW	1
SL	2
Total	16

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO1.1 Importance of operation research. SO1.2 Discuss about the Scope of Operation Research SO1.3Learn about the Advantages of OR SO1.4 Discuss about the Characteristics of Operation Research SO1.5 Describe about the Limitation of Operation Research .	1.1 Operation research 1.2 Scope and limitation.	**Unit-1.0 Introduction to Operation Research** 1.1 Definition of OR. 1.2 Various authors suggested by definitions of OR 1.3 History of OR Part 1 1.4 History of OR Part 2 1.5 Characteristics of OR 1.6 Advantages of OR 1.7 Scope of OR 1.8 Advantages of OR 1.9 Limitation of OR	1. Operation Research 2. Importance of Operation Research

SW-1Suggested Sessional Work(SW):

a. Assignments:

i. Importance of OR

19MI101/19MI151-L.2: Explain about the importance of linear programming like simplex methods.

Approximate Hours

Item	AppXHrs
Cl	09
LI	4
SW	1
SL	2
Total	16

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO2.1 Knowledge a brief on linear programming SO2.2 Understand the simplex methods SO2.3 Understand the problems of dual theory SO2.4Toknow the dynamic programming SO2.5 Learn about the problems	2.1 Linear programming 2.2 Dual problems.	**Unit-2 Linear Programming and Dynamic Programming** 2.1 Linear Programming 2.2. Simplex methods 2.3 Steps of simplex methods 2.4 Problems of Simplex methods 2.5 Dual Problems analysis 2.6 Dynamic problems 2.7 post optimality analysis 2.8 recursive equation approach, 2.9 computational procedure, forward and backward computations and problems of dimensionality.	i. Learning about the linear programming ii. Dynamic programming

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Dynamic programming

19MI101/19MI151-L.3: Discuss about the importance of network analysis like CPM and PERT which is benefitted for mining solutions.

Approximate Hours

Item	AppXHrs
Cl	09
LI	4
SW	1
SL	2
Total	16

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO3.1 Describe network analysis SO3.2Able to select numerical SO3.3 Explain the inventory models SO3.4Explain the project evaluation SO3.5 Analyze the problems	3.1 Network analysis 3.2 Inventory models.	**Unit-3: Network Analysis** 3.1 Introduction of Network analysis 3.2 critical path calculations, 3.3 variance and standard deviation 3.4 probability and cost considerations in project scheduling, 3.5 construction of time chart and resource leveling. 3.6 Inventory Models: 3.7 deterministic and probabilistic models. 3.8 Numerical 3.9 Numerical	i. CPM **ii.** PERT

SW-3Suggested Sessional Work (SW):

a. Assignments:

i) Importance of CPM and PERT

19MI101/19MI151-L.4: Illustrate the study about queue theory and problems solving.

Approximate Hours

Item	AppXHrs
Cl	09
LI	4
SW	1
SL	2
Total	16

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO4.1Explain Queuing Theory SO4.2 Application of Queuing Theory SO4.3 Benefits in Mining ndustry SO4.4 Analyze Numerical SO4.5 Explain queuing theory Problems	4.1 Queuing Theory 4.2 Problems .	**Unit-4: Queuing Theory:** 4.1 Basic concepts, 4.2 axiomatic derivation of the arrivals and departures, 4.3 distribution for Poisson queues, 4.4Poisson queuing models, 4.5 non-Poisson queuing models 4.6 queuing models with priorities for service. 4.7 Problems 4.8 Numerical 4.9 Numerical	i. Importance of Queuing Theory ii. Numerical

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Discuss about queuing theory

19MI101/19MI151-L.5: Understand the non-linear programming problems.

Approximate Hours

Item	AppXHrs
Cl	09
LI	4
SW	1
SL	2
Total	16

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Classroom Instruction(CI)**	**Self Learning (SL)**
SO5.1Explain the non-linear programming SO5.2Preparation of Numerical SO5.3Impotance of non-linear programming SO5.4Describe the programming – separable, quadratic, stochastic SO5.5Discuss problems	5.1 Non-`linear programming 5.2 Problems of NLP	**Unit5: Non-linear Programming:** 5.1 Basic concept 5.2 Problems 5.3 Unconstrained external problems, 5.4constrained external problems, 5.5 programming – separable, 5.6 quadratic, stochastic and 5.7 geometric. 5.8 Problem 5.9 Numerical	1.Non-linear problem 2.Numerical

SW-5Suggested Sessional Work (SW):

a. Assignments:

1. Importance of non-linear programming

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory Instruction (LI)	SessionalWork (SW)	Self Learning (Sl)	Total hour(Cl+SW+Sl)
19MI101/19MI151-L.1: Describe about the basic concept of operation research.	9	4	1	2	16
19MI101/19MI151-L.2: Explain about the importance of linear programming like simplex	9	4	1	2	16
19MI101/19MI151-L.3: Discuss about the importance of network analysis like CPM and PERT which is benefitted for mining solutions.	9	4	1	2	16
19MI101/19MI151-L.4: Illustrate the study about queue theory and problems solving.	9	4	1	2	16
19MI101/19MI151-L.5: Understand the non-linear programming problems.	9	4	1	2	16
Total Hours	45	20	5	10	80

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Describe about the basic concept of operation research.	03	02	-	05
CO-2	Explain about the importance of linear programming like simplex methods.	02	06	02	10
CO-3	Discuss about the importance of network analysis like CPM and PERT which is benefitted for mining solutions.	03	07	05	15
CO-4	Illustrate the study about queue theory and problems solving.	03	07	05	15
CO-5	Understand the non-linear programming problems.	02	02	01	05
Total		14	23	13	50

Legend: R:Remember, U:Understand, A:Apply

The end of semester assessment for operation research will be held with writtenexaminationof50 marks.

Note. Detailed Assessmentrubricneedtobepreparedbythecoursewiseteachersforabovetasks.
Teacherscanalsodesigndifferenttasksasperrequirement,for endsemesterassessment.

Suggested Learning Resources:

(a)Books:

S. No.	Title	Author	Publisher	Edition &Year
1	Operation Research	H. A Eiselt & Carl – Louis Sandblom	Springer	3rd and 2010
2	Operation Research – Theory and Application	J. K. Sharma	Trinity Press	6th and 2006

Link

https://www.stonybrook.edu/commcms/ams/graduate/or/

https://www.bbau.ac.in/dept/UIET/EME-601%20Operation%20Research.pdf

Curriculum Development Team

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Cos, Pos and PSOs Mapping

Program Title: M. Tech. Mining Engineering

Course Code: 19MI101/19MI151-L

Course Title: Operation Research

Course Outcomes	Program Outcome						Program Specific Outcome			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
	Develop the skilled knowledge of communi-cation in verbal and written forms	Apply the complex systems as part of research projects	Create, select & apply appropriate techniques, resources & modern engineering & IT tools	Understand the impact of professional engineering solutions in societal & environmental practices	Apply ethical principles & commit to professional ethics & responsibilities and norms of the engineering practice	The ability to engage in self-directed, reflective & lifelong learning for the benefit of the society	Dev. Analy tical skill for complex mining problems	Specialized in depth knowledge in specific areas of mining	Capability to comprehend articulated needs for mining industry	Research orientation based on articulated needs
CO1: Describe about the basic concept of operation research.	2	2-	1	1	-2	-1	2	1	1	1
CO 2: Explain about the importance of linear programming like simplex methods.	1	-1	-2	-3	2	1	1	1	2	2
CO3: Discuss about the importance of network analysis like CPM and PERT which is benefitted for mining solutions.	2	3	1	1	3	2	2	1	3	1
CO 4: Illustrate the study about queue theory and problems solving.	2	3	2	3	1	2	2	1	3	1
CO5: Understand the non-linear programming problems.	1	1	2	1	3	2	2	2	3	2

Legend:1–Low,2–Medium,3–High

Course Curriculum Map:

POs& PSOs No.	Cos No. & Titles	SOs No.	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 PSO1,2,3,4	CO1: Describe about the basic concept of operation research.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5	1.1 1.2	Unit-1.0 Introduction to Operation Research 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9	SL 1.1
PO1,2,3,4,5,6 PSO1,2,3,4	CO 2 Explain about the importance of linear programming like simplex methods.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	2.1 2.2	Unit-2 Linear programming and dynamic programming 2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9	SL 2.1
PO1,2,3,4,5,6 PSO1,2,3,4	CO3 Discuss about the importance of network analysis like CPM and PERT which is benefitted for mining solutions.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	3.1 3.2	Unit-3: Network Analysis 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8, 3.9	SL 3.1
PO1,2,3,4,5,6 PSO1,2,3,4	CO 4: Illustrate the study about queue theory and problems solving.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	4.1 4.2	Unit-4:Queuing Theory 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9	SL4.1
PO1,2,3,4,5,6 PSO1,2,3,4	CO 5: Understand the non-linear programming problems.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	5.1 5.2	Unit5:Non-linear programming 5.1,5.2,5.3,5.4,5.5, 5.6, 5.7, 5.8, 5.9	SL 5.1

Semester I

Course Code: 19MI102

Course Title : Applied Rock Mechanics

Pre-requisite: Student should have basic knowledge of stress and stress field, and properties of rock mass.

Rationale: The students studying advance rock mechanics will acquire stress and deformation related instrumentation like load cell, convergence recorder, bore hole extensometer. Students will acquire knowledge of measuring in situ and induced stresses. Students will acquire knowledge of Numerical modeling of rock masses and applications of numerical analysis.

Course Outcomes: The students will be able to

19MI102.1: Interpret Stress State and design of Local and Mass Support System (Rock Enforcement).
19MI102.2: Apply stress and deformation related instrumentation to measure rock movement and interpretation of data
19MI102.3: Predict surface subsidence and assess rock bursts and bump. Apply measures to control subsidence and bursts.
19MI102.4: Analyse mechanism of caving and slope failure. Apply FLAC 3D and FLAC 2D to assess slope failure.
19MI102.5: Apply numerical analysis in geo mechanics by using different methods of numerical modeling of rock masses and computational methods too.

Scheme of Studies

Code	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours(CI+SW+SL)	
PCC	19MI102	Applied Rock Mechanics	3	0	1	1	5	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits.

Note: SW&SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:
Theory

Code	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PCC	19MI102	Applied Rock Mechanics	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

19MI102**.1:** Interpret Stress State and design of Local And Mass Support System (Rock Enforcement).

Approximate Hours

Item	AppXHrs
Cl	9
LI	0
SW	2
SL	1
Total	12

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO1.1 T o study about various types of stress fields **SO1.2** To find stresses around narrow and circular openings **SO1.3** Design of support system in bord and pillar **SO1.4** Evaluate various supports in longwall workings **So1.**5 Assess pressure on supports by instrumentation .		1.1 **Unit-1.0** Stress field and stress equation 1.2 In situ and induced stress 1.3 Stress distribution around narrow and circular openings. 1.4 Introduction to local and mass support system 1.5 Design of support system in shafts. 1.6 Support system in headings. 1.7 Supports system in junctions and depillaring areas. 1.8 Support system in gates 1.9longwall faces and stopes .	1. Various methods of designing support system in underground

SW-1 Suggested Sessional Work (SW):

a. Assignments:

1. Design of support system in development district of bord and pillar from given data

b. Mini Project:

1. Strata monitoring devices and its applicability study

19MI102**.2:** Apply stress and deformation related instrumentation to measure rock movement and interpretation of data

Approximate Hours

Item	AppXHrs
Cl	9
LI	0
SW	2
SL	1
Total	12

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO2. Read the rock movement and interpret it . **SO2.2** Identify location of installing instrument to measure convergence. **SO2.3**To understands the out-come reading of recorder and suggests measures for safety of persons. **SO2.4**To calculate in situ stresses from the data. **SO2.**5 To lean use of instruments of measuring induced stresses.		**Unit -2.0** Apply stress and deformation related instrumentation to measure rock movement and interpretation of data. 2.1. Measurement of rock movements 2.2 interpretations of data. 2.3 Load cells1 2.4 Load cells-2 2.5 Convergence recorders. 2.6 Borehole extensometers-1 2.7 Borehole extensometers-2 2.8 Borehole cameras 2.9. Measurement of in-situ stresses.	i. Different types of ISRM in situ stress measurements ex USBM, CSIRO.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Collect data and details of different types of load cells.
ii. Study different types of bore hole extensometers and compare their efficacy.

b.Mini Project:

Plan a plan for installation of strata monitoring instrument in depillaring district of bord and pillar working.

19MI102**.3: :** Predict surface subsidence and assess rock bursts and bump. Apply measures to control subsidence and bursts.

Approximate Hours

Item	AppXHrs
Cl	9
LI	0
SW	2
SL	1
Total	12

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO3.1 Predict surface subsidence and bump. **SO3.2** Measurement of subsidence and showing in graph. **SO3.3** Preventive measures of subsidence at surface and taking safety measures. **SO3.4** Rock burst and bump prediction. **SO3.**5 Preventive measures of rock burst and bumps		Unit -3.0 Predict surface subsidence and assess rock bursts and bump. Apply measures to control subsidence and bursts. 3.1 Factors controlling magnitude 3.2 extent of surface subsidence-prevention 3.3 Prevention and control of damage to surface. 3.4 Method of prediction of mining subsidence 3.5 control of subsidence. 3.6 Subsidence measurement technique 3.7 Rock burst and bump 3.8 Mechanism of occurrence of bump 3.9 prediction	1 study of subsidence and its types and monitoring of subsidence

SW-3 Suggested Sessional Work (SW):

a. Assignments:

1 Problem on subsidence
2 Rock bumps and bursts.

b. Mini Project:

Study of rock burst and bumps in chinakuri mine and KGF

19MI102**.4** Analyse mechanism of caving and slope failure. Apply FLAC 3D and FLAC 2D to assess slope failure.

Approximate Hours

Item	AppXHrs
Cl	9
LI	0
SW	2
SL	2
Total	13

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO4.1 knowledge on mechanics of caving and caving cavability index **SO4.2** understanding the parameters of slope design **SO4.3** ; Analysis of slope failure **SO4.4** Study of drainage and reinforcement of slopes **SO4.**5 Using SSR for interpreting of slopes stability	..	4.1 Mechanics of caving 4.2 Cavability of rocks and caving height 4.3 Types of slope failure 4.4 Analysis of slope failure 4.5 Types of slope failure Continue 4.6 Types of slope failure Continue 2 4.7 Problems 4.8 Problems 1 4.9 Problems 2 .	1. Different types of slope failure and their cause 2. Different Methods of analysis of slope failure

SW-4 Suggested Sessional Work (SW):

a. Assignments

1. Design of opencast slopes
2. Calculations of FOS of slopes of dumps

b. **Mini Project:**

1. Case study on slope failure of RAJ MAHAL Opencast

19MI102.**5**: Apply numerical analysis in geo mechanics by using different methods of numerical modeling of rock masses and computational methods too.

Approximate Hrs

Item	AppXHrs
Cl	9
LI	0
SW	2
SL	1
Total	12

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO5.1 Knowledge on computational methods for numerical techniques **SO5.2** Various applications of numerical methods **SO5.3** Studying FEM and FDM methods of numerical modeling **SO5.4** Studying of DEM and MFM methods of numerical modeling **SO5.**Analysis of slope stability using FLAC 2D and FLAC 3D		5.1 Introduction to numerical techniques 5.2 Computational methods 5.3 Numerical methods of modeling rock masses 5.4 Application of numerical analysis 5.5 Case study 5.6 Case study 5.7 Case study 3 5.8 Case study 4 5.9 Case study 5	**1.** Analysis of slope stability using flac 2d and flac 3d using acquired data

SW-5 Suggested Sessional Work (SW):

a. Assignments:

1. Principles of working of various NUMERICAL MODELLING methods

b. Mini Project:

1. Analysis of slope stability using FLAC 2D and FLAC 3D

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self Learning (SL)	Total hour (Cl+SW+Sl)
19MI102**.1:** Interpret Stress State and design of Local and Mass Support System (Rock Enforcement).	9	0	2	1	12
19MI102**.2:** Apply stress and deformation related instrumentation to measure rock movement and interpretation of data	9	0	2	1	12
19MI102**.3:** Predict surface subsidence and assess rock bursts and bump. Apply measures to control subsidence and bursts.	9	0	2	1	12
19MI102**.4:** Analyse mechanism of caving and slope failure. Apply FLAC 3D and FLAC 2D to assess slope failure.	9	0	2	2	13
19MI102**.5:** Apply numerical analysis in geo mechanics by using different methods of numerical modeling of rock masses and computational methods too.	9	0	2	1	12
Total Hours	45	0	10	6	61

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Interpret Stress State and design of Local and Mass Support System (Rock Enforcement).	03	01	01	05
CO-2	Apply stress and deformation related instrumentation to measure rock movement and interpretation of data	02	06	02	10
CO-3	Predict surface subsidence and assess rock bursts and bump. Apply measures to control subsidence and bursts.	03	07	05	15
CO-4	Analyse mechanism of caving and slope failure. Apply FLAC 3D and FLAC 2D to assess slope failure.	-	10	05	15
CO-5	Apply numerical analysis in geo mechanics by using different methods of numerical modeling of rock masses and computational methods too.	03	02	-	05
Total		11	26	13	50

Legend: R:Remember, U:Understand, A:Apply

The end of semester assessment for advance rock mechanics will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to mining plant
7. Demonstration
8. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook ,Twitter,Whatsapp,Mobile,Onlinesources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition &Year
1	Fundamentals and applications of Rock Mechanics	Deb Debasis	PHI Learning Pvt. Ltd.	2016
2	Introduction to rock mechanics by IBM	IBM	IBM	

Link

https://nptel.ac.in/

Curriculum Development Team

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Cos, Pos and PSOs Mapping

Program Title: M.Tech in Mining Engineering

Course Code**:** 19MI102

Course Title: Applied Rock Mechanics

	Program Outcomes						Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
Course Outcome	Develop the skilled knowledge of communi-cation in verbal and written forms	Apply the complex systems as part of research projects	Create, select & apply appropriate techniques, resources & modern engineering & IT tools	Understand the impact of professional engineering solutions in societal & environmental practices	Apply ethical principles & commit to professional ethics & responsibilities and norms of the engineering practice	The ability to engage in self-directed, reflective & lifelong learning for the benefit of the society	Develop Analy tical skill for complex mining problems	Specialized in depth knowledge in specific areas of mining	Capability to comprehend articulated needs for mining industry	Research orientation based on articulated needs
CO1- Garnering the fundamental concept of In-situ Stresses	2	2-	1	1	-2	-1	2	1	1	1
CO2- Describe the various types of Stress Around Mine Opnings	1	-1	-2	-3	2	1	1	1	2	2
CO 3- Analyse the Design of Mine Openings and Pillars	2	3	1	1	3	2	2	1	3	1
CO 4- Explain the Design of Support and Goaf Support	2	3	2	3	1	2	2	1	3	1
CO 5- Elaborates the concepts of Rock Bursts, Bumps and Mine Subsidence	1	1	2	1	3	2	2	2	3	2

Legend: 1: Low 2: Medium 3: High

Course Curriculum Map

POs & PSOs Number	COs number & Title	SOs Number	Laboratory Instruction (LI)	Class Room Instructions (CI)	Self Learning (SL)
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 1-Garnering the fundamental concept of In-situ Stresses	SO 1.1 SO 1.2 SO 1.3 SO 1.4 SO 1.5		Unit 1:In-situ Stresses 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1,7, 1.8,1.9	SL 1.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 2: Describe the various types of Stress Around Mine Openings.	SO2.1 SO 2.2 SO 2.3 SO 2.4 SO 2.5		Unit 2:Stress Around Mine Openings 2.1, 2.2, 2.3, 2.4,2.5,2.6,2.7,2.8,2.9	SL 2.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 3- Analyse the Design of Mine Openings and Pillars	SO 3.1` SO 3.2 SO 3.3 SO 3.4 SO 3.5		Unit 3: Design of Mine Openings and Pillars 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8,3.9,	SL 3.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 4- Explain the Design of Support and Goaf Support.	SO 4.1 SO 4.2 SO 4.3		Unit 4: Design of Support and Goaf Support 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7.,4.8,4.9,	SL 4.1

		SO 4.4 SO 4.5			
	CO 5- Elaborates the concepts of Rock Bursts, Bumps and Mine Subsidence.	SO 5.1 SO 5.2 SO 5.3 SO 5.4 SO 5.5		Unit 5:Rock Bursts, Bumps and Mine Subsidence 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9,	SL 5.1

Semester I

Course Code: 19MI103

Course Title: Project Management

Pre-Requisite: The student should have adequate knowledge about basics of mine management, project infrastructure and project evaluation techniques.

Rationale: The student pursuing M. TECH. in Mining Engineering must develop adequate concept of management principles and their applications in mining industry, unique conditions and features at project development phase and skills to plan and execute projects in ground reality.

Course Outcome:

The student

19MI103 .1- Garnering concept of fundamental management theories and their evolution

19MI103 .2- Comprehension and application of management theories in mining projects

19MI103 .3- Developing skills for human resource and conflict management and build up of proper organization structure

19MI103 .4-Development of skills for resource allocation and utilization and inventory control

19MI103 .5- Comprehension of capital budgeting, financial resources and project evaluation techniques

Scheme of studies:

Code	Course code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Totaql study Hours (CI+LI+SW+SL)	
PCC	19MI103	Project Management	3	0	1	1	5	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits.

Note: SW&SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:
Theory

Code	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PCC	19MI103	Project Management	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

19MI103.1:-. Garnering concept of fundamental management theories.

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	1
Self Learning	1
Total	11

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO 1.1- Defining Management and its basic characteristics SO 1.2- Basic functions of management in organizations SO 1.3- Classical theories of management and its features SO 1.4- Neo-classical theories of management and its contributions SO 1.5- Modern theories of management and its different approaches		Unit1- Management theories and their evolution 1.1-Definitions of management and its characteristics 1.2-Basic functions of management 1.3-Evolution of management theories, particularly in post industrialization era 1.4-Classical theories of management in organization 1.5-Advantages and limitations of classical theories 1.6-Neo-classical theories of management. 1.7-Contributions of neo-classical theories of management 1.8-Modern theories of management and its classification 1.9- Numerical 1	(i)Classical concepts of management & development of various schools of management theories

Suggested Sessional works: a. Assignments:

(i) The scope and domain of management practices in the arena of globalization of organizations and information technology

19MI103.2:- Comprehension and application of management theories in mining projects

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	1
Self Learning	1
Total	11

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO 2.1- Understanding unique features of mining industry SO 2.2- Forecasting and planning for mining projects SO 2.3- Organization in mining industry- implications in project formation stage SO 2.4- Management by objectives in mining projects SO 2.4- Performance appraisal system for mining projects SO 2.5- Different phases of a mining project		Unit 2- Application of Management theories on mining projects 2.1- Unique features of mining industry 2.2- Forecasting and planning for mining projects and the risks involved 2.3- Organizing the mining projects- functional and general managerial aspects 2.4- Three universals of organization 2.5- Management by objectives- the concept 2.6- Three stages of management by objectives and problems of introducing MBO in mining projects 2.7- Production systems-Elements of its design and operation 2.8- Plant location and layout 2.9- Production development and analysis	(i) Specific aspects of mining industry and their impact on planning process for mining projects

Suggested Sessional works: a. Assignments:

(i) An analysis into the different factors affecting on the forecasting and planning of mining projects in consideration of high risks associated with project implementation

19MI103.3- Developing skills for human resource and conflict management and build up of proper organization structure

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	1
Self Learning	1
Total	11

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO 3.1- Characteristics of human resources during project formation SO 3.2- Arising of conflicts and their resolution SO 3.3- Styles of conflict management SO 3.4- Developing conflict management skills SO 3.4- Provisions in Industrial Disputes Act for resolution of industrial disputes in Mining projects		Unit 3- Project organization and conflict management 3.1- Typical features of project organization- human resources for projects 3.2- Forming, storming, norming and completion of projects- the four stages of project project implementation 3.3- Design of job and wage system 3.4- Method study and work measurement 3.5- Job evaluation, wage and incentive plans 3.6- Conflicts- an unavoidable characteristics in project organization 3.7- Types of conflict management 3.8- Development of conflict management skills 3.9- ID Act, 1947- Certain important definitions	(i)Different phases in a project's life

Suggested Sessional works: a. Assignments:

(i) Blake & Mouton's Grid to explain the modalities of conflict management in projects.

(ii)Case studies on conflict resolution- application of different types of conflict management

19MI103.4:- Development of skills for resource allocation and utilization and inventory control

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	1
Self Learning	1
Total	11

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO 4.1- Resource management in Project- an important parameter for project success SO 4.2- Establishment of system for material management and inventory control for projects SO 4.3- Layout and location plan for project and project stores SO 4.4- Analysis of stores and inventory for optimization of procurement, purchase and issuance SO4.5- Management Information system for inventory control		Unit 4- Inventory control for project implementation 4.1- Specific features for development of inventory at project stage 4.2- Resource mobilization and its optimization 4.3- Importance of access, layout and design for material handling facilities 4.4- Some important documents of material procurement and issuance process for projects 4.5- Procedures for regular and emergent purchases in projects 4.6- ABC analysis- value of inventory consumed 4.7- XYZ analysis- Value of inventory stored 4.8- VED indicators. Purchasing process. 4.9- Store keeping and control for projects	(i) Inventory control management as a part of project budgeting

Suggested Sessional works: a. Assignments:

(i) An analytical approach towards identification of vital, essential and desirable spares and consumables for a large complex project

19MI103.5:- Comprehension of capital budgeting, financial resources and project evaluation techniques

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	1
Self Learning	1
Total	11

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO5.1-Conept development of fixed and current assets and liabilities SO 5.2- Process of capital budgeting SO 5.3- Cost analysis and their classification SO 5.4- Principles of financial management SO 5.5- Project evaluation techniques		Unit 5- Comprehension of capital budgeting, financial resources and project evaluation techniques 5.1- Important financial terminologies- Equity Shares, Preference shares, Debentures, Bonds, Capital & Working capital 5.2- Assets and liabilities and their classification 5.3- Capital budgeting- its categories and contents 5.4- Process of capital budgeting 5.5-Cost-benefit analysis for investment proposals 5.6- Different principles of computation of costs 5.7- Appraisal criteria for investment proposals 5.8-Non-DCF systems for project evaluation 5.9- DCF system for project evaluation	Study area: (i)Capital budgeting of projects and control methods

Suggested Sessional works: a. Assignments:

(i) Classification of assets and liabilities and determination of working capital for a project

(ii) Calculation of Internal Rate of Return (IRR) for a project and its interpretation as a tool of project evaluation.

Brief of Hours suggested for the course outcome:

Course outcomes	Class Lectures (CL)	Laboratory Instructions (LI)	Sessional work (SW)	Self Learning (SL)	Total Hour (CL+LI+SW +SL)
19MI103.1- Garnering concept of fundamental management theories and their	9	0	1	1	11
19MI103.2- Comprehension and application of management theories in mining projects	9	0	1	1	11
19MI103.3- Developing skills for human resource and conflict management and build up of proper organization structure	9	0	1	1	11
19MI103.4- Development of skills for resource allocation and utilization and inventory control	9	0	1	1	11
19MI103.5- Comprehension of capital budgeting, financial resources and project evaluation techniques	9	0	1	1	11
Total Hours	45	0	5	5	55

Suggestions for End semester Assessment:

Suggested Specification Table

COs	Unit Titles	Marks Distribution			Total; Marks
		R	U	A	
CO 1	Management theories and their evolution	3	3	1	7
CO 2	Application of Management theories on mining projects	3	4	3	10
CO 3	Project organization and conflict management	3	5	5	13
CO 4	Inventory control for project implementation	3	5	5	13
CO 5	Comprehension of capital budgeting, financial resources and project evaluation techniques	2	3	2	7
	Total	14	20	16	50

Legend: R-Remember U-Understand A-Apply

The end of semester assessment for project management will be held with written examination of 50 marks

Suggested Instructional/ Implementation Strategies:

1. **Improved lectures**
2. Tutorial
3. Case studies
4. Group discussion
5. Role play
6. Visit to mines and mineral processing industries
7. Demonstration
8. Digital media application in teaching learning process and mass media
9. Brainstorming

Suggested Learning Resources

Sl.No	Title	Author	Publisher	Edition & Year
1.	Organization & Management	C R Basu	Oxford & IBH Pub.	
2.	Industrial Engineering & Production Management	Martand Tesand	S.Chand & Co. Ltd.	
3.	Industrial Engineering & Management	O P Khanna	Dhanpat Rai, Delhi	
4.	Practice of Management	S G Britton	Willy Eastern Ltd.	

Curriculum Development Team

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COs, POs & PSO Mapping:-

Program Title: M. Tech (Mining Engineering)
Course Code: 19MI103
Course Title: Project Management

	Program Outcomes						Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
Course outcome	Develop the skilled knowledge of communi-cation in verbal and written forms	Apply the complex systems as part of research projects	Create, select & apply appropriate techniques, resources & modern engineering & IT tools	Understand the impact of professional engineering solutions in societal & environmental practices	Apply ethical principles & commit to professional ethics & responsibilities and norms of the engineering practice	The ability to engage in self-directed, reflective & lifelong learning for the benefit of the society	Dev. Analy tical skill for complex mining problems	Specialized in depth knowledge in specific areas of mining	Capability to comprehend articulated needs for mining industry	Research orientation based on articulated needs
19MI103.1-Garnering concept of fundamental management theories and their	2	2-	1	1	-2	-1	2	1	1	1
19MI103.2-Comprehension and application of management theories in mining projects	1	-1	-2	-3	2	1	1	1	2	2
19MI103.3-Developing skills for human resource and conflict management and build up of proper organization structure	2	3	1	1	3	2	2	1	3	1

19MI103.4-Development of skills for resource allocation and utilization and inventory control	2	3	2	3	1	2	2	1	3	1
19MI103.5-Comprehension of capital budgeting, financial resources and project evaluation techniques	1	1	2	1	3	2	2	2	3	2

Legend: 1: Low 2: Medium 3: High

Course Curriculum Map:

POs & PSOs Number	COs number & Title	SOs Number	Laboratory Instruction (LI)	Class Room Instructions (CI)	Self Learning (SL)
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	19MI103.1- Garnering concept of fundamental management theories and their	SO 1.1 SO 1.2 SO 1.3 SO 1.4 SO 1.5		Unit 1- Management theories and their evolution 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8,1.9	SL 1.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	19MI103.2- Comprehension and application of management theories in mining projects	SO2.1 SO 2.2 SO 2.3 SO 2.4 SO 2.5		Unit 2- Application of Management theories on mining projects 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9,	SL 2.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	19MI103.3- Developing skills for human resource and conflict management and build up of proper organization structure	SO 3.1` SO 3.2 SO 3.3 SO 3.4 SO 3.5		Unit 3- - Project organization and conflict management 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9,	SL 3.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	19MI103.4- Development of skills for resource allocation and utilization and inventory control	SO 4.1 SO 4.2 SO 4.3 SO 4.4 SO 4.5		Unit 4- Inventory control for project implementation 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9	SL 4.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	19MI103.5- Comprehension of capital budgeting, financial resources and project evaluation techniques	SO 5.1 SO 5.2 SO 5.3 SO 5.4 SO 5.5		Unit 5- Comprehension of capital budgeting, financial resources and project evaluation techniques 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9,	SL 5.1

Semester I

Course Code: 19MI104-A

Course Title: Eco-friendly Mining & Processing

Pre-Requisite: The student should have adequate knowledge about the mining processes and the mining technologies so as to comprehend the general impacts of such mining processes and technologies on environment, society and economy.

Rationale: The student pursuing Master's degree(M.Tech) in Mining Engineering must develop adequate concept of different mining technologies and their impacts, both positive and adverse on economy and society along with environmental implications to comprehend in broader perspective its scopes & challenges and develop ability to formulate mitigation plans.

Course Outcome:

The student

19MI104-A.1- Garnering concept of Eco-friendly mining based on sustainable development principles. Formulation of SD framework for mining.

19MI104-A2- Enactment of sustainability development principles in Acts, Laws & Regulations related to mining projects and activities

19MI104-A.3- Environmental impacts of mining and mitigation plans

19MI104-A.4-Energy security of India and need for sustainable coal mining. Short term and Long term perspective of energy mix in India and its impact on mining industry.

19MI104-A.5- Innovative mining technologies and their application for sustainable development.

Scheme of studies:

Code	Course code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Totaql study Hours (CI+LI+SW+SL)	
PEC-`I	19MI104-A	Eco-friendly Mining & Processing	3	0	1	1	5	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits.

Note: SW&SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Code	Course Code	Course Title	**Scheme of Assessment(Marks)**							
			Progressive Assessment(PRA)						**End Semester Assessment (ESA)**	**Total Marks** (PRA+ESA)
			Class/Home Assignment5 number 3 marks each (CA)	Class Test2 (2besto ut of3) 10 mark s each(CT)	Semina r one (SA)	Class Activ ity any one (CAT)	Class Attendanc e (AT)	Total Marks (CA+CT+SA +CAT+AT)		
PEC-I	19MI104-A	Eco-friendly Mining & Processing	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

19MI104-A.1:- Garnering concept of Eco-friendly mining based on sustainable development principles. Formulation of SD framework for mining

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	6
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	9

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO 1.1- Eco-friendly mining based on the concept of sustainable development SO 1.2- Chronology of events leading to SD concept SO 1.3- Unique features of mining Industry SO1.4-Understanding sustainable development framework for mining SO1.5-Comprehension of the implementation of SD principles in mining industry for eco-friendly mining		Unit1- Eco-friendly mining on the Concept of Sustainable Development 1.1- Domain of eco-friendly mining & its importance 1.2-Defining sustainable development and its concept 1.3-Chronology of the phases for development of the concept of Sustainable Development (SD) 1.4- Unique features of mining industry 1.5- Why it is challenging to apply SD principles in mining industry 1.6-Application of SD principles in Mining Industry- SD framework for mining	Study area: (i)Contribution of mining industry in national development and its impact on environment

Suggested Sessional works:

(i) Importance of Mining Industry and need for eco-friendly mining based on principles of sustainable development

(ii) Unique features of Mining Industry- The challenges pertaining to the implementation of sustainability principles

Topic of Mini Project- Impact of implementation of SD principles in mining on Technology improvement and innovative mining.

19MI104-A.2:- Enactment of sustainability development principles in Acts, Laws & Regulations related to mining projects and activities

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	10
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	13

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO 2.1-Dynamics in mining legislations for actualization of SD principles SO 2.2- Notification for EIA under Environmental Protection Act SO2.3- Formulation of Environmental Management Plan (EMP) SO 2.4- Mine Closure Plan (MCP) in phases & in final stage of a mine's life SO 2.5- Star Rating system in Indian mining leaseholds		Unit 2- Changes in mining laws for inclusion of SD principles 2.1-Legislative measures to implement SD principles in Indian mining industry 2.2 –EIA under Environmental Protection Act,1968 for all new & expansion projects 2.3-EIA procedures 2.4- Different methods of EIA study 2.5- Formulation of EMP 2.6- Mine Closure Plan and its implementation 2.7- Progressive and final mine closure plan 2.8- -Star Rating System-the method to implement SD principles in Indian mining industry 2.9-Star rating system implementation in Indian coal mining sector 2.10- Basic features of the template for evaluation of mine performances based on star rating system	(i)Changes in mining legislative framework in India in the context of SD

Suggested Sessional works:

(i) An analysis into the changes in mining legislations in the context of sustainable development in mining industry

(ii) Effects of amendments in mining laws on techno-economic parameters of mining industry in India

Topic of Mini Project- An analysis into the feasibility of new and expansion mining projects in the context of eco-friendly mining

19MI104-A.3- Environmental impacts of mining and mitigation plans

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	11
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	14

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO3.1-Developing ability to assess the impact of mining activities on environment SO3.2-Comprehend the sources, dimension & mitigation plans to deal with water pollution due to mining activities SO3.3-Comprehend the impact of mining on air quality in mining complex and mitigation measures SO3.4- Impact of mining on Land environment and mitigation measures SO3.5-Understanding the need for preparing proper land use plan and its implementation.		Unit 3- Mining activities & environmental impacts 3.1-Macro & micro level impacts of mining on environment 3.2-Water pollution and water quality parameters 3.3-Physical water quality parameters 3.4-Chemical water quality parameters 3.5-Air pollution management due to mining activities 3.6-Air quality standards 3.7-Sources and prevention of air pollution in mines 3.8-Principles of operation for air pollution control equipment 3.9-Land environment and mining activities 3.10-Reclamation of mined out areas 3.11-Subsidence management	(i) Theoretical in depth studies of the impacts of different mining activities on environment and methods to deal with them

Suggested Sessional works:

(i) Comparison between the impacts of opencast and underground mining on environment in mining complexes

(ii) Importance of land use plan for sustainability of mining industry in Indian context

Topic of Mini Project- Total impact of mining industry on national economy in consideration of sustainability principles and making mining industry socially and environmentally acceptable.

19MI104-A.4:- Energy security of India and need for sustainable coal mining. Short term and Long term perspective of energy mix in India and its impact on mining industry.

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	8
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	11

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO4.1-Comprehending the criteria for energy security of any nation SO4.2-Acquiring knowledge about the present energy mix in India and its future perspective SO4.3-Analyzing the advantages and limitations of present day energy mix in India SO4.4-Garnaring knowledge and aspects of alternate sources of green energy to overcome the limitations of present energy mix SO4.5-Comprehension of the need for transformation in the energy mix in India to meet the challenges of sustainability in energy sector in India		Unit 4-Energy security with specific reference to sustainability in Indian context 4.1-Objective of energy security 4.2-Criteria for any resource as the mainstay of energy security for any nation 4.3-Present energy mix in Indian context 4.4-Short term and long term perspective of Indian energy mix 4.5-Sustainability of energy mix- the challenges 4.6-Sustainability concept and economic rules for non-renewable sources of energy 4.7-Alternative sources of renewable energy 4.8-Present status of renewable energy sources in India and their future perspective	Study area- (i)Impact of fossil fuel based energy and its impact on global warming and climate change

Suggested Sessional works:

(i) Role of fossil fuel based energy in Indian context and measures to overcome the limitations

(ii) Strategies in India to balance the energy security of nation and fulfilling the global commitment for reduction of carbon footprint

Topic of Mini Project- Can India outright change the form of national energy security from fossil fuel based energy dominance to non-fossil fuel based energy sources?

19MI104-A.5:- Innovative mining technologies and their application for sustainable development.

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	10
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	13

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO5.1-Understanding the term "Clean Coal Technology" and its implication in Indian context SO5.2-Aquiring knowledge about different forms of CCT in national as well as in global context SO5.3-Comprehension by analysis the role of CCT to balance the need for coal based power generation and reduction in carbon footprint. SO5.4- Importance of IGCC technology SO5.5- AI, Undersea mining & Space mining- the future prospects for mining industry.		Unit 5- Clean Coal Technologies (CCT) and Innovative Mining Technologies 5.1- Innovative mining technologies- need for Sustainable mining 5.2-Concept of clean coal technologies. Carbon neutral and carbon negative fuels 5.3-Coal gasification as a method of CCT 5.4-Mission Coal Gasification in India and its perspective 5.5-Coal Bed Methane (CBM) as an important source of CCT 5.6- Reservoir properties of CBM. Estimation of CBM resources in a coal seam 5.7-Technological procedure for CBM 5.8-Present status and perspective of CBM in Indian context 5.9-Compressed Natural Gas (CNG) as a cleaner fuel source 5.10-Liquefied Natural Gas (LNG) as a cleaner fuel source and with ability with overseas transport	Study area: (i) GoI initiatives for coal gasification and CBM projects as CCT

Suggested Sessional works:

(i) Review of the coal gasification mission in India

(ii) A study of the behavior of a CBM well from the point of view of gas production and technological measures to improve upon it.

Topic of Mini Project- How far you foresee the potentiality of CCT as a greener energy source in India?

Brief of Hours suggested for the course outcome:

Course outcomes	Class Lectures (CL)	Laboratory Instructions (LI)	Sessional work (SW)	Self Learning (SL)	Total Hour (CL+LI+SW+SL)
19MI104-A.1- Garnering concept of Eco-friendly mining based on sustainable development principles. Formulation of SD framework for mining	6	0	2	1	9
19MI104-A.2- Enactment of sustainability development principles in Acts, Laws & Regulations related to mining projects and activities	10	0	2	1	13
19MI104-A.3- Environmental impacts of mining and mitigation plans	11	0	2	1	14
19MI104-A.4- Energy security of India and need for sustainable coal mining. Short term and Long term perspective of energy mix in India and its impact on mining industry	8	0	2	1	11
19MI104-A.5- Innovative mining technologies and their application for sustainable development. Approximate hours:	10	0	2	1	13
Total Hours	45	0	10	5	60

Suggestions for End semester Assessment:

Suggested Specification Table

Cos	Unit Titles	Marks Distribution			Total; Marks
		R	U	A	
CO 1	- Garnering concept of Eco-friendly mining based on sustainable development principles. Formulation of SD framework for mining	3	3	1	7
CO 2	- Enactment of sustainability development principles in Acts, Laws & Regulations related to mining projects and activities	3	4	3	10
CO 3	Environmental impacts of mining and mitigation plans	3	5	5	13
CO 4	Energy security of India and need for sustainable coal mining. Short term and Long term perspective of energy mix in India and its impact on mining industry	3	5	5	13
CO 5	Innovative mining technologies and their application for sustainable development. Approximate hours:	2	3	2	7
	Total	14	20	16	50

Legend: R-Remember U-Understand A-Apply

The end of semester assessment for Eco-Friendly Mining will be held with written examination of 50 marks

Suggested Instructional/ Implementation Strategies:

1. **Improved lectures**
2. Tutorial
3. Case studies
4. Group discussion
5. Role play
6. Visit to mines and mineral processing industries
7. Demonstration
8. Digital media application in teaching learning process and mass media
9. Brainstorming

Suggested Learning Resources

Sl.No	Title	Author	Publisher	Edition & Year
1.	Mining Environment Management Manual	NareshChandra Saxena	Scientific Publisher	2004
2.	Mining and Environmental Sustainability	Prof. G. S. Roonwal	Daya publishing house	2014

(b) Link
https://nptel.ac.in

Curriculum Development Team

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COs, POs & PSO Mapping:-

Program Title: M.Tech (Mining Engineering)
Course Code**:** 19MI104-A
Course Title: Eco-friendly Mining & Processing

	Program Outcomes						Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
Course Outcome	Develop the skilled knowledge of communi-cation in verbal and written forms	Apply the complex systems as part of research projects	Create, select & apply appropri ate techniqu es, resource s & modern engineer ing & IT tools	Understand the impact of professiona l engineering solutions in societal & environme ntal practices	Apply ethical principles & commit to professiona l ethics & responsibili ties and norms of the engineering practice	The ability to engage in self-directed, reflective & lifelong learning for the benefit of the society	Dev. Analy tical skill for complex mining problem s	Specialized in depth knowledge in specific areas of mining	Capability to comprehen d articulated needs for mining industry	Research orientation based on articulated needs
CO1- - Garnering concept of Eco-friendly mining based on sustainable development principles. Formulation of SD framework for mining	2	2-	1	1	-2	-1	2	1	1	1
CO2- - Enactment of sustainability development principles in	1	-1	-2	-3	2	1	1	1	2	2

Acts, Laws & Regulations related to mining projects and activities										
CO 3- Environmental impacts of mining and mitigation plans	2	3	1	1	3	2	2	1	3	1
CO 4- Energy security of India and need for sustainable coal mining. Short term and Long term perspective of energy mix in India and its impact on mining industry	2	3	2	3	1	2	2	1	3	1
CO 5- Innovative mining technologies and their application for sustainable development.	1	1	2	1	3	2	2	2	3	2

Legend: 1: Low 2: Medium 3: High

Course Curriculum Map:

POs & PSOs Number	COs number & Title	SOs Number	Laboratory Instruction (LI)	Class Room Instructions (CI)	Self Learning (SL)
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 1- Garnering concept of Eco-friendly mining based on sustainable development principles. Formulation of SD framework for mining	SO 1.1 SO 1.2 SO 1.3 SO 1.4 SO 1.5		Unit 1- Eco-friendly mining on the concept of sustainable development 1.1, 1.2, 1.3, 1.4, 1.5, 1.6	SL 1.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 2- Enactment of sustainability development principles in Acts, Laws & Regulations related to mining projects and activities	SO2.1 SO 2.2 SO 2.3 SO 2.4 SO 2.5		Unit 2- Changes in mining laws for inclusion of SD principles 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10	SL 2.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 3- Environmental impacts of mining and mitigation plans	SO 3.1` SO 3.2 SO 3.3 SO 3.4 SO 3.5		Unit 3- Mining activities and environmental impacts 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10. 3.11	SL 3.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 4- Energy security of India and need for sustainable coal mining. Short term and Long term perspective of energy mix in India and its impact on mining industry	SO 4.1 SO 4.2 SO 4.3 SO 4.4 SO 4.5		Unit 4- Energy security with specific reference to sustainability in Indian context 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8	SL 4.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 5- Innovative mining technologies and their application for sustainable development.	SO 5.1 SO 5.2 SO 5.3 SO 5.4 SO 5.5		Unit 5- Clean coal technologies and innovative mining technologies 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10,	SL 5`.1

Semester-I

Course Code: 19MI104-B

Course Title: Safety and Risk Management in Mines

Pre-requisite: Student should have basic knowledge of scope and purpose of geology, Rocks, Minerals, various methods of age determination of rock and minerals.

Rationale: The students studying Mining field should possess foundational understanding about historical binding of rock and minerals. Helps us identify and mitigate natural hazards such as earthquakes, coastal erosion, flooding, and landslides.

Course Outcomes:

19MI104-B.1: Explain the various aspects various management principles and branches of management
19MI104-B.2: Describe the Acts and Rules for Health and Safety
19MI104-B.3: Describe the Acts and Rules for Health and Safety
19MI104-B.4: Describe the Acts and Rules for Mineral Conservation and Environmental protection
19MI104-B.5: Comprehend the MMDR Act 1957 and Rules.

Scheme of Studies:

Code	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
PEC-`I	19MI104-B	Safety and Risk Management in Mines	3	0	1	1	5	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. .Lecture (L) and Tutorial (T)and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW&SLhastobeplannedandperformedunderthecontinuousguidanceandfeedbackofteacherto ensure outcome of Learning.

Scheme of Assessment:

Theory

Code	Course Code	Course Title	Scheme of Assessment(Marks)							
			Progressive Assessment(PRA)						End Semester Assessment (ESA)	**Total Marks** (PRA+ESA)
			Class/Home Assignment 5number 3 marks each (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminar one (SA)	Class Activity anyone (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA +CAT+AT)		
PEC-`I	19MI104-B	Safety and Risk Management in Mines	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs),culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

19MI104-B.1: Explain the various aspects various management principles and branches of management.

Approximate Hours

Item	Approx. Hrs
Cl	9
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO1.1 Describe Principles of Scientific Management. **SO1.2**Explain the Organization. **SO1.3**Determination of Planning and control. **SO1.4** Explain Forms of Business Organization **SO1.5** Analyze Private and public enterprises with special reference to mining of minerals.		**Unit-1.0Management** 1.1 Principles of Scientific Management 1.2 Organization 1.3 Planning and control 1.4 Forms of Business Organization 1.5 Private enterprises with special reference to mining of minerals. 1.6 Public enterprises with special reference to mining of minerals. 1.7 Numerical 1.8 Problems 1 1.9 Problems 2	1. Planning and control.

SW-1SuggestedSessionalWork (SW):

a. Assignments:

i. Explain Forms of Business Organization

19MI104-B.2: Describe the Acts and Rules for Health and Safety.

Approximate Hours

Item	Approx. Hrs
Cl	**9**
LI	**0**
SW	**1**
SL	**1**
Total	**11**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
SO2.1 Describe the Dispute resolving . **SO2.2** Evaluate the Behavioral Sciences for Management. **SO2.3** Analyze the Systems of inventory control. **SO2.4** Comprehend the Management Information Systems (MIS) **SO2.**5 Describe Socio-Economic Impact of Mining.		**Unit-2 Basic Principles** 2.1 Dispute resolving. 2.2 Behavioral Sciences for Management 2.3 Conflict management 2.4 Inventory: Systems of inventory control 2.5 Purchase procedures. 2.6 Monitoring techniques. 2.7 Management Information Systems (MIS) 2.8 Socio-Economic Impact of Mining 2.9 Economics of mining	i. Systems of inventory control.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Comprehend the Management Information Systems (MIS).

19MI104-B.3: Describe the technical circulars and gazette notifications related to Mines Safety.

Approximate Hours

Item	Approx. Hrs
Cl	9
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
SO3.1 Infer Mine Legislation. **SO3.2** Explain Health and Safety Laws. **SO3.3** Explain The Mines Act, 1952; Mines Rules, 1955. **SO3.4** Interpret CMR 2017, Metalliferous Mine Regulation, 1961. **SO3.5** Relate the Mines Rescue Rules, 1985.		**Unit-3 : Overview of Mines Safety in India** 3.1 Overview 3.2 Mine Legislation 3.3 Health and Safety Laws 3.4 The Mines Act, 1952 3.5 Mines Rules, 1955. 3.6 CMR 2017 3.7 Metalliferous Mine Regulation, 1961. 3.8 Mines Rescue Rules, 1985 3.9 Provisions of Indian Electricity Rules, 1956 applicable to mines.	i. The Mines Act, 1952; Mines Rules, 1955.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Explain Health and Safety Laws.

19MI104-B.4: Describe the Acts and Rules for Mineral Conservation and Environmental protection.

Approximate Hours

Item	Approx. Hrs
Cl	9
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO4.1 Distinguish various Accident statistics; frequency rate and severity. **SO4.2** Evaluate Basic causes of accident occurrence. **SO4.3**Demonstrate Investigations into accidents. **SO4.4** Classify Contribution of human elements in mine safety**.** **SO4.5** Describe Risk Management: Theory and application.		**Unit-4:Accidents and their classification** 4.1 Accident statistics 4.2 frequency rate and severity rates. 4.3 Basic causes of accident occurrence 4.4 Investigations into accidents 4.5 Accident reports 4.6 In-depth study into various causes of accidents 4.7 Measures for improving safety in mines 4.8 TRAP (take responsibility in accident prevention) 4.9 Contribution of human elements in mine safety	i. basic causes of accident

SW-4 Suggested Sessional Work (SW):

a. Assignments:

ii. Classify Contribution of human elements in mine safety**.**

19MI104-B.5: Comprehend the geological formations in India.

Approximate Hours

Item	Approx. Hrs
Cl	9
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
SO5.1 Explain MMDR Act 1957. **SO5.2** Demonstrate Mining Plan Approval procedure. **SO5.3** Indian Bureau of Mines and various duties. **SO5.4** Evaluate Indian Bureau of Mines and various responsibilities. **SO5.5**Describe IBM for Mineral Administration.		**Unit 5: MMDR Act** 5.1 MMDR Act 1957 and Rules made there under. 5.2 Mining Plan Approval procedure 5.3 Indian Bureau of Mines and various duties 5.4 Indian Bureau of Mines and various responsibilities. 5.5 IBM for Mineral Administration 5.6 Risk Management 5.7 Theory and application 5.8 risk management techniques 5.9 means of managing	i.Mining Plan

SW-5 Suggested Sessional Work(SW):

a. Assignments:

i. Demonstrate Mining Plan Approval procedure.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (SL)	Total hour (Cl+SW+Sl)
19MI104-B **.1**: Explain the various aspects various management principles and branches of management	9	1	1	11
19MI104-B **.2**: Describe the Acts and Rules for Health and Safety	9	1	1	11
19MI104-B **.**3: Describe the technical circulars and gazette notifications related to Mines Safety**.**	9	1	1	11
19MI104-B **4:** Describe the Acts and Rules for Mineral Conservation and Environmental protection	9	1	1	11
19MI104-B **.5**: Comprehend the MMDR Act 1957 and Rules.	9	1	1	11
Total Hours	45	5	5	55

CO	**Unit Titles**	**Marks Distribution**			**Total Marks**
		R	**U**	**A**	
CO-1	Management	03	01	01	05
CO-2	Basic Principles of Trade unionism	02	06	02	10
CO-3	Overview of Mines Safety in India	03	07	05	15
CO-4	Accidents and their classification	-	10	05	15
CO-5	MMDR Act	03	02	-	05
Total		11	26	13	50

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

Legend: R:Remember, U:Understand, A:Apply

The end of semester assessment for safety and risk management in mines will be held with written examination of 50 marks. **Note**. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to mining industry
7. Demonstration
8. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition &Year
1	Engineering Economics and Industrial Organisation	Banga & Sharma	Khana Publishers, New-Delhi,	2006, p-1364.
2	Industrial &Labour laws	Jain, S.P	M/s Dhanpatrai& Sons, Delhi	
3	Legislation in Indian Mines, Vol. I &II.,	Rakesh & Prasad	Asha Lata, Classified Mine Circulars issued by DGMS. Varanasi.	

(b) Web link:

https://archive.nptel.ac.in/Harddisk/Direct_Download.html

https://epathshala.nic.in/

https://swayam.gov.in/

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Cos, Pos and PSOs Mapping

Program Title: M. Tech. Mining Engineering

Course Code: 19MI104-B

Course Title: Safety and Risk Management in Mines

Course Outcomes	Program Outcome						Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
	Engineering Knowledge	Problem analysis	Design/ development of solutions	Conduct investigations of complex problems	Modern Tool usage	The engineer and society	Develop analytical skills in identifying and accordingly take actions for solution of mining problems.	Should develop sufficient knowledge about the economic, environmental and societal impacts of mining and basic concepts of mitigation measures.	Develop sufficient skill in project evaluation techniques, mine management, conflict resolution management and general management and safety in mines.	Development of the base for innovation & research in the field of mining engineering.
CO-1 Explain the various aspects various management principles and branches of management life.	1	2	1	1	1	2	2	3	2	1
CO-2 Describe the Acts and Rules for Health and Safety.	1	1	2	2	1	2	2	1	2	1
CO- 3 Describe the technical circulars and gazette notifications related to Mines Safety.	1	1	1	1	1	2	1	1	2	2
CO-4 Describe the Acts and Rules for Mineral Conservation and Environmental protection	2	2	3	2	3	2	3	3	3	2
CO-5 Comprehend the MMDR Act 1957 and Rules.	1	2	1	1	1	3	3	3	1	3

Legend:1–Low,2–Medium,3–High

Course Curriculum Map:

Pos & PSOs No.	Cos No. & Titles	SOs No.	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 PSO1,2,3,4	CO-1 Explain the various aspects various management	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5		Unit-1.0 Management 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9	SL 1.1
PO1,2,3,4,5,6 PSO1,2,3,4	CO- 2 Describe the Acts and Rules for Health and Safety	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		Unit-2 Basic Principles of Trade unionism 2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9	SL 2.1
PO1,2,3,4,5,6 PSO1,2,3,4	CO-3 Describe the technical circulars and gazette notifications related to Mines Safety.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 : Overview of Mines Safety in India 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9	SL 3.1
PO1,2,3,4,5,6 PSO1,2,3,4	CO-4 Describe the Acts and Rules for Mineral Conservation and Environmental protection	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4: Accidents and their classification 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9	SL 4.1
PO1,2,3,4,5,6 PSO1,2,3,4	CO -5 Comprehend the MMDR Act 1957 and Rules.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		Unit5: MMDR Act 5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9	SL 5`.1

Semester I

Course Code: **19MI105-A**

Course Title: **Geo-informatics**

Pre-Requisite:

Geoinformatics are crucial to developing the technology, policies, standards, human resources and related activities necessary to maintain and preserve spatial data. Using an interdisciplinary teaching model, Mines' GIS and Geoinformatics graduate program gives graduate students hands-on experience in geospatial training and advanced application and quantitative analysis of GIS and remote sensing. Graduates in this program will enhance their skills, stay ahead of the technology curve and advance their careers to become top-notch professionals and leaders in their field.

Rationale:

Geoinformatics course facilitates mineral exploration via gathering, storing, and providing access to large spatial datasets. GIS collects information on the spatial location of various minerals and uses it to guide mining experts on where best to focus their efforts.

Course Outcome:

19MI105-A.1 Acquiring the ability to interpret the distribution and processes of management.
19MI105-A.2 Understanding the dynamic interrelationship between mining and geology.
19MI105-A.3 Accurate topographic data and aerial imagery guide engineers in designing efficient and safe infrastructure.
19MI105-A.4 Improving decision-making, saving costs, and ensuring adherence to rules.
19MI105-A.5Identify the most efficient paths, avoid congested areas, and optimize the utilization of their fleet.

Scheme of studies:

Code	Course code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total study Hours (CI+LI+SW+SL)	
PEC-`II	19MI105-A	Geo-informatics	3	0	1	1	5	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture(L) and Tutorial (T)and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory, workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:
Theory

Code	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						**End Semester Assessment (ESA)**	**Total Marks** (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PEC-`II	19MI105-A	Geo-informatics	15	20	5	5	5	50	50	100

Course-Curriculum:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

19MI105-A.1 Acquiring the ability to interpret the distribution and processes of management.

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	12

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO 1.1-Geoinformatics based on the concept of sustainable development SO 1.2- Understand the MIS SO 1.3- Role of geoinformatics in minor level SO1.4-Fractal analysis and damage analysis SO1.5- Micro instrumentation in geoinformatics		Unit1- Principles of geoinformatics 1.1- Basic concept of geoinformatics. 1.2-Application of geoinformatics. 1.3- Principles of geoinformatics. 1.4- Introduction to MIS 1.5- Types of Information & Sub Systems 1.6 Organization Need for MIS 1.7 Stages and development of MIS 1.8- Decision Support System 1.9-Micro level planning	(i) Role and importance of remote sensing

Suggested Sessional works:

a. Assignments;

(i) Importance of geoinformatics and need in prospecting and exploration.

b. Topic of mini project:

1. Unique features of management system in Mining Industry.

19MI105-A.2 Understanding the dynamic interrelationship between mining and geology.

Approximate hours

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	12

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO 2.1-Understand the importance of geological structure SO 2.2- Identifying the geological structure SO 2.3- Analysis the Block size analysis through structural data SO 2.4- Identifying External influence in mining SO 2.5 Understand the Stress around excavation		Unit 2- Geological Discontinuities 2.1-Introduction 2.2- Fault 2.3- Fold 2.4- Joint 2.5- Unconformities 2.6- Intact rock strength and deformation 2.7- Shear stress along a discontinuity 2.8- Set of discontinuity 2.9- External influence	(i)Importance and effect of geological discontinuities in mining area.

Suggested sessional works: a. Assignments:

(i) An analysis into the changes in mining industry due to geological structure.

b.Topic of Mini Project- An analysis into the feasibility of new and expansion mining projects in the context of geological structure.

19MI105-A.3 Accurate topographic data and aerial imagery guide engineers in designing efficient and safe infrastructure.

Approximate hours

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	12

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO3.1-Contributes to scientific knowledge by providing valuable information about the Earth's surface. SO3.2- Detect the various form of radiation, enabling applications like weather monitoring, agriculture etc. SO3.3- Provide information concerning the physical characteristics of the land which influence the management of individual land parcels or the allocation of lands to various uses. SO3.4- Enable to understand the 3D remote sensing in mining. SO3.5- Understand the uses of remote sensing for mineral exploration.		**Unit 3- Remote Sensing** 3.1-Introduction to remote sensing 3.2- Platform& Sensor 3.3- Areial photography 3.4- Hyperspectral Remote Sensing 3.5- Mineral Mapping 3.6- Case studies 3.7- Microwave remote sensing 3.8- Remote Sensing for Mineral Exploration 3.9- Case studies	(i) Practice with ArcGIS software and microDEM.

Suggested Sessional works: a. Assignments:

(i) Comparison between the impacts of opencast and underground mining on mineral exploration.

b.Topic of Mini Project- Mapping the any mine exploration through remote sensing data.

19MI105-A.4:-Improving decision-making, saving costs, and ensuring adherence to rules.

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	12

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO4.1-Comprehend fundamental concepts and practices of Geographic Information Systems SO4.2-advances in Geospatial Information Science and Technology SO4.3-Apply basic graphic and data visualization concepts such as color theory, symbolization, and use of white space. SO4.4- Get knowledge to the advanced Satellite of Remote Sensing, Hyperspectral Remote Sensing, LIDAR Remote Sensing SO4.5- Acquire skills in handling instruments, tools, techniques and modelling while using Remote Sensing Technology.		Unit 4-Geographic Information System 4.1-Introduction 4.2- Data structure, map and map elements 4.3- Geospatial analysis 4.4- Case studies 4.5- Triangulated irregular network 4.6- Digital elevation model 4.7-Raster image analysis 4.8- Raster image analysis 4.9- Case studies	(i)Apllications of GIS in different fields

Suggested Sessional works: a. Assignments:

(i) Role and limitation of GIS in mining industry

b.Topic of Mini Project- Mapping the Indian coal mines with the help of GIS technologies.

19MI105-A.5:-Identify the most efficient paths, avoid congested areas, and optimize the utilization of their fleet.

Approximate hours

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	12

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO5.1- Provides users with positioning, navigation, and timing. SO5.2-This system consists of three segments: the space segment, the control segment, and the user segment. SO5.3-Calculate GPS satellite orbit positions and velocities. SO5.4- Calculate user position using GPS pseudorange data SO5.5-		Unit 5- Global Positioning System 5.1 Introduction 5.2 GPS Satellites 5.3 Triangulation 5.4 Application 5.5 Application in Mining 5.6 Advantage and disadvantage 5.7 Map data interpretation 5.8 Data plot on map 5.9 Case study	Watch GPS working process in field.

Suggested Sessional works: a. Assignments:

(i) Plot GPS data on map.

b.Topic of Mini Project- Field visit record the GPS data and plot and interpretate.

Brief of Hours suggested for the course outcome:

Course outcomes	Class Lectures (CL)	Laboratory Instructions (LI)	Sessional work (SW)	Self Learning (SL)	Total Hour (CL+LI+SW +SL)
19MI105-A.1 Acquiring the ability to interpret the distribution and processes of management.	9	0	2	1	12
19MI105-A.2 Understanding the dynamic interrelationship between mining and geology.	9	0	2	1	12
19MI105-A.3 Accurate topographic data and aerial imagery guide engineers in designing efficient and safe infrastructure.	9	0	2	1	12
19MI105-A.4 Improving decision-making, saving costs, and ensuring adherence to rules.	9	0	2	1	12
19MI105-A.5Identify the most efficient paths, avoid congested areas, and optimize the utilization of their fleet.	9	0	2	1	12
Total Hours	45	0	10	5	60

Suggestions for End semester Assessment:

Suggested Specification Table

COs	Unit Titles	Marks Distribution			Total; Marks
		R	U	A	
CO 1	Acquiring the ability to interpret the distribution and processes of management.	3	3	1	7
CO 2	Understanding the dynamic interrelationship between mining and geology.	3	4	3	10
CO 3	Accurate topographic data and aerial imagery guide engineers in designing efficient and safe infrastructure.	3	5	5	13
CO 4	Improving decision-making, saving costs, and ensuring adherence to rules.	3	5	5	13
CO 5	Identify the most efficient paths, avoid congested areas, and optimize the utilization of their fleet.	2	3	2	7
	Total	14	20	16	50

Legend: R-Remember U-Understand A-Apply

The end of semester assessment for Geoinformatics will be held with written examination of 50 marks

Suggested Instructional/ Implementation Strategies:

1. **Improved lectures**
2. Tutorial
3. Case studies
4. Group discussion
5. Role play
6. Visit to mining industries
7. Demonstration
8. Digital media application in teaching learning process and mass media
9. Brainstorming

Suggested Learning Resources

Sl.No	Title	Author	Publisher	Edition & Year
1.				
1.				
2.				
3.				

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COs, POs & PSO Mapping

Program Title: M. Tech (Mining Engineering)
Course Code: 19MI105-A
Course Title: Geo-informatics

	Program Outcomes						Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
Course Outcome	Develop the skilled knowledge of communi-cation in verbal and written forms	Apply the complex systems as part of research projects	Create, select & apply appropriate techniques, resources & modern engineering & IT tools	Understand the impact of professional engineering solutions in societal & environmental practices	Apply ethical principles & commit to professional ethics & responsibilities and norms of the engineering practice	The ability to engage in self-directed, reflective & lifelong learning for the benefit of the society	DevAnalytical skill for complex mining problems	Specialized in depth knowledge in specific areas of mining	Capability to comprehend articulated needs for mining industry	Research orientation based on articulated needs
CO1- - Acquiring the ability to interpret the distribution and processes of management.	2	2-	1	1	-2	-1	2	1	1	1
CO2- - Understanding the dynamic interrelationship	1	-1	-2	-3	2	1	1	1	2	2

between mining and										
CO 3- Accurate topographic data and aerial imagery guide engineers in designing efficient and safe infrastructure.	2	3	1	1	3	2	2	1	3	1
CO 4- Improving decision-making, saving costs, and ensuring adherence to rules.	2	3	2	3	1	2	2	1	3	1
CO 5-Identify the most efficient paths, avoid congested areas, and optimize the utilization of their fleet.	1	1	2	1	3	2	2	2	3	2

Legend: 1: Low 2: Medium 3: High

Course Curriculum Map:

POs & PSOs Number	COs number & Title	SOs Number	Laboratory Instruction (LI)	Class Room Instructions (CI)	Self Learning (SL)
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 1: Acquiring the ability to interpret the distribution and processes of management.	SO 1.1 SO 1.2 SO 1.3 SO 1.4 SO 1.5		1.1, 1.2, 1.3, 1.4, 1.5, 1.6,1.7,1.8,1.9	SL 1.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO2:Understanding the dynamic interrelationship between mining and geology.	SO2.1 SO 2.2 SO 2.3 SO 2.4 SO 2.5		2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9	SL 2.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO3: Accurate topographic data and aerial imagery guide engineers in designing efficient and safe infrastructure.	SO 3.1` SO 3.2 SO 3.3 SO 3.4 SO 3.5		3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9	SL 3.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO:4 Improving decision-making, saving costs, and ensuring adherence to rules.	SO 4.1 SO 4.2 SO 4.3 SO 4.4 SO 4.5		4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8,4.9	SL 4.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO5: Identify the most efficient paths, avoid congested areas, and optimize the utilization of their fleet.	SO 5.1 SO 5.2 SO 5.3 SO 5.4 SO 5.5		5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9	SL 5`.1

Semester-I

Course Code:	19MI105-B
Course Title:	Surface Mining Operations & Equipment
Pre-requisite:	Student should have basic knowledge of shaft sinking, methods of shaft sinking, drilling and blasting parameters of mining and methods of tunnels making.
Rationale:	The students studying should possess foundational understanding about Student should have basic knowledge of shaft sinking, methods of shaft sinking, drilling and blasting parameters of mining and methods of tunnels making. Additionally, students ought to acquire fundamental insights into various drilling machines technology, blast design parameters of open cast mining.

Course Outcomes:

19MI105-B.1: Understand the knowledge of prospecting, methods of exploration.

19MI105-B.2: Acquired the knowledge of different shaft sinking methods, working cycle of shaft sinking.

19MI105-B.3: Understanding of the special types of shafts sinking methods, safety in shaft sinking and statutory provisions as laid down under CMR, MMR issued by DGMS.

19MI105-B.4: Understanding of the knowledge of explosive properties, blast design parameters in open cast mining and types of different drilling machines.

19MI105-B.5: Understanding of the preparation of tunnels, Drivage techniques with blasting.

Scheme of Studies:

Code	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits(C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
PEC-II	19MI105-B	Surface Mining Operations & Equipment	3	0	1	1	5	3

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies),

SW: Sessional Work (includes assignment, seminar, mini project etc.)

,**SL:** Self Learning,

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment: Theory

Code	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PEC-`II	19MI105-B	Surface Mining Operations & Equipment	15	20	5	5	5	50	50	100

Course-Curriculum Detailing

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should show case their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

19MI105-B.1: Understand the knowledge of prospecting, methods of exploration.

Approximate Hours

Item	Appx Hrs
Cl	9
LI	0
SW	1
SL	2
Total	12

Session Outcomes (SOs)	**Laboratory Instruction(LI)**	**Classroom Instruction (CI)**	**Self-Learning(SL)**
SO1.1Definitions, prospecting, shaft, bore holes SO1.2 Methods of exploration SO1.3Borehole logging, deflection of boreholes SO1.4 Fishing tools and exploratory drilling SO1.5 Surface layout		**Unit-1.0General Introduction** 1.1 Definitions reconnaissance principles. 1.2 methods of prospecting. 1.3 Pit, shaft, trench and boreholes. 1.4 Methods of Exploration. 1.5 Selection of sites for boreholes.1.6 Surface layout of boring. 1.7 Details of equipment. 1.8 Borehole logging. 1.9 Maintenance of records. data.	1. Borehole logging; Maintenance of records; Deflection of boreholes. 2. Difficulties in boring; Fishing tools and their uses.

SW-1Suggested Sessional Work(SW):

a. Assignments:

i. Exploration methods

19MI105-B.2: Acquired the knowledge of different shaft sinking methods, working cycle of shaft sinking.

Approximate Hours

Item	AppXHrs
Cl	9
LI	0
SW	1
SL	2
Total	12

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning(SL)**
SO2.1 ToUnderstand the mine entries, location **SO2.2** To learn about preparatory work required of shaft sinking **SO2.3**Tounderstand theshaft sinking methods **SO2.4**To understand the sinking cycle **SO2.**5 To learn about the support system of shaft sinking		**Unit 2 Shaft Sinking I** 2.1 Shaft Sinking. 2.2 Mine Entries - Choice, location. 2.3 Size of mine entries. 2.4 Access to seated deposits by Adit/Drifts/Incline. 2.5 Selection - Location - Preparatory work required. 2.6 Sinking appliances, equipment and services. 2.7 Sinking methods and procedure. 2.8 Reaching up tothe rock head - Pre-sink. 2.9 Sinking through the rock.	i. Mine entries, location of mine ii. Methods of shaft sinking

SW-2Suggested Sessional Work(SW):

a. Assignments:

i. Shaft sinking methods

19MI105-B.3: Understanding of the special types of shafts sinking methods, safety in shaft sinking and statutory provisions as laid down under CMR, MMR issued by DGMS.

Approximate Hours

Item	AppXHrs
Cl	9
LI	0
SW	1
SL	2
Total	12

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO3.1 Special methods of shaft sinking **SO3.2 C**ementation method **SO3.3** Drilling and boring **SO3.4** Safety features as per requirement of CMR **SO3.5**Freezing methods		**Unit-3: Shaft Sinking II** 3.1 Shaft Sinking – II. 3.2 Station construction and initial development. 3.3 Special methods of shaft sinking. 3.4 Piling System-Caisson Method. 3.5Sinking drumprocess-Forced drop. 3.6Shaft method -Pneumatic caisson method. 3.7 Special methods by temporaryor permanent isolation of water -Cementation. 3.8 Boring/Drilling-Cementation -Sinking and Walling. 3.9 The freezing process - Drilling and lining of boreholes-Formation and maintenance.	i. Shaft sinking methods ii. Freezing methods and Safety provisions

SW-3Suggested Sessional Work (SW):

a. Assignments:

1. Special Shaft sinking methods

19MI105-B.4: Understanding of the knowledge of explosive properties, blast design parameters in open cast mining and types of different drilling machines.

Approximate Hours

Item	AppXHrs
Cl	9
LI	0
SW	1
SL	2
Total	12

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction(CI)**	**Self-Learning(SL)**
SO4.1 Understand the drilling machine SO4.2 Explosive properties SO4.3 Blast design parameters SO4.4 Fragmentation SO4.5 Advances in Blasting		**Unit-4 Drilling and Blasting** 4.1 Drilling – Introduction selection-application-classification. 4.2 construction of few drill machines. 4.3 Drill bits – operation & maintenance etc. 4.4 Explosives & Accessories used in Mines. 4.5 Selection-Classification-Properties-Testing. 4.6 Underground Coal Mines. Permitted & non-permitted. 4.7 Explosives-Explosives used in Quarries. 4.8 Opencast Mines (details of selection, blast design. will be taught in Surface Mining). 4.9 Storage-Transport of explosives & accessories.	i. Blast design parameters in mining ii. Types of explosives

SW-4Suggested Sessional Work(SW):

a. Assignments:

i. Blast design parameters

19MI105-B.5: Understanding of the preparation of tunnels, Drivage techniques with blasting.

Approximate Hours

Item	AppX Hrs
Cl	9
LI	0
SW	1
SL	2
Total	12

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction(CI)**	**Self-Learning(SL)**
SO5.1 Conventional methods of tunnels **SO5.2** Over view of site investigation **SO5.3** Role of the techniques in blasting **SO5.4** Post blasting handling **SO5.**5 Support system		**Unit 5:Drifts/Drivage's & Tunnels** 5.1 Conventional Methods. 5.2 Introduction, Preparations for driving drivage's/tunnels. 5.3 Site investigations, Location of - Rocks and ground. 5.4 characterization-Size,shape, length. 5.5 Orientation (route) - function of drives. 5.6 Tunnels - Drivage techniques (fordrives and tunnels). 5.7 Drivage techniques with blasting (Pattern of holes - Blasting off the solid. 5.8 UG Gassy seams- Pattern of Holes-Charging and blasting the rounds - Placement of primer. 5.9 Stemming - Depth of round/hole - Charge density in cut-holes and rest of the face area – Smooth blasting).	1. Methods of tunnels 2. Blasting techniques

SW-5Suggested Sessional Work(SW):

a. Assignments:
Support system

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory Instruction (LI)	SessionalWork (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
19MI105-B.1:Understand the knowledge of prospecting, methods of exploration.	9	0	1	2	12
19MI105-B.2:Acquired the knowledge of different shaft sinking methods, working cycle of shaft sinking.	9	0	1	2	12
19MI105-B.3: Understanding of the special types of shaft sinking methods, safety in shaft sinking and statutory provisions as laid down under CMR, MMR issued	9	0	1	2	12
19MI105-B.4: Understanding of the knowledge of explosive properties, blast design parameters in open cast mining and types of different drilling machines.	9	0	1	2	12
19MI105-B.5: Understanding of the preparation of tunnels and Drivage techniques with blasting.	9	0	1	2	12
Total Hours	**45**	**0**	**5**	**10**	**60**

Suggestion for End Semester Assessment

Suggested Specification Table (ForESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Understand the knowledge of prospecting, methods of exploration.	03	01	01	05
CO-2	Acquired the knowledge of different shaft sinking methods, working cycle of shaft sinking.	02	06	02	10
CO-3	Understanding of the special types of shafts sinking methods, safety in shaft sinking and statutory provisions as laid down under CMR, MMR issued by DGMS.	07	05	03	15
CO-4	Understanding of the knowledge of explosive properties, blast design parameters in open cast mining and types of different drilling machines.	03	03	04	10
CO-5	Understanding of the preparation of tunnels and Drivage techniques with blasting.	03	02	05	10
Total		14	23	13	50

Legend: R:Remember, U: Understand, A:Apply

The end of semester assessment for surface mining operations will be held with written examination of 50 marks.

Note. Detailed assessmentrubric needs to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/ Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog, Facebook,Twitter,WhatsApp, Mobile,On-line sources)
9. Brainstorming

Suggested Learning Resources:

(a)Books:

S. No.	Title	Author	Publisher	Edition &Year
1	Elements Of Mining Technology	D.J. Deshmukh	Denett & Co. Nagpur, N e w Delhi, Chennai P u n e	2016
2	Mining Competition Handbook (For GATE, Overman, Mining Sirdar and others competitive exams)	Dr. Sandeep Prasad	Orange Books Publication	1st and 2023
3	Das, S.K., Surface Mining Technology, Lovely Prakashan, Dhanbad			
4.	Kennedy, B.A.(Editor), 1990, Surface Mining, SME, USA, 2nd Edition.			

Web Link:

https://en.wikipedia.org/wiki/Drilling_and_blasting

https://core.ac.uk/download/pdf/53188886.pdf

https://nptel.ac.in/

Curriculum Development Team

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Cos, Pos and PSos Mapping

Program Title: M. Tech. Mining Engineering

Course Code: 19MI105-B

Course Title: Surface Mining Operations & Equipment

Course Outcomes	Program outcome						Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool usage	The engineering society	Develop analytical skills in identifying and accordingly take actions for solution of mining problems.	Should develop sufficient knowledge about the economic, environmental and societal impacts of mining and basic concepts of mitigation measures.	Develop sufficient skill in project evaluation techniques, mine management, conflict resolution management and general management and safety in mines.	Development of the base for innovation & research in the field of mining engineering.
CO1 : Understand the knowledge of prospecting, methods of exploration.	1	2	1	1	1	2	2	3	2	1
CO 2 : Acquired the knowledge of different shaft sinking methods, working cycle of shaft sinking.	1	1	2	2	1	2	2	2	2	1
CO3 : Understanding of the special types of shaft sinking methods, safety in shaft sinking and statutory provisions as laid down under CMR, MMR issued by DGMS.	2	2	1	1	1	2	1	1	2	2
CO4:Understanding of the knowledge of explosive properties, blast design parameters in open cast mining and types of different drilling machines.	2	2	3	2	3	2	3	3	3	2
CO5:Understanding of the preparation of tunnels and Drivage techniques with blasting.	1	2	1	1	1	3	3	3	1	3

Legend:1–Low,2–Medium,3–High

Course Curriculum Map

Pos& PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO1,2, 4, 5,6 PSO1,2,3,4	CO1 : Understand the knowledge of prospecting, methods of exploration.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5		Unit-1.0 General Introduction 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9	SL 1.1
PO1,2,3,4,5,6 PSO1,2,3,4	CO 2 Acquired the knowledge of different shaft sinking methods, working cycle of shaft sinking.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		Unit-2Shaft Sinking I 2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9,	SL 2.1
PO1,2,3,4,5,6 PSO1,2,3	CO3 Understanding of the special types of shaft sinking methods, safety in shaft sinking and statutory provisions as laid down under CMR, MMR issued by DGMS.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit-3:Shaft Sinking II 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9,	SL 3.1
PO1,2,3,4,5,6 PSO1,2,3,4	CO 4: Understanding of the knowledge of explosive properties, blast design parameters in open cast mining and types of different drilling machines.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4: Drilling and Blasting 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,	SL 4.1
PO1,2,3, 5,6 PSO1,2,3,4	CO 5: Understanding of the preparation of tunnels and Drivage techniques with blasting.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		Unit5: Drifts / Drivage's and Tunnels 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9,	SL 5.1

Semester I

Course Code: 19MI152

Course Title: Comprehensive Viva Voce covering Proposed Thesis

Pre- requisite: Conduct research to resolving the problem of mining operations like blasting, vibration, safety etc. by applying advanced technology adopted in field of mining industries.

Rationale: The basic purpose of M. Tech Comprehensive Viva Voce covering Proposed Thesis is to understand the application of research methodology tools to do research on particular topic related to mining and follow technical writing skill to design the synopsis, thesis, research paper, abstract, articles, etc as per results obtained during research studies.

Course Outcomes:

PROJ-MIN05 Propose Comprehensive Viva Voce covering Proposed Thesis tools for conducting research on selected topic of mining field and prepare Final manuscript i.e. Thesis

Scheme of Studies:

CODE	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
MLC	19MI152	Comprehensive Viva Voce covering Proposed Thesis	0	4	0	0	4	2

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),**LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)**SW:** Sessional Work (includes assignment, seminar, mini project etc.),**SL:** Self Learning, **C:**Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

CODE	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks(PRA + ESA)
			Class/Home Assignment 5 number3 markseach(CA)	ClassTest 2(2 bestout of3)10 marks each(CT)	Seminar one	Class Activity anyone(CAT)	Class Attendance(AT)	Total Marks(CA+CT+SA+CAT+AT)		
MLC	19MI152	Comprehensive Viva Voce covering Proposed Thesis	0	0	0	0	0	0	100	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

19MI152 Comprehensive Viva Voce covering Proposed Thesis tools for conducting research on selected topic of mining field and prepare Final manuscript i.e. Thesis .

Approximate Hours

Item	Approximate Hours
CI	**0**
LI	**4**
SW	**0**
SL	**30**
Total	**34**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1. Choose the topic and objectives for the research. **SO2.** Select the suitable data during the research.	1. Research 2. Types of Research		**1.** Finding of reviews related with the topic of research. **2.** Preparation of manuscripts related to concerned topic.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab Instruction (LI)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
19MI152 Propose Comprehensive Viva Voce covering Proposed Thesis tools for conducting research on selected topic of mining field and prepare Final manuscript i.e. Thesis .	0	4	30	34
Total	0	4	30	34

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Group Discussion
3. Demonstration
4. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year

1	Research publications			
2	Science direct			
3	Research gate			
5	Academia			
6	Multi authored books			
7	Book chapters			

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Cos, POs and PSOs Mapping

Course Code: 19MI152

Course Title: - Comprehensive Viva Voce covering Proposed Thesis

	Program Outcomes						Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
Course Outcome	Develop the skilled knowledge of communication in verbal and written forms	Apply the complex systems as part of research projects	Create, select & apply appropriate techniques, resources & modern engineering & IT tools	Understand the impact of professional engineering solutions in societal & environmental practices	Apply ethical principles & commit to professional ethics & responsibilities and norms of the engineering practice	The ability to engage in self-directed, reflective & lifelong learning for the benefit of the society	Dev. Analytical skill for complex mining problems	Specialized in depth knowledge in specific areas of mining	Capability to comprehend articulated needs for mining industry	Research orientation based on articulated needs
CO1- Propose Comprehensive Viva Voce tools for conducting research on selected topic of mining field and prepare Final manuscript	2	2-	1	1	1	1	2	1	1	1

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6, PSO 1,2, 3, 4,	19MI152 Propose Comprehensive Viva Voce covering Proposed Thesis tools for conducting research on selected topic of mining field and prepare Final manuscript	**SO1.1** **SO1.2** **SO1.3** **SO1.4** **SO1.5**	1.1. 1.2		SL 1.1

Semester II

Course Code: 19MI201
Course Title: Underground Space Technology

Pre-Requisite: The student should have adequate knowledge about Rock Mechanics and basic concept of soil mechanics along with sufficient concept of rock excavation engineering processes.

Rationale: The student pursuing Master's degree(M.Tech) in Mining Engineering must develop adequate concept of rock excavation engineering in underground conditions, comprehend the complexities of large underground excavations predominantly in urban areas covering both consolidated and unconsolidated strata conditions.

Course Outcome:
The student

19MI201.1- Garnering concept of underground space technology (UST) based on rock excavation engineering and its importance in urban development.
19MI201.2- Comprehension and application of rock mechanics and soil mechanics principles for underground structure construction
19MI201.3- Developing engineering skills in tunnel constructions in variable geo-mechanical rock conditions
PEC-MIN 109.4-Understanding the reorientation of stresses during single and multiple excavations and determination of their influence zones
19MI201.5- Development of knowledge and skill for in-situ stress and strain determination of rocks as structural material

Scheme of studies:

Code	Course code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Totaql study Hours (CI+LI+SW+SL)	
PCC	19MI201	Underground Space Technology	3	0	1	1	5	3

Legend: **CI:** Class room Instruction (Includes different instructional strategies i.e .Lecture (L) and Tutorial (T) and others),

LI: LaboratoryInstruction(IncludesPracticalperformancesinlaboratoryworkshop,fieldorotherlocationsusingdifferentinstructionalstrategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:
Theory

Code	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment(PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5number 3 marks each (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminar one (SA)	Class Activityan yone (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+ CAT+AT)		
PCC	19MI201	Underground space technology	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). AsthecourseprogresseS,studntsshouldshowcasetheirmasteryofSessionOutcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

19MI201.1:- Garnering concept of underground space technology (UST) based on rock excavation engineering and its importance in urban development.

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	6
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	9

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO 1.1- Concept and domain of UST SO1.2- Importance of UST in urban planning SO1.3- Application of the principles of rock mechanics in underground space construction SO1.4- Importance of soil mechanics in understanding UST problems SO1.5- Unique Scope of UST-combining rock mechanics & soil mechanics approaches for construction of underground spaces.		Unit1- Underground Space Technology- Its objectives 1.1-Objectives of Underground Space Technology (UST) 1.2-Challenges of continually growing urbanization 1.3 – Domain, challenges and attributes to UST 1.4- Differentiation between strata control engineering and UG space mining engineering 1.5- Rocks and soils-two important domains of UST 1.6-Geo-mechanics- Rock mechanics & Soil Mechanics	Study area: (i)Different facets of urbanization and role of UST

Suggested Sessional works:

(i) The scope and domain of Underground space technology in modern urban development- an analysis.

(ii) Distinction between rock excavation engineering and underground space technology engineering

Topic of Mini Project- The global trend of urbanization and expanding domain of Underground Space Technology

19MI201.2:- Comprehension and application of rock mechanics and soil mechanics principles for underground structure construction

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	10
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	13

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO 2.1-Classification of rocks as a structural material SO2.2- Dual domain of UST- Rock mechanics and soil mechanics SO2.3- Impact of ground movement on structures with UG foundations and UG excavations SO2.4- Differentiation between rock mechanics and soil mechanics and distinction of their impacts on UG excavations SO2.5- Formation of tensile and compression zones due to earth pressures and ground movement		Unit 2- Classification of rocks & ground deformation on structures 2.1-Important definitions related to rocks and classification of rocks 2.2- Important terms related to Underground Space Technology (UST) 2.3- Impact of ground deformations on structures 2.4- Impact of ground movement on structures with less rigidity 2.5- Effects of ground movement and ground deformation within zone of influence of UG space excavations 2.6-Basics of soil mechanics 2.7-Convex bending- Earth pressure in tensile zone 2.8- Concave bending- Earth pressure in compression zone 2.9-Inherent complexities in rock mechanics influencing UG structures 2.10-Factors influencing UG structures	(i)In-depth study of rock mechanics and soil mechanics

Suggested Sessional works:

(i) An analysis into the different factors affecting on rock as a structural material

(ii) Effect of ground deformations on the foundations of structures at shallow depth of cover

Topic of Mini Project- Stability factor of UG caverns of large dimensions in consideration of dual effects of rock and soil mechanics

19MI201.3- Developing engineering skills in tunnel constructions in variable geo-mechanical rock conditions

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	11
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	14

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO3.1- Importance of tunneling in multivariate conditions SO3.2- Different tunneling techniques and their application SO3.3- Tunneling in hard ground by D&B mrthod. SO3.4- Mechanized tunneling with Tunnel Boring Machines (TBM) SO3.5- Tunneling in soft ground- challenges faced and their dealing		Unit 3- Tunneling & UG excavations 3.1-Tunneling- its features and importance 3.2- Tunneling technique- Ground arch effect during tunneling 3.3- Cut & cover tunneling 3.4- Basics of construction of bored or mined tunnels 3.5- Soft ground tunnels 3.6- Jacked box tunnels 3.7- Sequential Excavation Method (SEM) of tunneling 3.8- Pipe jacking method of tunneling 3.9- Utility tunneling method 3.10- Vehicular tunnels. Supporting of transport tunnels 3.11- Spoil removal system from face.	(i) Tunneling experience in high stress ground conditions

Suggested Sessional works:

(i) Tunneling in Hydro-power projects in highly susceptible to ground movement conditions

(iii) Specific considerations for tunneling in soft ground or conditions of high flow rate of ground water

Topic of Mini Project- Specific features of under river bed large tunnel construction projects.

19MI201.4:- Understanding the reorientation of stresses during single and multiple excavations and determination of their influence zones

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	12

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO4.1- Generation of stress field around UG excavations SO4.2- Stress equations to determine radial, tangential and shear stresses at any point in the stress field SO4.3- Kirsch solution. Drawing inferences from the Kirsch solution SO4.4- Prediction of the extent of boundary failure SO4.5- Determination of the influence zone in case of two or multiple Excavations or tunneling		Unit 4- Stresses around Underground openings 4.1- Stress analysis around underground openings 4.2-Stresses and displacements in circular excavations- Kirsch solution 4.3- Stress equations. Inferences from the stress equations 4.4- Calculation of radial, tangential and shear stresses of a point in a stress field 4.5- verification by calculation and graphical representation. Inferences from Kirsch solution 4.6- Prediction of the extent of boundary failure 4.7- Induced stress measurement in multiple openings 4.8- Drivage of 2^{nd} tunnel and influence zone of induced stresses 4.9- Calculation of induced stresses due to excavation of 2^{nd} tunnel	(i)In-depth study of rock mechanics principles in understanding development of stress field and its influence on UG structures

Suggested Sessional works:

(i) An analytical approach towards identification of stresses and their influence zones affecting underground constructions

(ii) Inferences from Kirsch Solution

Topic of Mini Project- Determination of influence zone of stresses in tunneling and designing multi-tunnel systems

19MI201.5:- Development of knowledge and skill for in-situ stress and strain determination of rocks as structural material

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	12

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO5.1-Comprehending the basic properties of rock in-situ SO5.2- Acquaintance with the different machines and equipment for rock testing in in-situ condition SO5.3- Capability to interpret the data based on test results for different parameters of rock characteristics SO5.4- Determination of induced stress and strain in rock mass SO$.5- Application of various methods for in-situ stress and strain measurement		Unit 5- In-situ testing of rocks- Field determination of of strength properties 5.1- Basic properties of in-situ rocks for rock engineering 5.2-Plate loading test 5.3- Interpretation of the stress-strain graph for strain hardened materials 5.4- Deformability of rock mass-Jacking test 5.5- Calculation of Young's modulus of elasticity by using diametrical deformation 5.6- In-situ shear strength test for determination of shear strength of rock 5.7- Internal stresses of rock mass-Methods of measuring strains 5.8- Flat jack testing method 5.9- Process of strain measurement by over-coring method.	Study area: (i)Instrumentation for in-situ determination of stress and strain in rock mass

Suggested Sessional works:

(i) Establishing relationship between test results obtained in in-situ rock conditions and results obtained from rock samples through laboratory tests

(ii) A chronology of advent in instrumentation for measuring and monitoring of stress and strin in rock mass in an induced stress field due to UG space openings.

Topic of Mini Project- How far you foresee the potentiality of the role of instrumentation in designing underground spaces with an futuristic approach?

Brief of Hours suggested for the course outcome:

Course outcomes	Class Lectures (CL)	Laboratory Instructions (LI)	Sessional work (SW)	Self Learning (SL)	Total Hour (CL+LI+SW +SL)
19MI201.1- Garnering concept of underground space technology (UST) based on rock excavation engineering and its importance in urban development	6	0	2	1	9
19MI201.2- Comprehension and application of rock mechanics and soil mechanics principles for underground structure construction	10	0	2	1	13
19MI201.3- Developing engineering skills in tunnel constructions in variable geo-mechanical rock conditions	11	0	2	1	14
19MI201.4- Understanding the reorientation of stresses during single and multiple excavations and determination of their influence zones	9	0	2	1	12
19MI201.5- Development of knowledge and skill for in-situ stress and strain determination of rocks as structural material	9	0	2	1	12
Total Hours	45	0	10	5	60

Suggestions for End semester Assessment:

Suggested Specification Table

COs	Unit Titles	Marks Distribution			Total; Marks
		R	U	A	
CO 1	19MI201.1- Garnering concept of underground space technology (UST) based on rock excavation engineering and its importance in urban development	3	3	1	7
CO 2	19MI201.2- Comprehension and application of rock mechanics and soil mechanics principles for underground structure construction	3	4	3	10
CO 3	19MI201.3- Developing engineering skills in tunnel constructions in variable geo-mechanical rock conditions	3	5	5	13
CO 4	19MI201.4- Understanding the reorientation of stresses during single and multiple excavations and determination of their influence zones	3	5	5	13
CO 5	19MI201.5- Development of knowledge and skill for in-situ stress and strain determination of rocks as structural material	2	3	2	7
	Total	14	20	16	50

Legend: R-Remember U-Understand A-Apply

The end of semester assessment for Underground Space Technology will be held with written examination of 50 marks

Suggested Instructional/ Implementation Strategies:

1. **Improved lectures**
2. Tutorial
3. Case studies
4. Group discussion
5. Role play
6. Visit to mines and mineral processing industries
7. Demonstration
8. Digital media application in teaching learning process and mass media
9. Brainstorming

Suggested Learning Resources

Sl.No	Title	Author	Publisher	Edition & Year
1.				
2.				

COs, POs & PSO Mapping:-

Program Title: M.Tech (Mining Engineering)
Course Code**:** 19MI201
Course Title: Underground Space Technology

	Program Outcomes						Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
Course Outcome	Develop the skilled knowledge of communi-cation in verbal and written forms	Apply the complex systems as part of research projects	Create, select & apply appropriate techniques, resources & modern engineering & IT tools	Understand the impact of professional engineering solutions in societal & environmental practices	Apply ethical principles & commit to professional ethics & responsibilities and norms of the engineering practice	The ability to engage in self-directed, reflective & lifelong learning for the benefit of the society	Dev. Analy tical skill for complex mining problems	Specialized in depth knowledge in specific areas of mining	Capability to comprehend articulated needs for mining industry	Research orientation based on articulated needs
CO 1- Garnering concept of underground space technology (UST) based on rock excavation engineering and its importance in urban development	2	2-	1	1	-2	-1	2	1	1	1
CO 2- Comprehension and application of rock mechanics and soil mechanics principles for	1	-1	-2	-3	2	1	1	1	2	2

underground structure construction										
CO 3- Developing engineering skills in tunnel constructions in variable geo-mechanical rock conditions	2	3	1	1	3	2	2	1	3	1
CO 4- Understanding the reorientation of stresses during single and multiple excavations and determination of their influence zones	2	3	2	3	1	2	2	1	3	1
CO 5- Development of knowledge and skill for in-situ stress and strain determination of rocks as structural material	1	1	2	1	3	2	2	2	3	2

Legend : 1: Low 2: Medium 3: High

Course Curriculum Map:

POs & PSOs Number	COs number & Title	SOs Number	Laboratory Instruction (LI)	Class Room Instructions (CI)	Self Learning (SL)
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 1- Garnering concept of underground space technology (UST) based on rock excavation engineering and its importance in urban development	SO 1.1 SO 1.2 SO 1.3 SO 1.4 SO 1.5		Unit 1- Underground Space Technology- Its objectives 1.1, 1.2, 1.3, 1.4, 1.5, 1.6	SL 1.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 2-Comprehension and application of rock mechanics and soil mechanics principles for underground structure construction	SO2.1 SO 2.2 SO 2.3 SO 2.4 SO 2.5		Unit 2- Classification of rocks & ground deformation on structures 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10	SL 2.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 3- Developing engineering skills in tunnel constructions in variable geo-mechanical rock conditions	SO 3.1` SO 3.2 SO 3.3 SO 3.4 SO 3.5		Unit 3- Tunneling & UG excavations 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10. 3.11	SL 3.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 4- Understanding the reorientation of stresses during single and multiple excavations and determination of their influence zones	SO 4.1 SO 4.2 SO 4.3 SO 4.4 SO 4.5		Unit 4- Stresses around Underground openings 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9	SL 4.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 5- Development of knowledge and skill for in-situ stress and strain determination of rocks as structural material	SO 5.1 SO 5.2 SO 5.3 SO 5.4 SO 5.5		Unit 5- In-situ testing of rocks-Field determination of strength properties 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9.	SL 5`.1

Semester II

Course Code: 19MI202

Course Title: Rock Fragmentation Engineering

Pre-Requisite: Pre-Requisite: The student opting for this course at master's degree level in mining engineering must have obtained his bachelors degree with rock mechanics as one of the subjects. He must possess a sound knowledge of geological aspects, various mining processes and mechanics of solids.

Rationale: Rationale: The student studying this course for their master's degree in mining engineering must develop a sound concept of various mining activities and methods, rock breakage methods including blast free methods.

Course Outcome

19MI202**. 1**: Elaborate Rock Fragmentation by Blasting
19MI202**. 2**: Describe the Fragmentation Measurement Methods
19MI202**. 3:** Evaluate the Blasting Nuisances
19MI202**. 4:** Explain the Mechanical Methods of Fragmentation
19MI202**. 5**Analyse the Special Blasting Techniques and Alternative Rock Breakage Methods

Scheme of studies

Code	Course code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Totaql study Hours (CI+LI+SW+SL)	
Professional Core Course (PCC)	19MI202	Rock Fragmentation Engineering	3	0	1	1	5	3

Legend: **CI:** Class room Instruction (Includes different instructional strategies i.e .Lecture (L) and Tutorial (T) and others),

LI: LaboratoryInstruction(IncludesPracticalperformancesinlaboratoryworkshop, fieldorotherlocationsusingdifferentinstructionalstrategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:
Theory

Code	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment(PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5number 3 marks each (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminar one (SA)	Class Activityan yone (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PCC	19MI202	Rock Fragmentation Engineering	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). Asthecourseprogresses,studntsshouldshowcasetheirmasteryofSessionOutcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

19MI202**. 1:** Elaborate Rock Fragmentation by Blasting

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	12

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO 1.1- Describing the selection of Explosives for Blasting. SO 1.2- Analysing the mechanism of rock fragmentation by blasting. SO 1.3- Explaining the design of multi row blasting in surface mines. SO1.4- Describing the blast casting in surface mines. SO1.5- Analysing the design of blasting rounds in tunnels.		**Unit 1Fragmentation by Blasting** 1.1 Evolution and classification of explosives 1.2 Trends and selection of explosives 1.3 Mechanism of rock fragmentation by blasting 1.4 Meaning and concept of rock fragmentation 1.5 Designing multi row blasting 1.6 Designing blasting rounds in tunnels and drifts 1.7 Controlled blasting techniques 1.8 Casting of rocks 1.9 Rock types	(i) Concept of rock fragmentation by blasting.

Suggested Sessional works: a. Assignments:

1. Discuss the various methods of controlled blasting with suitable diagrams.
2. Describe the evolution and classification of explosives.

b. Topic of Mini Project: PPTs Presentation on controlled blasting techniques.

19MI202**.2:** Describe the Fragmentation Measurement Methods

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	12

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO 2.1- Pre blast and post blast measurements. SO 2.2- Developments in blast performance monitoring. SO2.3- Fragmentation Assessment Techniques. SO 2.4- Documentation in blast monitoring. SO 2.5- Audit and Documentation in blast monitoring.		**UNIT 2: Fragmentation Measurement Methods** 2.1 Blast surveying 2.2 Blast monitoring and instrumentation 2.3 Methods of fragmentation assessment and monitoring 2.4 Recent developments in blast performance monitoring Documentation 2.5 Audit and documentation in blast monitoring 2.6 Computational methods 2.7 Computational methods in blast monitoring. 2.8 Computational methods in blast monitoring continue 2.9 Computational methods in blast monitoring etc	(i) Pre blast and post blast surveys.

Suggested sessional works: a. Assignments:

1) Fragmentation assessment and Monitoring.
2) Recent developments in blast monitoring.

b. Topic of Mini Project-

PPTs Presentation on computational methods in blast monitoring.

19MI202**.3:** Evaluate the Blasting Nuisances

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	12

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO3.1-Developing the concept of air overpressure or air blast. SO3.2-Comprehending the micro and macro level damages due to blasting. SO3.3-Comprehending the fly rocks due to blasting. SO3.4- Analysing the control of blasting damages. SO3.5-Understanding ground vibrations due to blasting.		**UNIT 3:Blasting Nuisances** 3.1 Micro and macro level damages due to blasting 3.2 Ground vibrations due to blasting – An overview 3.3 Air over pressure or air blast 3.4 Fly rocks due to blasting 3.5 Noise pollution 3.6 Control of blasting damages continue 3.7 Control of blasting damages 3.8 ground vibrations due to blasting continue 3.9 ground vibrations due to blasting.	(i) Noise pollution due to blasting

Suggested sessional works

1) Control of blasting damages
2) Fly rocks due to blasting

Topic of Mini Project

PPTs Presentation on micro and macro level damages due to blasting

19MI202**.4:**Explain the Mechanical Methods of Fragmentation

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	12

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO4.1-Comprehending the fundamentals of mechanical methods of fragmentation SO4.2-Acquiring knowledge of rock fragmentation by rollers and disc cutters. SO4.3-Analyzing the fragmentation by ploughs. SO4.4-Garnaring knowledge on fragmentation by shearers. SO4.5-Comprehending rock fragmentation by TBMs.		**UNIT 4 : Mechanical Methods of Fragmentation** 4.1 mechanical methods of fragmentation – some aspects 4.2 Fragmentation by water jets 4.3 Fragmentation by rollers and disc cutters 4.4 Fragmentation by ploughs 4.5 Rock fragmentation by shearers 4.6 Other mechanical methods – 4.7 TBM 4.8 TBM diagram 4.9 Shearer diagram	(i) Other mechanical methods of rock fragmentation.

Suggested sessional works: a. Assignments

1) Rock fragmentation by Water jets.
2) Rock fragmentation by Rollers and Disc Cutters.

b. Topic of Mini Project

PPTs Presentation on Rock fragmentation by mechanical methods.

19MI202**.5:**Analyse the Special Blasting Techniques and Alternative Rock Breakage Methods.

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	1
Total	12

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO5.1-Understanding the special blasting techniques. SO5.2-Aquiring knowledge on alternative methods of rock breakage. SO5.3-Comprehending blasting in hot strata. SO5.4-Describing Nuclear Explosives. SO5.5- Understanding De stress blasting.		**UNIT 5:Special Blasting Techniques and Alternative Rock Breakage Methods** 5.1 De stress Blasting 5.2 Under water blasting 5.3 Demolition blasting 5.4 Smooth blasting 5.5 Blasting in hot strata 5.6 Alternative methods of rock fragmentation - An overview 5.7 Physical methods of rock breakage 5.8 Chemical methods of rock breakage 5.9 Nuclear methods	(i) Alternative methods of rock breakage.

Suggested sessional works

1) Chemical methods of rock breakage.
2) Demolition Blasting.

Topic of Mini Project

PPTs Presentation on Special blasting techniques

Brief of Hours suggested for the course outcome:

Course outcomes	Class Lectures (CL)	Laboratory Instructions (LI)	Sessional work (SW)	Self Learning (SL)	Total Hour (CL+LI+SW +SL)
19MI202**. 1** Elaborate Rock Fragmentation by Blasting	9	0	2	1	12
19MI202**. 2**: Describe the Fragmentation Measurement Methods.	9	0	2	1	12
19MI202**. 3:** Evaluate the Blasting Nuisances	9	0	2	1	12
19MI202**. 4:** Explain the Mechanical Methods of Fragmentation	9	0	2	1	12
19MI202**. 5**Analyse the Special Blasting Techniques and Alternative Rock Breakage Methods	9	0	2	1	12
Total Hours	45	0	10	5	6

Suggestions for End semester Assessment:

Suggested Specification Table

COs	Unit Titles	Marks Distribution			Total; Marks
		R	U	A	
CO 1	Rock Fragmentation by Blasting	3	3	1	7
CO 2	Fragmentation Measurement Methods	3	4	3	10
CO 3	Blasting Nuisances	3	5	5	13
CO 4	Mechanical Methods of Fragmentation	3	5	5	13
CO 5	Special Blasting Techniques and Alternative Rock Breakage Methods Approximate hours:	2	3	2	7
	Total	14	20	16	50

Legend: R-Remember U-Understand A-Apply

The end of semester assessment for Rock Fragmentation Engineering will be held with written examination of 50 marks

Suggested Instructional/ Implementation Strategies:

Improved lectures

Tutorial

Case studies

Group discussion

Role play

Visit to mines and mineral processing industries

Demonstration

Digital media application in teaching learning process and mass media

Brainstorming

Suggested Learning Resources

Sl.No	Title	Author	Publisher	Edition & Year
1.	Engineering Rock Blasting Operations	Bhandari, S.	A.A. Balkema, Rotterdam, Netherlands	First Edition, 1997.
2	Explosives and Blasting Techniques	Pradhan, G.K.	Minetech Publishers, Bhubaneshwar	Third Edition, 2018.
3	Rock Mechanics for Underground Mining	Brady, B.H.G. and Brown, E.T.	Chapman and Hall	Third Edition, 1993
4	Rock Blasting Effects and Operations	Roy, P.P.	Oxford and IBH Publishing Co Private Limited, New Delhi.	First Edition, 2005
5	Explosives and Rock Blasting	Anon	Atlas Powder Company, USA	First Edition, 1989
6	The Modern Technology of Rock Blasting	Langfores, U. and Khilstorm, B.	John Wiley and Sons Inc, NY.	First Edition, 1976.
7	Surface Blast Design	Konya, C.J. and Walter,E.J.	Prentice Hall International inc. USA.	First Edition, 1990.
8	Rock Fragmentation by Blasting - Fragblast 10.	Singh, P.K.	CRC Press, NY - A Balkema Book.	First Edition, 2013
9	Rock Excavation	Compiled by Dr. Sean Dessureault	Arizona University Lecture Series, USA	First Edition, 2006
10	Engineering in Rocks for Slopes, Foundations and Tunnels.	Ramamurthy, T.	Prentice Hall of India Private Limited, New Delhi.	First Edition, 2007.

Curriculum Development Team

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COs, POs & PSO Mapping

Program Title: M. Tech in Mining Engineering
Course Code**:** 19MI202
Course Title: Rock Fragmentation Engineering

	Program Outcomes						Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
Course Outcome	Develop the skilled knowledge of communi-cation in verbal and written forms	Apply the complex systems as part of research projects	Create, select & apply appropriate techniques, resources & modern engineering & IT tools	Understand the impact of professional engineering solutions in societal & environmental practices	Apply ethical principles & commit to professional ethics & responsibilities and norms of the engineering practice	The ability to engage in self-directed, reflective & lifelong learning for the benefit of the society	Dev. Analy tical skill for complex mining problems	Specialized in depth knowledge in specific areas of mining	Capability to comprehend articulated needs for mining industry	Research orientation based on articulated needs
CO1- Elaborate Rock Fragmentation by Blasting	2	2-	1	1	-2	-1	2	1	1	1
CO2- Describe the Fragmentation Measurement Methods	1	-1	-2	-3	2	1	1	1	2	2
CO-3- Evaluate the Blasting Nuisances	2	3	1	1	3	2	2	1	3	1
CO -4- Explain the Mechanical Methods of Fragmentation	2	3	2	3	1	2	2	1	3	1
CO-5 Analyse the Special Blasting Techniques and Alternative Rock Breakage Methods	1	1	2	1	3	2	2	2	3	2

Legend: 1: Low 2; Medium 3: High

Course Curriculum Map:

POs & PSOs Number	COs number & Title	SOs Number	Laboratory Instruction (LI)	Class Room Instructions (CI)	Self Learning (SL)
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO-1: Elaborate Rock Fragmentation by Blasting .	SO 1.1 SO 1.2 SO 1.3 SO 1.4 SO 1.5		Unit 1- Fragmentation by Blasting 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8,1.9,	SL 1.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO-2: Describe the Fragmentation Measurement Methods.	SO2.1 SO 2.2 SO 2.3 SO 2.4 SO 2.5		Unit 2- Fragmentation Measurement Methods. 2.1, 2.2, 2.3, 2.4, 2.5, 2.6,2.7,2.8,2.9,	SL 2.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO- 3: Evaluate the Blasting Nuisances	SO 3.1` SO 3.2 SO 3.3 SO 3.4 SO 3.5		Unit 3- Blasting Nuisances 3.1, 3.2, 3.3, 3.4, 3.5, 3.6,3.7,3.8,3.9	SL 3.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO- 4: Explain the Mechanical Methods of Fragmentation	SO 4.1 SO 4.2 SO 4.3 SO 4.4 SO 4.5		Unit-4: Mechanical Methods of Fragmentation 4.1, 4.2, 4.3, 4.4, 4.5, 4.6,4.7,4.8,4.9,	SL 4.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO -5: Analyse the Special Blasting Techniques and Alternative Rock Breakage Methods	SO 5.1 SO 5.2 SO 5.3 SO 5.4 SO 5.5		Unit 5: Special Blasting Techniques and Alternative Rock Breakage Methods 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9,	SL 5.1

Semester II

Course Code: 19MI203

Course Title: **SUBSIDENCE ENGINEERING**

Pre-Requisite: The student should have adequate knowledge about the Mine Subsidence is the movement of the ground that can occur after underground coal mining. After coal is extracted from beneath the ground, the land above can sink and fill the hollow mine workings. This can cause tilts and strains on the ground surface.

Rationale: The student pursuing Master's degree (M.Tech) in Mining Engineering must develop adequate concept of different mining technologies and their impacts. The mine subsidence is the movement of ground, block, or slope. It is caused by readjustment of overburden due to collapse and failure of underground

Course Outcome:

The student

19MI203.1- Theories of surface and sub-surface subsidence due to mining

19MI203.2- What are the types of subsidence. What are the factors affecting subsidence.

19MI203.3-. Prediction of subsurface. How to plot Subsidence and subsidence graphs and models.

19MI203.4- Special mining methods technology layouts to minimize subsidence.

19MI203.5 Impact of subsidence on structures. How to measure it. How to control it

Scheme of studies:

Code	Course code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total study Hours (CI+LI+SW+SL)	
Professional Elective Course (PEC)	19MI203	Subsidence Engineering	3	0	1	1	5	3

Legend: **CI:** Class room Instruction (Includes different instructional strategies i.e .Lecture (L) and Tutorial (T) and others),

LI: LaboratoryInstruction(IncludesPracticalperformancesinlaboratoryworkshop, fieldorotherlocationsusingdifferentinstructionalstrategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:
Theory

Code	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment(PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5number 3 marks each (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminar one (SA)	Class Activityan yone (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PCC	19MI203	Subsidence Engineering	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). Asthecourseprogresses,studntsshouldshowcasetheirmasteryofSessionOutcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

19MI203**.1:-** Gathering concept of Subsidence Engineering mining based on different Mining Conditions.

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	2
Total	13

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO 1.1- Theories of surface subsidence SO 1.2- Theories of sub surface subsidence SO 1.3- Subsidence due to mining activities SO1.4- Subsidence due to non-mining activities SO1.5- Zones of movement in the overlying beds.		Unit1- Subsidence due to underground mining 1.1- Reasons and concept of surface subsidence 1.2-Defining subsidence development and its concept 1.3-Chronology of the phases for subsidence 1.4- Unique features of Subsidence in mining industry 1.5- Why it is challenging to protect surface structure in mining industry 1.6-Application of principles in Mining Industry 1.7 Precaution before subsidence in under ground 1.8 Precaution before subsidence on the surface 1.9 Detail and in depth study before subsidence	Study area: (i)Contribution of mining industry in national development and its impact due to subsidence (ii) A realistic approach for assessment of impacts of subsidence in mining

Suggested sessional works:

(i) Importance of Mining Industry and need to know about subsidence mining based on principles of sustainable development

(ii) Unique features of Mining Industry- The challenges pertaining to the implementation of sustainability principles

Topic of Mini Project - Impact of subsidence on surface due to underground mining.

19MI203**.2:-** Subsidence in different conditions and different types of minerals and rocks

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	2
Total	13

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO 2.1- Rock kinematics in mining for principles SO 2.2- Types of subsidence SO2.3- Factors affecting subsidence Management Plan SO 2.4- Methods of prediction of subsidence SO 2.5- Empirical, analogue, numerical and physical models		Unit 2- Changes in mining laws for subsidence 2.1-Legislative measures to implement subsidence Indian mining industry 2.2 –factors Affecting subsidence and there precautions 2.3- Types of subsidence and detail study 2.4 Subsidence in coal or metal 2.5 Precautions to be taken during subsidence 2.6- How to get advance information the type and amount of subsidence 2.7- Calculation of amplitude of subsidence by applying empirical formulas 2.8 numerical and Physical Modeling of Subsidence 2.9 Numericals	(i)Changes in mining legislative framework in India in the context of subsidence (ii)Impact of the subsidence on mineral economy in Indian context

Suggested sessional works:

(i) An analysis into the changes in mining legislations in the context of subsidence in mining industry

(ii) Effects of amendments in mining laws on techno-economic parameters of mining industry in India

Topic of Mini Project- An analysis into the feasibility of new and expansion mining projects in subsidence of any depillaring areas

19MI203**.3-** Prediction of subsurface subsidence

Item	Approximate Hours
Class room Instructions (CI)	10
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	2
Total	14

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO3.1- Prediction of subsidence subsurface SO3.2- Subsidence and subsidence models SO3.3- Measurement of subsidence. SO3.4- Impact of mining on Land and Damages due to subsidence SO3.5-. Damages due to pot holing, cracks due to subsidence		Unit 3- Mining activities & impact of Subsidence 3.1-Macro & micro level damages due to subsidence 3.2- Nature and shape of subsidence 3.3- Cracks and widen cracks due to subsidence 3.4- Pot holing due to subsidence 3.5-Action of management due to mining activities 3.6- Measurement of subsidence 3.7-Sources and prevention of damages in the mines 3.8-Measurement of amplitude with the help of equipment 3.9-Land environment and mining activities 3.10-Reclamation of mined out areas	(i) Theoretical in depth studies of the impacts of different mining activities due to subsidence (ii)Acquiring practical knowledge from different case studies of subsidence impacts of mining and their analysis.

Suggested sessional works:

(i) Comparison between damages due to subsidence and underground mining on different types of Rocks

(ii) Importance of land use plan for sustainability of mining industry in Indian context

Topic of Mini Project- Total impact of mining industry on national economy in consideration of sustainability principles and making mining industry socially and environmentally acceptable.

19MI203**.4:-** Short term and Long term perspective of Mining without affecting and damaging the surface features

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	8
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	2
Total	12

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO4.1- Time dependent component of subsidence SO4.2-Acquiring knowledge about subsidence with increase of time SO4.3-Analyzing the limitations of subsidence in India SO4.4- Special mining layouts to minimize subsidence. SO4.5- Study of subsidence of different natures		Unit 4-Subsidence effects with increase of time in Indian context 4.1-Objective of stud7 4.2-Subsidence in coal 4.3-subsidence in other minerals 4.4-Short term and long term study 4.5-Sustainability after subsidence 4.6- Subsidence where over burden is soft 4.7- - Subsidence where over burden is medium 4.8-- Subsidence where over burden is hard	Study area- (i)Impact of subsidence where over burden is soft (ii)In depth study where over burden is very hard in nature

Suggested sessional works:

(i) Due to subsidence Indian context and measures to overcome the limitations

(ii) Strategies in India to balance the Production without much damage to the nature

Topic of Mini Project- How to get permission in forest Area to depillaring without affecting nature

19MI203**.5:-** Impact of subsidence on structures

Approximate hours:

Item	Approximate Hours
Class room Instructions (CI)	9
Laboratory Instructions (LI)	0
Sessional work (SW)	2
Self Learning	2
Total	13

Session Outcomes (SOs)	Laboratory Instructions (LI)	Class Room Instructions (CI)	Self Learning (SL)
SO5.1-Understanding the Subsidence depending upon nature of overlying rocks SO5.2- Impact of subsidence on structures in national as well as in global context SO5.3-Design of Shaft keeping in mind the subsidence near around SO5.4- Importance of shaft pillars during subsidence SO5.5- Precaution during subsidence		Unit 5- Subsidence and its impact 5.1- Impact of subsidence on surface 5.2-Precautions to be taken in underground for regular fall 5.3- In case of coal which method of work is in application 5.4- In case of Long wall Subsidence is very smooth 5.5-In case of Bord and pillar subsidence not smooth 5.6- Now a day's Continuous Miner is in working. Subsidence with CM 5.7-monitoring of regular fall in underground working 5.8-Otherwise Induce Blasting method is to be adopted 5.9-Necessary precautions at the surface	Study area: (i)Nature of subsidence due to different workings methods (ii) How to take permission in forest area for subsidence

Suggested sessional works:

(i) Review of the Subsidence with different types of methods used in underground

(ii) A study of the behavior of a subsidence and measures to improve upon it.

Topic of Mini Project- How far you foresee the potentiality of acquiring surface rights for subsidence in forest area in India?

Brief of Hours suggested for the course outcome:

Course outcomes	Class Lectures (CL)	Laboratory Instructions (LI)	Sessional work (SW)	Self Learning (SL)	Total Hour (CL+LI+SW +SL)
19MI203.1- Theories of surface and sub-surface subsidence due to mining	9	0	2	2	13
19MI203.2- What are the types of subsidence. What are the factors affecting subsidence.	9	0	2	2	13
19MI203.3-. Prediction of subsurface. How to plot Subsidence and subsidence nomograms.	9	0	2	2	13
19MI203.4- Special mining methods technology layouts to minimize subsidence.	10	0	2	2	14
19MI203.5 Impact of subsidence on structures. How to measure it. How to control it	8	0	2	2	12
Total Hours	45	0	10	10	65

Suggestions for End semester Assessment:

Suggested Specification Table

COs	Unit Titles	Marks Distribution			Total; Marks
		R	U	A	
CO 1	Theories of surface and sub-surface subsidence due to mining	3	3	1	7
CO 2	What are the types of subsidence? What are the factors affecting subsidence	3	4	3	10
CO 3	Prediction of subsurface. How to plot Subsidence and subsidence models and graphs.	3	5	5	13
CO 4	Special mining methods technology layouts to minimize subsidence.	3	5	5	13

CO 5	Impact of subsidence on structures. How to measure it. How to control it	2	3	2	7
	Total	14	20	16	50

Legend: R-Remember U-Understand A-Apply

The end of semester assessment for Subsidence Mining will be held with written examination of 50 marks

Suggested Instructional/ Implementation Strategies:

1. **Improved lectures**
2. Tutorial
3. Case studies
4. Group discussion
5. Role play
6. Visit to mines and mineral processing industries
7. Demonstration
8. Digital media application in teaching learning process and mass media
9. Brainstorming

Suggested Learning Resources

Sl.No	Title	Author	Publisher	Edition & Year
1.	Theory and Technology of Rock Excavation	Dingxiang Zou	Springer Verlag, Singapore	2016
2.	Autonomous Rock Excavation	Xiaobo Shi	China	1998
3.	Underground Excavations in Rock	Everet Hoek & ET Brown		1980

Curriculum Development Team

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COs, POs & PSO Mapping:-

Program Title: M.Tech (Mining Engineering)
Course Code**:** 19MI203
Course Title: Subsidence Engineering

	Program Outcomes						Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
Course Outcome	Develop the skilled knowledge of communi-cation in verbal and written forms	Apply the complex systems as part of research projects	Create, select & apply appropriate techniques, resources & modern engineering & IT tools	Understand the impact of professional engineering solutions in societal & environmental practices	Apply ethical principles & commit to professional ethics & responsibilities and norms of the engineering practice	The ability to engage in self-directed, reflective & lifelong learning for the benefit of the society	Dev. Analy tical skill for complex mining problems	Specialized in depth knowledge in specific areas of mining	Capability to comprehend articulated needs for mining industry	Research orientation based on articulated needs
CO1- - Theories of surface and sub-surface subsidence due to mining	2	2-	1	1	-2	-1	2	1	1	1
CO2- - What are the types of subsidence? What are the factors affecting subsidence	1	-1	-2	-3	2	1	1	1	2	2
CO 3- Prediction of subsurface. How to plot Subsidence and subsidence models and graphs.	2	3	1	1	3	2	2	1	3	1
CO 4- Special mining methods technology layouts to minimize subsidence.	2	3	2	3	1	2	2	1	3	1

CO 5- Impact of subsidence on structures. How to measure it. How to control it	1	1	2	1	3	2	2	2	3	2

Legend: 1: Low 2: Medium 3: High

Course Curriculum Map:

POs & PSOs Number	COs number & Title	SOs Number	Laboratory Instruction (LI)	Class Room Instructions (CI)	Self Learning (SL)
PO: 1,2,3,4,5,6 PSO: 1,2,3,4,	CO 1- Theories of surface and sub-surface subsidence due to mining	SO 1.1 SO 1.2 SO 1.3 SO 1.4 SO 1.5		Unit 1- Subsidence due to underground mining 1.1, 1.2, 1.3, 1.4,1.5,1.6, 1.7, 1.8, 1.9	SL 1.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4,	CO 2- What are the types of subsidence? What are the factors affecting subsidence	SO2.1 SO 2.2 SO 2.3 SO 2.4 SO 2.5		Unit 2- Changes in mining laws for subsidence 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9	SL 2.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4,	CO 3- Prediction of subsurface. How to plot Subsidence and subsidence models and graphs.	SO 3.1` SO 3.2 SO 3.3 SO 3.4 SO 3.5		Unit 3- Mining activities & impact of Subsidence 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10.	SL 3.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4,	CO4- Special mining methods technology layouts to minimize subsidence.	SO 4.1 SO 4.2 SO 4.3 SO 4.4 SO 4.5		Unit 4- Subsidence effects with increase of time in Indian context 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8	SL 4.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4,	CO5- Innovative mining technologies and their application for sustainable development.	SO 5.1 SO 5.2 SO 5.3 SO 5.4 SO 5.5		Unit5- Impact of subsidence on surface 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9	SL 5`.1

Semester-II

Course Code: 19MI204

Course Title: Engineering Geology

Pre-requisite: Student should have basic knowledge of scope and purpose of geology, Rocks, Minerals, various methods of age determination of rock and minerals.

Rationale: The students studying Mining Engineering should possess foundational understanding about principles of Stratigraphy mineral resource distribution. They must have knowledge of economic value of minerals. They should be able to prospect the minerals through various methods.

Course Outcomes:

19MI204**.1:** Describe physiographic division of India and geological time scale.
19MI204**.2:** Analyse process of ore formation of economic Mineral deposits.
19MI204**.3:** Demonstrate metallic and non-metallic deposits, their origin and occurrence.
19MI204**.4:** Explain physical properties, processes of occurrence of coal, petroleum and fossil fuels.
19MI204**.5:** Evaluate geophysical prospecting methods, application of remote sensing and GIS.

Scheme of Studies:

Code	Course Code	**Course Title**	**Scheme of studies(Hours/Week)**					**Total Credits (C)**
			Cl	**LI**	**SW**	**SL**	**Total Study Hours(CI+LI+SW+SL)**	
Program Core (PCC)	19MI204	Engineering Geology	3	0	1	1	5	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits.

Note: SW&SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Code	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						**End Semester Assessment (ESA)**	**Total Marks** (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+ CAT+AT)		
PCC	19MI 204	Engineering Geology	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

19MI204.1: Describe physiographic division of India and geological time scale.

Approximate Hours

Item	Approx. Hrs
Cl	9
LI	0
SW	2
SL	1
Total	12

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO1. Describe the Geological time-scale. **SO1.2**Demonstrate Physiographic Division of India. **SO1.3**Interpret Cuddapah System. **SO1.4**Explain Vindhya System. **SO1.5**Describe Gondwana super group.		**Unit1:** Genetic rock structures 1.1 Objectives of Stratigraphy 1.2 Geological time-scale 1.3 Physiographic Division of India 1.4 Cuddapah System 1.5 Vindhya System 1.6 Gondwana super group 1.7 Deccan traps 1.8 Fossil: Definition 1.9 Mode of occurrence	1. Mineral resource distribution.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Explain principles of Stratigraphy.

b. Mini Project:

i. Flow diagram of geological time scale.

19MI204.2: Analyse process of ore formation of economic mine

Approximate Hours

Item	Approx. Hrs
Cl	9
LI	0
SW	2
SL	1
Total	12

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
SO2.1 Describe Elements of economic geology specific gravity. **SO2.2** Explain Process of ore ation of economic Mineral deposits with examples **SO2.3**AnalyseStudy of Metalliferous deposits of India-, Fe, Cu, Mg, Al, Au, Pb, & Zn. **SO2.4** Relate Metallogentic/Mineral ogenetic provinces of India. **SO2.5**Evaluate Petroleum Geology.		**Unit-2:**Economic Geology 2.1Elements of economic geology 2.2 Definition of forms of Ore, Gangue 2.3 Process of ore formation of economic Mineral deposits with examples. 2.4 Study of Metalliferous deposits of India-, Fe, Cu 2.5 Study of Metalliferous deposits of India-Mg, Al, Au 2.6 Study of Metalliferous deposits of India- Pb, & Zn. 2.7Metallogentic provinces of India. 2.8 Mineralogenetic provinces of India. 2.9 Petroleum Geology.	i. Process of ore formation of economic Mineral deposits

SW-2 Suggested Sessional Work (SW):

a. Assignments:

ii. Discuss the process of ore formation of economic minerals.

iii. Write notes on Mn, Cu, Fe.

b. Mini Project:

Show economic minerals zones in India map.

19MI204.**3:** Demonstrate metallic and non-metallic deposits, their origin and occurrence.

Approximate Hours

Item	Approx. Hrs
Cl	9
LI	0
SW	2
SL	1
Total	12

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO3.1 Explain Metallic and Non-metallic deposits. **SO3.2**Evaluate about graphite, copper, zinc, lead, gold. **SO3.3** Discuss about iron, manganese, radioactive minerals, asbestos, mica, and gemstone-origin. **SO3.4**Analyse Mode of occurrence and distribution in India. **SO3.5** Assess Origin and occurrence of industrial minerals- ceramic, refractory, abrasive, glass and paint industry.		**Unit-3 :**Economic Indian Mineral Deposits 3.1 Metallic deposits 3.2 Non-metallic deposits 3.3 Study of graphite, copper. 3.4 Study of zinc, lead, gold. 3.5 Study of iron ,manganese, radioactive minerals, 3.6 Study of asbestos, mica, gemstone-origin 3.7 Mode of occurrence and distribution in India 3.8 Origin and occurrence of industrial minerals- ceramic, refractory 3.9 Origin and occurrence of industrial minerals-glass and paint industry	i. Study of iron, manganese, radioactive minerals, asbestos, mica.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Discuss about iron, manganese, and radioactive minerals, asbestos.
ii. Origin and occurrence of industrial minerals- ceramic.

b. Mini Project:

Prepare a report of economic minerals in India.

19MI204**.4: Explain physical properties, processes of occurrence of coal, petroleum and fossil fuels.**

Approximate Hours

Item	Approx. Hrs
Cl	9
LI	0
SW	2
SL	1
Total	12

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO4.1 Discuss about Origin. **SO4.2** Relate the Physical properties. **SO4.3** Evaluate the Processes. **SO4.4** Demonstrate Occurrence of coal and its types. **SO4.5**Evaluate Fossil fuel distribution in sedimentary basins of India.		**Unit-4:**Coal and Petroleum Geology 4.1Origin of coal 4.2 Explain In situ Theory 4.3Explain the Drift Theory 4.4 Physical properties of coal 4.5 Processes of coal formation 4.4 Occurrence of coal and its types 4.5Petroleumdeposits 4.8 State the distribution of Oil fields in India 4.9 Fossil fuel distribution in sedimentary basins of India	i. Occurrence of coal and its types

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Discuss about Origin.
ii. Evaluate Fossil fuel distribution in sedimentary basins of India.

c. Mini Project:

i. Visit a mining industry and prepare a report on coal deposit.

19MI204.5: Evaluate geophysical prospecting methods, application of remote sensing and GIS.

Approximate Hours

Item	Approx. Hrs
Cl	9
LI	0
SW	2
SL	1
Total	12

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO5.1 Describe Geophysical prospecting methods. **SO5.2** Apply Seismic electrical, magnetic and gravity methods of mineral. Prospecting. **SO5.3**Analyse Introduction to aerial and satellite remote sensing. **SO5.4**Evaluate Application of remote sensing in geological mapping and mineral exploration. **SO5.5** Judge Application of GIS in geological mapping and mineral exploration.		**Unit 5:** Geophysics, Remote Sensing and GIS 5.1 Objectives: Guide lines for location of mineral deposits 5.2 Prospecting methods principles 5.3 Geophysical prospecting methods 5.4 Seismic electrical 5.5 magnetic and gravity methods of mineral prospecting 5.6 Introduction to aerial and satellite remote sensing 5.7 Application of remote sensing in geological mapping 5.8 Application of remote sensing in mineral exploration 5.9 Application of GIS in geological mapping and mineral exploration	1. Application of remote sensing in geological mapping.

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Seismic electrical, magnetic and gravity methods of mineral.

b. Mini Project:

Prepare power point presentation for application of Remote sensing.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+LI+SW+Sl)
19MI204**.1:** Describe physiographic division of India and geological time scale.	9	0	2	1	12
19MI204**.2:** Analyse process of ore formation of economic Mineral deposits.	9	0	2	1	12
19MI204**.3:** Demonstrate metallic and non-metallic deposits, their origin and occurrence.	9	0	2	1	12
19MI204**.4:** Explain physical properties, processes of occurrence of coal, petroleum and fossil fuels.	9	0	2	1	12
19MI204**.5:** Evaluate geophysical prospecting methods, application of remote sensing and GIS.	9	0	2	1	12
Total Hours	45	0	10	5	60

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Stratigraphy	03	01	01	05
CO-2	Economic Geology	02	06	02	10
CO-3	Types of Cement Manufactured in India	03	07	05	15
CO-4	Economic Indian Mineral Deposits	-	10	05	15
CO-5	Geophysics, Remote Sensing and GIS	03	02	-	05
Total		11	26	13	50

Legend: R: Remember, U: Understand, A:Apply

The end of semester assessment for engineering Geology will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Demonstration
7. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
8. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition& Year
1	Introduction to Geology	G.B.Mahapatra	CBS Publishers And Distributors Pvt Ltd	2017
2	A Text Book of Geology	P.K.Mukherjee	World press	2013
3	Engineering And General Geology	ParbinSingh	Katson Educational Series	2013

(b) Web link:

https://geology.com/

https://archive.nptel.ac.in/Harddisk/Direct_Download.html

https://epathshala.nic.in/

https://swayam.gov.in/

Curriculum Development Team

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Cos, Pos and PSOs Mapping

Program Title: M. Tech. Mining Engineering

Course Code: 19MI204

Course Title: Engineering Geology

Course Outcomes	Program outcome						Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
	Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool usage	The engineer and society	Develop analytical skills in identifying and accordingly take actions for solution of mining problems.	Should develop sufficient knowledge about the economic, environmental and societal impacts of mining and basic concepts of mitigation measures.	Develop sufficient skill in project evaluation techniques, mine management, conflict resolution management and general management and safety in mines.	Development of the base for innovation & research in the field of mining engineering.
CO-1 Describe physiographic division of India and geological time scale.	1	2	1	1	1	2	2	3	2	1
CO-2 Analyse process of ore formation of economic Mineral deposits.	1	1	2	2	1	2	2	1	2	1
CO-3 Demonstrate metallic and non-metallic deposits, their origin and occurrence. of rocks and minerals	1	1	1	1	1	2	1	1	2	2
CO-4 Explain physical properties, processes of occurrence of coal, petroleum and fossil fuels. of Minerals.	2	2	3	2	3	2	3	3	3	2
CO-5 Evaluate geophysical prospecting methods, application of remote sensing and GIS.	1	2	1	1	1	3	3	3	1	3

Legend:1–Low,2–Medium,3–High

Course Curriculum Map:

Pos & PSOs No.	Cos No. & Titles	SOs No.	Laboratory Instruction	Classroom Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 PSO1,2,3,4	CO-1 Describe physiographic division of India and geological time scale.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5		Unit-1.0 Stratigraphy 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9	SL 1.1
PO1,2,3,4,5,6 PSO1,2,3,4	CO- 2 Analyse process of ore formation of economic Mineral deposits.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		Unit-2 Economic Geology 2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9	SL 2.1
PO1,2,3,4,5,6 PSO1,2,3,4	CO-3 Demonstrate metallic and non-metallic deposits, their origin and occurrence.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 : Economic Indian Mineral 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9	SL 3.1
PO1,2,3,4,5,6 PSO1,2,3,4	CO-4 Explain physical properties, processes of occurrence of coal, petroleum and fossil fuels.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4: Coal and Petroleum Geology 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9	SL 4.1
PO1,2,3,4,5,6 PSO1,2,3,4	CO -5 Evaluate geophysical prospecting methods, application of remote sensing and GIS.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		Unit5: Geophysics, Remote Sensing and GIS 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8,5.9	SL 5`.1

Semester-II

Course Code:	19MI205
Course Title:	Drilling Technology
Pre-requisite:	Student should have basic knowledge of shaft sinking, methods of shaft sinking, drilling and blasting parameters of mining and methods of tunnels making.
Rationale:	The students studying should possess foundational understanding about Student should have basic knowledge of shaft sinking, methods of shaft sinking, drilling and blasting parameters of mining and methods of tunnels making. Additionally, students ought to acquire fundamental insights into various drilling machines technology, blast design parameters of open cast mining.

Course Outcomes:

19MI205.1: Understand the knowledge of prospecting, methods of exploration.
19MI205.2: Acquired the knowledge of different shaft sinking methods, working cycle of shaft sinking.
19MI205.3: Understanding of the special types of shaft sinking methods, safety in shaft sinking and statutory provisions as laid down under CMR, MMR issued by DGMS.
19MI205.4: Understanding of the knowledge of explosive properties, blast design parameters in open cast mining and types of different drilling machines.
19MI205.5: Understanding of the preparation of tunnels, Drivage techniques with blasting.

Scheme of Studies:

Code	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits(C)
			Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
Program Core(PCC)	19MI205	Drilling Technology	3	0	1	1	5	3

Legend: **CI:** Class room Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW&SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:
Theory

Code	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment(PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/HomeAssignment5number 3 mark seach (CA)	Class Test2 (2bestout of3) 10 marks each(CT)	Seminarone (SA)	Class Activity anyone (CAT)	Class Attendance (AT)	Total Marks CA+CT+SA+CAT+AT)		
PCC	19MI205	Drilling Technology	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should show case their mastery of Session Outcomes(SOs),culminating in the over all achievement of Course Outcomes (COs) upon the course's conclusion.

19MI205**.1:** Understand the knowledge of prospecting, methods of exploration.

Approximate Hours

Item	AppXHrs
Cl	09
LI	0
SW	1
SL	2
Total	12

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO1.1 Definitions, prospecting, shaft, bore holes **SO1.2** Methods of exploration **SO1.3**Borehole logging, deflection of boreholes **SO1.4** Fishing tools and exploratory drilling SO1.5 Surface layout		**Unit-1.0General Introduction** 1.1 Definitions – Reconnaissance; principles and 1.2 methods of prospecting – pit, shaft, trench and boreholes; 1.3 Methods of Exploration, 1.4 Selection of sites for boreholes; Surface layout of boring; 1.5Details of equipment, 1.6 Borehole logging; Maintenance of records; 1.7Deflection of boreholes; 1.8Difficulties in boring; Fishing tools and their uses; 1.9Methods of exploratory drilling for oil; Interpretation of borehole data.	1. Borehole logging; Maintenance of records; Deflection of boreholes; 2. Difficulties in boring; Fishing tools and their uses;

SW-1Suggested Sessional Work(SW):

a. Assignments:

i. Exploration methods

19MI205**.2:** Acquired the knowledge of different shaft sinking methods, working cycle of shaft sinking.

Approximate Hours

Item	AppXHrs
Cl	09
LI	0
SW	1
SL	2
Total	12

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO2.1 ToUnderstand the mine entries, location **SO2.2** To learn about preparatory work required of shaft sinking **SO2.3**Tounderstand the shaft sinking methods **SO2.4**To understand the sinking cycle **SO2.**5 To learn about the support system of shaft sinking		**Unit 2 Shaft Sinking I** 2.1 Shaft Sinking - I - Mine Entries - Choice, location and 2.2 size of mine entries, Access to seated deposits by Adit/Drifts/Incline- 2.3 Introduction – Selection - Location - Preparatory work required - 2.4 Sinking appliances, equipment and services – 2.5 Sinking methods and procedure – 2.6 Reaching up to the rock head - Pre-sink - Sinking through the rock- 2.7 Shaft centering-Cycle (Drilling, Blasting, Lashing and 2.8 mucking-Hoisting - Support or shaft lining – 2.9 Auxiliary operations - Dewatering – Ventilation-Illumination)	i. Mine entries, location of mine ii. Methods of shaft sinking

SW-2 Suggested Sessional Work(SW):

a. Assignments:

i. Shaft sinking methods

19MI205**.3:** Understanding of the special types of shaft sinking methods, safety in shaft sinking and statutory provisions as laid down under CMR, MMR issued by DGMS.

Approximate Hours

Item	AppX Hrs
Cl	09
LI	0
SW	1
SL	2
Total	12

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO3.1 Special methods of shaft sinking **SO3.2 C**ementation method **SO3.3** Drilling and boring **SO3.4** Safety features as per requirement of CMR **SO3.5**Freezing methods		**Unit-3 : Shaft Sinking II** **3.1** Shaft Sinking – II - Station construction and initial development(Cross-measure drifts and laterals) **3.2** Special methods of shaft sinking - Piling system-Caisson method-Sinking drum process-Forced drop- 3.4 shaft method -Pneumatic caisson method – 3.5 Special methods by temporary or permanent isolation of water - Cementation – 3.6 Boring/Drilling-Cementation - Sinking and Walling 3.7 The freezing process - Drilling and lining of boreholes-Formation and maintenance of the ice column -Actual sinking operations - Thawing of ice wall – 3.8 Freezing – Shafts - Shaft drilling and boring - Shaft drilling Shaft boring- 3.9 Safety in sinking shafts & Statutory provisions as laid down under CMR, MMR & Circulars issued by DGMS.	i. Shaft sinking methods ii. Freezing methods and Safety provisions

SW-3 Suggested Sessional Work(SW):

a. Assignments:

1. Special Shaft sinking methods

19MI205**.4:** Understanding of the knowledge of explosive properties, blast design parameters in open cast mining and types of different drilling machines.

Approximate Hours

Item	AppXHrs
Cl	09
LI	0
SW	1
SL	2
Total	12

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
O4.1 Understand the drilling machine **SO4.2** Explosive properties **SO4.3 Blast design parameters** **SO4.4** Fragmentation **SO4.**5 Advances in Blasting	.	**Unit-4 Drilling and Blasting** 4.1 Drilling – Introduction-selection-application-classification- 4.2 construction of few drill machines –drill bits – operation & maintenance etc. 4.3 Explosives & Accessories used in Mines – Selection-Classification-Properties-Testing- 4.4 Underground Coal Mines – Permitted &Non-Permitted 4.5 Explosives-Explosives used in Quarries 4.6 Opencast Mines (details of selection, blast design, will be taught in Surface Mining) – Storage-Transport of explosives & accessories – 4.8 Theories of Blasting 4.8 Environmental Impact due to Blasting – 4.9 Safety during Blasting – Advances in Blasting	i. Blast design parameters in mining ii. Types of explosives

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Blast design parameters

19MI205**.5:** Understanding of the preparation of tunnels, Drivage techniques with blasting.

Approximate Hours

Item	AppXHrs
Cl	09
LI	0
SW	1
SL	2
Total	12

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO5.1 Conventional methods of tunnels **SO5.2** Over view of site investigation **SO5.3** Role of the techniques in blasting **SO5.4** Post blasting handling **SO5.**5 Support system		**Unit 5: Drifts/Drivages & Tunnels** 5.1 (Conventional Methods) 5.2 Introduction – Preparations for driving drivages/tunnels- 5.3 Site investigations - Location of - Rocks and ground 5.4 characterization-Size, shape, length and orientation (route) - function of drives and tunnels - Drivage techniques (for drives and tunnels) – 5.5 Drivage techniques with blasting (Pattern of holes - Blasting off the solid in 5.6 UG Gassy seams- Pattern of Holes- Charging and blasting the rounds - Placement of primer - 5.7 Stemming - Depth of round/hole - Charge density in cut-holes and rest of the face area – Smooth blasting). 5.8 Post Blast Handling - Muck disposal and handling (mucking and transportation) - 5.9 Ventilation during drivage/ tunneling - Working cycle (including auxiliary operations)-Driving large sized drives/tunnels in tough rocks	1. Methods of tunnels 2. Blasting techniques

SW-5 Suggested Sessional Work(SW):

a. Assignments:

Support system

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory Instruction (LI)	SessionalWork (SW)	Self Learning (Sl)	Total hour(Cl+SW+Sl)
19MI205.1: Understand the knowledge of prospecting, methods of exploration	9	0	1	2	12
19MI205**.2:** Acquired the knowledge of different shaft sinking methods, working cycle of	9	0	1	2	12
19MI205.3: Understanding of the special types of shaft sinking methods, safety in shaft sinking and statutory provisions as laid down under CMR, MMR issued by DGMS.	9	0	1	2	12
19MI205**.4:** Understanding of the knowledge of explosive properties, blast design parameters in open cast mining and types of different drilling machines.	9	0	1	2	12
19MI205.5: Understanding of the preparation of tunnels and Drivage techniques with blasting.	9	0	1	2	12
Total Hours	45	0	5	10	60

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Understand the knowledge of prospecting, methods of exploration	03	01	01	05
CO-2	Acquired the knowledge of different shaft sinking methods, working cycle of shaft sinking.	02	06	02	10
CO-3	Understanding of the special types of shaft sinking methods, safety in shaft sinking and statutory provisions as laid down under CMR, MMR issued by DGMS.	07	05	03	15
CO-4	Understanding of the knowledge of explosive properties, blast design parameters in open cast mining and types of different drilling machines.	03	03	04	10
CO-5	Understanding of the preparation of tunnels and Drivage techniques with blasting.	03	02	05	10
Total		14	23	13	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for drilling technology will be held with written examination of 50 marks.

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to mining industry
7. Demonstration
8. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog, Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
9. Brainstorming

Suggested Learning Resources:

(a)Books:

S. No.	Title	Author	Publisher	Edition &Year
1	Elements Of Mining Technology	D.J. Deshmukh	Denett & Co. Nagpur, N e w Delhi, Chennai P u n e	2016
2	Mining Competition Handbook (For GATE, Overman, Mining Sirdar and others competitive exams)	Dr. Sandeep Prasad	Orange Books Publication	1st and 2023
3	Das, S.K., Surface Mining Technology, Lovely Prakashan, Dhanbad			
4.	Kennedy, B.A.(Editor), 1990, Surface Mining, SME, USA, 2nd Edition.			

Web Link:

https://en.wikipedia.org/wiki/Drilling_and_blasting

https://core.ac.uk/download/pdf/53188886.pdf

Curriculum Development Team

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Cos, Pos and PSOs Mapping

Program Title: M. Tech. Mining Engineering

Course Code: **19MI205**

Course Title: Drilling Technology

Course Outcomes	Program outcome						Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design/ development of solutions	Conduct investigations of complex problems	Modern Tool usage	The engineer and society	Develop analytical skills in identifying and accordingly take actions for solution of mining problems.	Should develop sufficient knowledge about the economic, environmental and societal impacts of mining and basic concepts of mitigation measures.	Develop sufficient skill in project evaluation techniques, mine management, conflict resolution management and general management and safety in mines.	Development of the base for innovation & research in the field of mining engineering.
CO1 : Understand the knowledge of prospecting, methods of exploration	1	2	1	1	1	2	2	3	2	1
CO 2 : Acquired the knowledge of different shaft sinking methods, working cycle of shaft sinking.	1	1	2	2	1	2	2	2	2	1
CO3 : Understanding of the special types of shaft sinking methods, safety in shaft sinking and statutory provisions as laid down under CMR, MMR issued by DGMS.	2	2	1	1	1	2	1	1	2	2
CO4: Understanding of the knowledge of explosive properties, blast design parameters in open cast mining and types of different drilling machines.	2	2	3	2	3	2	3	3	3	2
CO5: Understanding of the preparation of tunnels and Drivage techniques with blasting.	1	2	1	1	1	3	3	3	1	3

Legend: 1–Low, 2–Medium, 3–High

Course Curriculum Map:

Pos & PSOs No.	Cos No. & Titles	SOs No.	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO1,2, 4, 5,6 PSO1,2,3,4	CO1 : Understand the knowledge of prospecting, methods of exploration	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5		Unit-1.0 General Introduction 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9	SL 1.1
PO1,2, 4, 5,6 PSO1,2,3,4	CO 2 Acquired the knowledge of different shaft sinking methods, working cycle of shaft sinking.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		Unit-2 Shaft Sinking I 2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9	SL 2.1
PO1,2, 4, 5,6 PSO1,2,3,4	CO3 Understanding of the special types of shaft sinking methods, safety in shaft sinking and statutory provisions as laid down under CMR, MMR issued by DGMS.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 : Shaft Sinking II 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9	SL 3.1
PO1,2, 4, 5,6 PSO1,2,3,4	CO 4: Understanding of the knowledge of explosive properties, blast design parameters in open cast mining and types of different drilling machines.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4: Drilling and Blasting 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9	SL 4.1
PO1,2,3,4, 5,6 PSO1,2,3,4	CO 5: Understanding of the preparation of tunnels and Drivage techniques with blasting.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		Unit5: Drifts / Drivages and Tunnels 5.1,5.2,5.3,5.4,5.5, 5.6,5.7,5.8,5.9	SL 5.1

Semester II

Course Code: 19MI251

Course Title : Applied Rock Mechanics -` Lab

Pre-requisite: Student should have basic knowledge of stress and stress field, and properties of rock mass.

Rationale: The students studying advance rock mechanics will acquire stress and deformation related instrumentation like load cell, convergence recorder, bore hole extensometer. Students will acquire knowledge of measuring in situ and induced stresses. Students will acquire knowledge of Numerical modeling of rock masses and applications of numerical analysis.

Course Outcomes: The students will be able to

19MI251**.1:** Interpret Stress State and design of Local and Mass Support System (Rock Enforcement).
19MI251**.2:** Apply stress and deformation related instrumentation to measure rock movement and interpretation of data
19MI251**.3:** Predict surface subsidence and assess rock bursts and bump. Apply measures to control subsidence and bursts.
19MI251**.4:** Analyse mechanism of caving and slope failure. Apply FLAC 3D and FLAC 2D to assess slope failure.
19MI251**.5:** Apply numerical analysis in geo mechanics by using different methods of numerical modeling of rock masses and computational methods too.

Scheme of Studies

Code	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours(CI+SW+SL)	
PCC	19MI251	Applied Rock Mechanics -` Lab	0	4	0	0	4	2

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW&SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:
Practical

Code	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
PCC	19MI251	Applied Rock Mechanics - ` Lab	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

19MI251**.1:** Interpret Stress State and design of Local And Mass Support System (Rock Enforcement).

Approximate Hours

Item	AppXHrs
Cl	0
LI	4
SW	2
SL	1
Total	7

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO1.1 T o study about various types of stress fields **SO1.2** To find stresses around narrow and circular openings **SO1.3** Design of support system in bord and pillar **SO1.4** Evaluate various supports in longwall workings **So1.**5 Assess pressure on supports by instrumentation .	1.1Bore hole Extensometer and measurement of displacement with its help. 1.2 Measurement f strain by tape extensometer.		1. Various methods of designing support system in underground

SW-1 Suggested Sessional Work (SW):

a. Assignments:

1. Design of support system in development district of bord and pillar from given data

b. Mini Project:

1. Strata monitoring devices and its applicability study

19MI251**.2:** Apply stress and deformation related instrumentation to measure rock movement and interpretation of data

Approximate Hours

Item	AppXHrs
Cl	0
LI	4
SW	2
SL	1
Total	7

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO2. Read the rock movement and interpret it . **SO2.2** Identify location of installing instrument to measure convergence. **SO2.3**To understands the out-come reading of recorder and suggests measures for safety of persons. **SO2.4**To calculate in situ stresses from the data. **SO2.**5 To lean use of instruments of measuring induced stresses.	I1.Load cell and measurement of convergence I.2.Flat jack method and measurement of in situ stress .		i. Different types of ISRM in situ stress measurements ex USBM, CSIRO.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Collect data and details of different types of load cells.
ii. Study different types of bore hole extensometers and compare their efficacy.

b.Mini Project:

Plan a plan for installation of strata monitoring instrument in depillaring district of bord and pillar working.

19MI251**.3: :** Predict surface subsidence and assess rock bursts and bump. Apply measures to control subsidence and bursts.

Approximate Hours

Item	AppXHrs
Cl	0
LI	4
SW	2
SL	1
Total	7

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO3.1 Predict surface subsidence and bump. **SO3.2** Measurement of subsidence and showing in graph. **SO3.3** Preventive measures of subsidence at surface and taking safety measures. **SO3.4** Rock burst and bump prediction. **SO3.**5 Preventive measures of rock burst and bumps	1.Determination of ground vibrations with seismograph , and its effect on design of slopes 2.Factors influencing the stability of slope . Design for maintaining slope in adverse conditions		1 study of subsidence and its types and monitoring of subsidence

SW-3 Suggested Sessional Work (SW):

a. Assignments:

1 Problem on subsidence

2 Rock bumps and bursts.

b. Mini Project:

Study of rock burst and bumps in chinakuri mine and KGF

19MI251**.4** Analyse mechanism of caving and slope failure. Apply FLAC 3D and FLAC 2D to assess slope failure.

Approximate Hours

Item	AppXHrs
Cl	0
LI	4
SW	2
SL	2
Total	8

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO4.1 knowledge on mechanics of caving and caving cavability index **SO4.2** understanding the parameters of slope design **SO4.3** ; Analysis of slope failure **SO4.4** Study of drainage and reinforcement of slopes **SO4.**5 Using SSR for interpreting of slopes stability	LI1.Mechanism of rock bursting bumps and factors influencing it . LI2.Shorcreting method of support – principle , application etc..	.	1. Different types of slope failure and their cause 2. Different Methods of analysis of slope failure

SW-4 Suggested Sessional Work (SW):

a. Assignments

1. Design of opencast slopes
2. Calculations of FOS of slopes of dumps

b. **Mini Project:**

1. Case study on slope failure of RAJ MAHAL Opencast

19MI251**.5**: Apply numerical analysis in geo mechanics by using different methods of numerical modeling of rock masses and computational methods too.

Approximate Hrs

Item	AppXHrs
Cl	0
LI	4
SW	2
SL	1
Total	7

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO5.1 Knowledge on computational methods for numerical techniques **SO5.2** Various applications of numerical methods **SO5.3** Studying FEM and FDM methods of numerical modeling **SO5.4** Studying of DEM and MFM methods of numerical modeling **SO5.**Analysis of slope stability using FLAC 2D and FLAC 3D	LI 1 design of support system LI2.Application of numerical methods in geo –mechanics .		**1.** Analysis of slope stability using flac 2d and flac 3d using acquired data

SW-5 Suggested Sessional Work (SW):

a. Assignments:

1. Principles of working of various NUMERICAL MODELLING methods

b. Mini Project:

1. Analysis of slope stability using FLAC 2D and FLAC 3D

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Laboratory Instruction (LI)	Sessional Work (SW)	Self Learning (SL)	Total hour (Cl+SW+Sl)
19MI251-**L.1:** Interpret Stress State and design of Local and Mass Support System (Rock Enforcement).	0	4	2	1	7
19MI251-**L.2:** Apply stress and deformation related instrumentation to measure rock movement and interpretation of data	0	4	2	1	7
19MI251-**L.3:** Predict surface subsidence and assess rock bursts and bump. Apply measures to control subsidence and bursts.	0	4	2	1	7
19MI251-**L.4:** Analyse mechanism of caving and slope failure. Apply FLAC 3D and FLAC 2D to assess slope failure.	0	4	2	2	8
19MI251-**L.5:** Apply numerical analysis in geo mechanics by using different methods of numerical modeling of rock masses and computational methods too.	0	4	2	1	7
Total Hours	60	20	10	6	36

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Interpret Stress State and design of Local and Mass Support System (Rock Enforcement).	03	01	01	05
CO-2	Apply stress and deformation related instrumentation to measure rock movement and interpretation of data	02	06	02	10
CO-3	Predict surface subsidence and assess rock bursts and bump. Apply measures to control subsidence and bursts.	03	07	05	15
CO-4	Analyse mechanism of caving and slope failure. Apply FLAC 3D and FLAC 2D to assess slope failure.	-	10	05	15
CO-5	Apply numerical analysis in geo mechanics by using different methods of numerical modeling of rock masses and computational methods too.	03	02	-	05
Total		11	26	13	50

Legend: R:Remember, U:Understand, A:Apply

The end of semester assessment for advance rock mechanics -` lab will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to mining plant
7. Demonstration
8. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook ,Twitter,Whatsapp,Mobile,Onlinesources)
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition &Year
1	Fundamentals and applications of Rock Mechanics	Deb Debasis	PHI Learning Pvt. Ltd.	2016
2	Introduction to rock mechanics by IBM	IBM	IBM	

Link

https://nptel.ac.in/

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Cos, Pos and PSOs Mapping

Program Title: Master of Technology in Mining Engineering

Course Code**:** 19MI251

Course Title: Applied Rock Mechanics -` Lab

	Program Outcomes						Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
Course Outcome	Develop the skilled knowledge of communi-cation in verbal and written forms	Apply the complex systems as part of research projects	Create, select & apply appropriate techniques, resources & modern engineering & IT tools	Understand the impact of professional engineering solutions in societal & environmental practices	Apply ethical principles & commit to professional ethics & responsibilities and norms of the engineering practice	The ability to engage in self-directed, reflective & lifelong learning for the benefit of the society	Develop analytical skill for complex mining complex mining problems	Specialized in depth knowledge in specific areas of mining	Capability to comprehen d articulated needs for mining industry	Research orientation based on articulated needs
CO1- Garnering the fundamental concept of In-situ Stresses	2	2-	1	1	-2	-1	2	1	1	1
CO2- Describe the various types of Stress Around Mine Opnings	1	-1	-2	-3	2	1	1	1	2	2
CO 3- Analyse the Design of Mine Openings and Pillars	2	3	1	1	3	2	2	1	3	1
CO 4- Explain the Design of Support and Goaf Support	2	3	2	3	1	2	2	1	3	1
CO 5- Elaborates the concepts of Rock Bursts, Bumps and Mine Subsidence	1	1	2	1	3	2	2	2	3	2

Legend: 1: Low 2: Medium 3: High

Course Curriculum Map

POs & PSOs Number	COs number & Title	SOs Number	Laboratory Instruction (LI)	Class Room Instructions (CI)	Self Learning (SL)
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 1-Garnering the fundamental concept of In-situ Stresses	SO 1.1 SO 1.2 SO 1.3 SO 1.4 SO 1.5	1.1 1.2		SL 1.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 2: Describe the various types of Stress Around Mine Openings.	SO2.1 SO 2.2 SO 2.3 SO 2.4 SO 2.5	2.1 2.2		SL 2.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 3- Analyse the Design of Mine Openings and Pillars	SO 3.1` SO 3.2 SO 3.3 SO 3.4 SO 3.5	3.1 3.2		SL 3.1
PO: 1,2,3,4,5,6 PSO: 1,2,3,4	CO 4- Explain the Design of Support and Goaf Support.	SO 4.1 SO 4.2 SO 4.3 SO 4.4	4.1 4.2		SL 4.1

		SO 4.5			
	CO 5- Elaborates the concepts of Rock Bursts, Bumps and Mine Subsidence.	SO 5.1 SO 5.2 SO 5.3 SO 5.4 SO 5.5	5.1 5.2		SL 5.1

Semester II

Course Code: 19MI252

Course Title: Seminar

Pre- requisite: Conduct research to resolving the problem of mining operations like blasting, vibration, safety etc. by applying advanced technology adopted in field of mining industries.

Rationale: The basic purpose of M. Tech research is to understand the application of research methodology tools to do research on particular topic related to mining and follow technical writing skill to design the synopsis, thesis, research paper, abstract, articles, etc as per results obtained during research studies.

Course Outcomes:

PROJ-MIN05 Propose research methodology tools for conducting research on selected topic of mining field and prepare Final manuscript i.e. Thesis

Scheme of Studies:

CODE	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
PROJ	19MI252	Seminar	0	0	0	0	2	1

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),**LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)**SW:** Sessional Work (includes assignment, seminar, mini project etc.),**SL:** Self Learning, **C:**Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

CODE	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks(PRA + ESA)
			Class/Home Assignment 5 number3 markseach(CA)	ClassTest 2(2 bestout of3)10 marks each(CT)	Seminar one	Class Activity anyone(CAT)	Class Attendance(AT)	Total Marks(CA+CT+SA+ CAT+AT)		
PROJ	19MI252	Seminar	0	0	0	0	0	0	100	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

19MI252 propose seminar tools for conducting research on selected topic of mining field and prepare Final manuscript i.e. Thesis .

Approximate Hours

Item	Approximate Hours
CI	**0**
LI	**2**
SW	**0**
SL	**30**
Total	**32**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1. Choose the topic and objectives for the research.	**1** Perform research work as per their topic by using various tools and production technology methods in particular season of crop.		**1.** Finding of reviews related with the topic of research. **2.** Preparation of manuscripts related to concerned topic.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab Instruction (LI)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
PROJ-MIN05 Propose research methodology tools for conducting research on selected topic of mining field and prepare Final manuscript i.e. Thesis .	0	2	30	32
Total	0	2	30	32

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Group Discussion
3. Demonstration
4. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Research publications			
2	Science direct			
3	Research gate			
5	Academia			
6	Multi authored books			
7	Book chapters			

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6. Prof P K Palit, Department of Mining Engineering, AKS University, Satna
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8. Er. P. S. Tiwari, Department of Mining Engineering, AKS University, Satna
9. Er. P. C. Tiwari, Department of Mining Engineering, AKS University, Satna
10. Er. Ramesh Kant, Department of Mining Engineering, AKS University, Satna

Cos, POs and PSOs Mapping

Course Code: 19MI252
Course Title: -Seminar

	Program Outcomes						Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
Course Outcome	Develop the skilled knowledge of communication in verbal and written forms	Apply the complex systems as part of research projects	Create, select & apply appropriate techniques, resources & modern engineering & IT tools	Understand the impact of professional engineering solutions in societal & environmental practices	Apply ethical principles & commit to professional ethics & responsibilities and norms of the engineering practice	The ability to engage in self-directed, reflective & lifelong learning for the benefit of the society	Dev. Analytical skill for complex mining problems	Specialized in depth knowledge in specific areas of mining	Capability to comprehend articulated needs for mining industry	Research orientation based on articulated needs
CO1- Propose seminar tools for conducting research on selected topic of mining field and prepare Final manuscript	2	2-	1	1	1	1	2	1	1	1

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6, PSO 1,2, 3, 4,	19MI252 Propose seminar tools for conducting research on selected topic of mining field and prepare Final manuscript	**SO1.1**	**1.1**Submission of research proposal consisting concern programme		SL 1.1

Semester III

Course Code: 19MI352

Course Title: Dissertation – Interim Evaluation

Pre- requisite: Conduct research to resolving the problem of mining operations like blasting, vibration, safety etc. by applying advanced technology adopted in field of mining industries.

Rationale: The basic purpose of M. Tech Dissertation – Interim Evaluation is to understand the application of research methodology tools to do research on particular topic related to mining and follow technical writing skill to design the synopsis, thesis, research paper, abstract, articles, etc as per results obtained during research studies.

Course Outcomes:

PROJ-MIN05 Propose Dissertation – Interim Evaluation tools for conducting research on selected topic of mining field and prepare Final manuscript i.e. Thesis

Scheme of Studies:

CODE	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
RESEARCH PROJ	19MI352	Dissertation – Interim Evaluation	0	10	0	0	10	5

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),**LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)**SW:** Sessional Work (includes assignment, seminar, mini project etc.),**SL:** Self Learning, **C:**Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

CODE	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks(PRA + ESA)
			Class/Home Assignment 5 number3 markseach(CA)	ClassTest 2(2 bestout of3)10 marks each(CT)	Seminar one	Class Activity anyone(CAT)	Class Attendance(AT)	Total Marks(CA+CT+SA+CAT+AT)		
RESEARCH PROJ	19MI352	Dissertation – Interim Evaluation	0	0	0	0	0	0	100	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

19MI352 Propose research methodology tools for conducting research on selected topic of mining field and prepare Final manuscript i.e. Thesis .

Approximate Hours

Item	Approximate Hours
CI	**0**
LI	**10**
SW	**0**
SL	**30**
Total	**40**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1. Choose the topic and objectives for the research. **SO2.** Select the suitable data during the research. **SO3.** Assemble the data taken during the research for interpretation. **SO4.** Arrange the whole work with the interpretate data.	**1** Perform research work as per their topic by using various tools and production technology methods in particular season of crop. **2**. Collection of data **3**. Analysis and interpretation of data **4**. Submission of final thesis based on the research topic 5. conclusion		**1.** Finding of reviews related with the topic of research. **2.** Preparation of manuscripts related to concerned topic.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab Instruction (LI)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
19MI352 Propose Dissertation – Interim Evaluation tools for conducting research on selected topic of mining field and prepare Final manuscript i.e. Thesis .	0	10	30	40
Total	0	10	30	40

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Group Discussion
3. Demonstration
4. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Research publications			
2	Science direct			
3	Research gate			
5	Academia			
6	Multi authored books			
7	Book chapters			

Course Curriculum Team:

1. Dr. Sandeep Prasad, Department of Mining Engineering, AKS University, Satna
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10. Er. Ramesh Kant, Department of Mining Engineering, AKS University, Satna

Cos, POs and PSOs Mapping

Course Code: 19MI352

Course Title: - Dissertation – Interim Evaluation

	Program Outcomes						Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
Course Outcome	Develop the skilled knowledge of communication in verbal and written forms	Apply the complex systems as part of research projects	Create, select & apply appropriate techniques, resources & modern engineering & IT tools	Understand the impact of professional engineering solutions in societal & environmental practices	Apply ethical principles & commit to professional ethics & responsibilities and norms of the engineering practice	The ability to engage in self-directed, reflective & lifelong learning for the benefit of the society	Dev. Analytical skill for complex mining problems	Specialized in depth knowledge in specific areas of mining	Capability to comprehend articulated needs for mining industry	Research orientation based on articulated needs
CO1- Propose Dissertation – Interim Evaluation tools for conducting research on selected topic of mining field and prepare Final manuscript	2	2-	1	1	1	1	2	1	1	1

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6, PSO 1,2, 3, 4,	19MI352 Propose Dissertation – Interim Evaluation tools for conducting research on selected topic of mining field and prepare Final manuscript	**SO1.1** **SO1.2** **SO1.3** **SO1.4**	**1.1** **1.2** **1.3** **1.4** **1.5**		SL 1.1

Semester III

Course Code: 19MI351

Course Title: Seminar on Dissertation Evaluation

Pre- requisite: Conduct research to resolving the problem of mining operations like blasting, vibration, safety etc. by applying advanced technology adopted in field of mining industries.

Rationale: The basic purpose of M. Tech Seminar on Research Project Evaluation is to understand the application of power point presentation tools to do research on particular topic related to mining and follow technical writing skill to design the synopsis, thesis, research paper, abstract, articles, etc as per results obtained during seminar and viva.

Course Outcomes:

19MI351 Propose power point presentation tools for conducting research on selected topic of mining field and prepare for final viva.

Scheme of Studies:

CODE	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
RESEARCH PROJ	19MI351	Seminar on Dissertation Evaluation	0	10	0	0	10	5

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),**LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)**SW:** Sessional Work (includes assignment, seminar, mini project etc.),**SL:** Self Learning, **C:**Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

CODE	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks(PRA + ESA)
			Class/Home Assignment 5 number3 markseach(CA)	ClassTest 2(2 bestout of3)10 marks each(CT)	Seminar one	Class Activity anyone(CAT)	Class Attendance(AT)	Total Marks(CA+CT+SA+ CAT+AT)		
REEARCH PROJ	19MI351	Seminar on Dissertation Evaluation	0	0	0	0	0	0	100	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

19MI351 Propose power point presentation tools for conducting research on selected topic of mining field and prepare for final viva.

Approximate Hours

Item	Approximate Hours
CI	**0**
LI	**10**
SW	**0**
SL	**30**
Total	**40**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1. Choose the topic and objectives for the research. **SO2.** Select the suitable data during the research. **SO3.** Assemble the data taken during the research for interpretation. **SO4.** Arrange the whole work with the interpretate data. **SO5.** Formulate the hypothesis according the final composition.	**1** Perform research work as per their topic by using various tools and production technology methods in particular season of crop. **2**. Collection of data **3**. Analysis and interpretation of data **4**. Submission of final thesis based on the research topic 5. Conclusion		**1.** Finding of reviews related with the topic of research. **2.** Preparation of manuscripts related to concerned topic.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab Instruction (LI)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
19MI351 Propose power point presentation tools for conducting research on selected topic of mining field and prepare for final viva.	0	10	30	40
Total	0	10	30	40

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Group Discussion
3. Demonstration
4. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Research publications			
2	Science direct			
3	Research gate			
5	Academia			
6	Multi authored books			
7	Book chapters			

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7. Prof A K Mittal, Department of Mining Engineering, AKS University, Satna
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9. Er. P. C. Tiwari, Department of Mining Engineering, AKS University, Satna
10. Er. Ramesh Kant, Department of Mining Engineering, AKS University, Satna

Cos, POs and PSOs Mapping

Course Code: 19MI351

Course Title: - Seminar on Dissertation Evaluation

	Program Outcomes						Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
Course Outcome	Develop the skilled knowledge of communication in verbal and written forms	Apply the complex systems as part of research projects	Create, select & apply appropriate techniques, resources & modern engineering & IT tools	Understand the impact of professional engineering solutions in societal & environmental practices	Apply ethical principles & commit to professional ethics & responsibilities and norms of the engineering practice	The ability to engage in self-directed, reflective & lifelong learning for the benefit of the society	Dev. Analytical skill for complex mining problems	Specialized in depth knowledge in specific areas of mining	Capability to comprehend articulated needs for mining industry	Research orientation based on articulated needs
CO1- Propose power point presentation tools for conducting research on selected topic of mining field and prepare for final viva.	2	2-	1	1	1	1	2	1	1	1

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6, PSO 1,2, 3, 4,	19MI351Propose power point presentation tools for conducting research on selected topic of mining field and prepare for final viva.	**SO1.1** **SO1.2** **SO1.3** **SO1.4** **SO1.5**	**1.1**Submission of research proposal consisting concern programme **1.2** Explain definition of the problems reference to topic **1.3** Explanation of results **1.4** Arrange the references of past work of 10 years **1.5** Collection of data by focusing their objectives and observations to be taken mentioned in their synopsis		SL 1.1

Semester IV

Course Code: 19MI451

Course Title: Dissertation (Open Defense)

Pre- requisite: Conduct research to resolving the problem of mining operations like blasting, vibration, safety etc. by applying advanced technology adopted in field of mining industries.

Rationale: The basic purpose of M. Tech Dissertation – Interim Evaluation is to understand the application of research methodology tools to do research on particular topic related to mining and follow technical writing skill to design the synopsis, thesis, research paper, abstract, articles, etc as per results obtained during research studies.

Course Outcomes:

PROJ-MIN05 Propose Dissertation (Open Defense) tools for conducting research on selected topic of mining field and prepare Final manuscript i.e. Thesis

Scheme of Studies:

CODE	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
RESEARCH PROJ	19MI451	Dissertation – Interim Evaluation	0	10	0	0	10	5

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),**LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)**SW:** Sessional Work (includes assignment, seminar, mini project etc.),**SL:** Self Learning, **C:**Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

CODE	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks(PRA + ESA)
			Class/Home Assignment 5 number3 markseach(CA)	ClassTest 2(2 bestout of3)10 marks each(CT)	Seminar one	Class Activity anyone(CAT)	Class Attendance(AT)	Total Marks(CA+CT+SA+CAT+AT)		
RESEARCH PROJ	19MI451	Dissertation (Open Defense)	0	0	0	0	0	0	100	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

19MI451 Propose Dissertation (Open Defense)tools for conducting research on selected topic of mining field and prepare Final manuscript i.e. Thesis .

Approximate Hours

Item	Approximate Hours
CI	**0**
LI	**10**
SW	**0**
SL	**30**
Total	**40**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1. Choose the topic and objectives for the research. **SO2.** Select the suitable data during the research. **SO3.** Assemble the data taken during the research for interpretation. **SO4.** Arrange the whole work with the interpretate data.	**1** Perform research work as per their topic by using various tools and production technology methods in particular season of crop. **2**. Collection of data **3**. Analysis and interpretation of data **4**. Submission of final thesis based on the research topic 5. conclusion		**1.** Finding of reviews related with the topic of research. **2.** Preparation of manuscripts related to concerned topic.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab Instruction (LI)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
19MI451 Propose Dissertation (Open Defense)tools for conducting research on selected topic of mining field and prepare Final manuscript i.e. Thesis .	0	10	30	40
Total	0	10	30	40

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Group Discussion
3. Demonstration
4. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Research publications			
2	Science direct			
3	Research gate			
5	Academia			
6	Multi authored books			
7	Book chapters			

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9. Er. P. C. Tiwari, Department of Mining Engineering, AKS University, Satna
10. Er. Ramesh Kant, Department of Mining Engineering, AKS University, Satna

Cos, POs and PSOs Mapping

Course Code: 19MI451

Course Title: - Dissertation (Open Defense)

	Program Outcomes						Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
Course Outcome	Develop the skilled knowledge of communication in verbal and written forms	Apply the complex systems as part of research projects	Create, select & apply appropriate techniques, resources & modern engineering & IT tools	Understand the impact of professional engineering solutions in societal & environmental practices	Apply ethical principles & commit to professional ethics & responsibilities and norms of the engineering practice	The ability to engage in self-directed, reflective & lifelong learning for the benefit of the society	Dev. Analytical skill for complex mining problems	Specialized in depth knowledge in specific areas of mining	Capability to comprehend articulated needs for mining industry	Research orientation based on articulated needs
CO1- Propose Dissertation (Open Defense) tools for conducting research on selected topic of mining field and prepare Final manuscript	2	2-	1	1	1	1	2	1	1	1

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6, PSO 1,2, 3, 4,	19MI451 Propose Dissertation (Open Defense) tools for conducting research on selected topic of mining field and prepare Final manuscript	**SO1.1** **SO1.2** **SO1.3** **SO1.4**	**1.1** **1.2** **1.3** **1.4** **1.5**		SL 1.1

Semester IV

Course Code: 19MI452

Course Title: Dissertation (Evaluation)

Pre- requisite: Conduct research to resolving the problem of mining operations like blasting, vibration, safety etc. by applying advanced technology adopted in field of mining industries.

Rationale: The basic purpose of M. Tech Dissertation (Evaluation)is to understand the application of research methodology tools to do research on particular topic related to mining and follow technical writing skill to design the synopsis, thesis, research paper, abstract, articles, etc as per results obtained during research studies.

Course Outcomes:

PROJ-MIN05 Propose Dissertation (Evaluation)tools for conducting research on selected topic of mining field and prepare Final manuscript i.e. Thesis

Scheme of Studies:

CODE	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
RESEARCH PROJ	19MI452	Dissertation (Evaluation)	0	20	0	0	20	10

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),**LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)**SW:** Sessional Work (includes assignment, seminar, mini project etc.),**SL:** Self Learning, **C:**Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

CODE	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks(PRA + ESA)
			Class/Home Assignment 5 number3 markseach(CA)	ClassTest 2(2 bestout of3)10 marks each(CT)	Seminar one	Class Activity anyone(CAT)	Class Attendance(AT)	Total Marks(CA+CT+SA+ CAT+AT)		
RESEARCH PROJ	19MI452	Dissertation (Evaluation)	0	0	0	0	0	0	100	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

19MI452 Propose Dissertation (Evaluation) tools for conducting research on selected topic of mining field and prepare Final manuscript i.e. Thesis .

Approximate Hours

Item	Approximate Hours
CI	**0**
LI	**20**
SW	**0**
SL	**30**
Total	**50**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1. Choose the topic and objectives for the research. **SO2.** Select the suitable data during the research. **SO3.** Assemble the data taken during the research for interpretation. **SO4.** Arrange the whole work with the interpretate data.	**1** Perform research work as per their topic by using various tools and production technology methods in particular season of crop. **2**. Collection of data **3**. Analysis and interpretation of data **4**. Submission of final thesis based on the research topic 5. conclusion		**1.** Finding of reviews related with the topic of research. **2.** Preparation of manuscripts related to concerned topic.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab Instruction (LI)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
19MI452 Propose Dissertation (Evaluation) tools for conducting research on selected topic of mining field and prepare Final manuscript i.e. Thesis .	0	20	30	50
Total	0	20	30	50

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Group Discussion
3. Demonstration
4. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Research publications			
2	Science direct			
3	Research gate			
5	Academia			
6	Multi authored books			
7	Book chapters			

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9. Er. P. C. Tiwari, Department of Mining Engineering, AKS University, Satna
10. Er. Ramesh Kant, Department of Mining Engineering, AKS University, Satna

Cos, POs and PSOs Mapping

Course Code: 19MI452

Course Title: - Dissertation (Evaluation)

	Program Outcomes						Program Specific Outcomes			
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4
Course Outcome	Develop the skilled knowledge of communication in verbal and written forms	Apply the complex systems as part of research projects	Create, select & apply appropriate techniques, resources & modern engineering & IT tools	Understand the impact of professional engineering solutions in societal & environmental practices	Apply ethical principles & commit to professional ethics & responsibilities and norms of the engineering practice	The ability to engage in self-directed, reflective & lifelong learning for the benefit of the society	Dev. Analytical skill for complex mining problems	Specialized in depth knowledge in specific areas of mining	Capability to comprehend articulated needs for mining industry	Research orientation based on articulated needs
CO1- Propose Dissertation (Evaluation) tools for conducting research on selected topic of mining field and prepare Final manuscript	2	2-	1	1	1	1	2	1	1	1

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6, PSO 1,2, 3, 4,	19MI452 Propose Dissertation (Evaluation) tools for conducting research on selected topic of mining field and prepare Final manuscript	**SO1.1** **SO1.2** **SO1.3** **SO1.4**	**1.1** **1.2** **1.3** **1.4** **1.5**		SL 1.1