



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Mining Engineering

Subject Code: BE05022051

Subject Name: Mine System Engineering

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Elective Course - 1

Prerequisite:	Basics of Mining Engineering; Engineering Mathematics
Rationale:	Mine System Engineering is an interdisciplinary field that integrates mining operations, systems analysis, optimization techniques, simulation, and decision-making tools to enable efficient mine management. The course enables students to analyze and optimize complex mining systems across productivity, safety, economy, reliability, and sustainability. It provides knowledge of operational research tools, project management, network analysis, simulation techniques, inventory management, and modern smart mining technologies essential for scientific mine planning and operational excellence.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Understand the principles, components, and applications of systems engineering in mining operations.	15
CO-2	Apply operational research techniques and optimization models for mine planning, scheduling, and resource allocation.	25
CO-3	Analyze transportation, assignment, project management, and network models for solving mining engineering problems.	20
CO-4	Evaluate simulation, reliability, maintenance, and inventory management systems used in mining industries.	20
CO-5	Apply modern digital technologies, automation, and sustainable approaches for integrated mine system management.	20

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
L	T	P	PBL	Total no of hours per semester		Theory		Tutorial / Practical			
						ESE (E)	PA / CA (M)	PA/ CA (I)	PBL (I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200



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Content:

Sr. No.	Content	Total Hrs.
1	Introduction to Systems Engineering: Concept of system, subsystem and system environment; classification of systems; systems approach in mining; system analysis and synthesis; planning and design aspects; productivity concepts; systems optimization; factors influencing mining system performance; creativity and decision-making techniques in mining engineering.	07
2	Linear Programming and Optimization Techniques: Linear programming models; assumptions and formulation; graphical and simplex methods; feasible and optimal solutions; primal and dual problems; sensitivity analysis; applications in mine production planning, blending, equipment allocation, scheduling, and manpower optimization.	10
3	Transportation, Assignment and Network Models: Transportation models and solution methods; assignment problems and algorithms; shortest route problems; minimal spanning tree; maximal flow models; applications of transportation and network optimization in mine haulage, ventilation, and logistics systems.	08
4	Project Management using PERT and CPM: Project planning and scheduling; network construction; critical path analysis; floats and slack; probability concepts in PERT; time-cost optimization; crashing techniques; resource leveling; project monitoring and control; case studies related to mine development and excavation projects.	08
5	Simulation and Reliability of Mine Systems: Concepts and applications of simulation; Monte Carlo simulation; discrete-event simulation; simulation of mine haulage and maintenance systems; reliability, maintainability, and availability analysis; preventive and predictive maintenance; reliability evaluation of mining equipment and systems.	07
6	Inventory Management and Modern Trends in Mine Systems: Inventory concepts and models; EOQ models; quantity discount models; static and dynamic inventory systems; inventory control in mines; digital mine systems; mine automation; IoT and AI applications; decision support systems; smart and sustainable mining technologies.	05
TOTAL		45



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Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	35	30	10	10	00

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from the above table.

The syllabus of Mine System Engineering directly contributes to:

SDG 4	Quality Education
SDG 8	Decent Work and Economic Growth
SDG 9	Industry Innovation and Infrastructure
SDG 11	Sustainable Cities and Communities
SDG 12	Responsible consumption
SDG 13	Climate action

Reference Books:

Sr. No.	Title	Author(s)	Publisher
1	Introduction to Operations Research	Hillier and Lieberman	McGraw Hill
2	Operations Research	P. K. Gupta and D. S. Hira	S. Chand
3	Mathematical Models in Operations Research	J. K. Sharma	Tata McGraw Hill
4	Operations Research: Theory and Practice	Ravindran, Phillips and Solberg	Wiley India
5	SME Mining Engineering Handbook	Peter Darling	SME Publications
6	Simulation Modeling and Analysis	Averill Law	McGraw Hill
7	Reliability Engineering	E. Balagurusamy	Tata McGraw Hill



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8	Mine Planning and Equipment Selection	Panagiotou & Michalakopoulos	CRC Press
9	Systems Engineering Principles and Practice	Alexander Kossiakoff	Wiley
10	Cummins Mining Engineers Handbook	SME-AIME	SME Publications

List of Experiments:

1. Formulation and solution of linear programming problems related to mining operations.
2. Graphical solution of optimization problems.
3. Transportation and assignment problem solving using software tools.
4. Critical path analysis using CPM and PERT networks.
5. Simulation of mine haulage systems using spreadsheet/software models.
6. Reliability and availability analysis of mining equipment.
7. EOQ and inventory management calculations for mine stores.
8. Resource allocation and scheduling for mining projects.
9. Monte Carlo simulation applications in mining engineering.
10. Case study analysis on smart mine systems and automation.

Major Equipment:

- i. Computer Systems with OR Software
- ii. MATLAB / Scilab / Python Tools
- iii. Project Scheduling Software (MS Project/Primavera)
- iv. Mine Planning Software
- v. Simulation Software Package
- vi. Reliability Analysis Software
- vii. Network Modeling Tools
- viii. Inventory Management Demonstration Models
- ix. Smart Mine Monitoring Demonstration Kit
- x. Digital Mine Communication System

Open-Source Software/learning website:

1. NPTEL Engineering Courses
2. SWAYAM Online Courses
3. Python OR-Tools
4. Scilab Optimization Toolbox
5. MATLAB Academic Resources
6. SME Mining Engineering Resources
7. Mine Planning Tutorials on YouTube



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8. Open-source Simulation Resources

List of suggested activities for Problem-based Learning (PBL):

Sr. No	PBL category	Name of the activity	No. of hours	Evaluation Criteria
1.	Complex Problem-Solving targeting relevant SDGs / Mini Project	Mini Project	10h (need to be changed as per total PBL hours)	Based on the novelty of project, technical understanding, report quality and presentation
2.	Case Study Analysis / Seminar	Seminar	10h (need to be changed as per total PBL hours)	Based on the quality of report and presentation, technical understanding
3.	Micro project	Micro project	5h (need to be changed as per total PBL hours)	Based on the novelty of project, technical understanding, quality of report and demonstration
4.	Industry/Research laboratory visit	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
5.	Video Based Learning	Technical video-based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
6.	Assignment / Technical Writing / Research Writing	Assignment writing. Numerical based assignment is preferable.	5 assignments of 4 h each Total = 20h	Based on the correctness of submitted assignment
7.	Group Discussion / Quiz / Simulation	Problem solving/Coding using C, C++, MATLAB, Python, SCILAB, modeling and Analysis software or any other software	5 small coding-based assignment of 2h each Total = 10h	Based on the coding solution submitted.
8.	Video Based Learning	Self-learning online course	Minimum duration of the course should be 10h	Examination based assessment at the end of course. Based on the certificate produced.
9.	Complex Problem-	Identification and solution of Complex	Maximum 2 problems. Study of the problem	Based on the depth of the solution submitted.



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	Solving targeting relevant SDGs / Mini Project	problem	and solution finding, Total = 10h	
10.	Video Based Learning	Videos on Industrial safety/Disaster Management aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
11.	Research Paper Review / Analysis	Technical paper reading and summarization of research papers based on relevant subject	5 research papers = 20h	Summarize research paper and evaluation critical parameters
12.	Poster / Chart / PowerPoint presentation	Poster/chart/power point preparation on technical topics	Duration = 6h	Based on poster/chart preparation and presentation skills
13.	Industry/Research laboratory visit	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/sustainability/any other issue	Duration = 15h for industrial exposure Problem identification and tentative solution = 10h Total = 20h	Based on evaluation of critical problems and solutions
14.	Group Discussion / Quiz / Simulation	Group Discussion on emerging/trending technical topics based on subject	Duration = 1h – 3h per topic	Based on performance in group discussion, technical depth, knowledge etc.
15.	Case Study Analysis / Seminar	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
16.	Group Discussion / Quiz / Simulation	Application/Software development	Duration = 10h	Depending on the complexity of the Application/Software
17.	Assignment / Technical Writing / Research Writing	Research paper publication	Duration = 10h	Based on submission of proof of publication
18.	Micro project	Upgradation/Reverse engineering studies of existing equipment of the laboratory	Duration 10h	Based on the performance of the equipment
19.	Industry/Research	Expert lecture/session	Duration 3h	Based on the proof of



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	rich laboratory visit		For attending the lecture/session– 2h and for report writing 1h	attendance and report submitted
20.	Video Based Learning	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
21.	Assignment / Technical Writing / Research Writing	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.
22.	Assignment / Technical Writing / Research Writing	Preparation of a report on Indian Standard(s)	10h (study of Indian Standard(s) + report	Based on report quality and understanding of the relevant Indian Standard(s).

List of suggested activities for Term Work / Self Learning:

a. Assignments: (Seminar Topics/ Visits/Self-Learning Topics) Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.)

- Solve optimization problems related to mine production planning.
- Prepare CPM/PERT charts for mine projects.
- Analyze mine equipment reliability and maintenance data.
- Study inventory control methods used in mining industries.
- Prepare a comparative study of conventional and smart mining systems.

b. Micro Projects:

A Suggested list of course-wise micro-projects is mentioned herewith

- Develop a simulation model for mine haulage operations.
- Prepare a computerized mine scheduling model.
- Conduct a case study on mine system optimization.
- Develop an inventory management model for mining stores.
- Analyze a smart mine automation system.

Note:

- Mini Project – 10 Marks , Micro Project – 5 Marks
- The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.
