MINE SYSTEM ENGINEERING		Semester	VI
Course Code	**BMN701**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

- Identify and develop operational research models from the verbal description of the Real Systems.
- Enables to create mathematical models that are useful to solve optimization problems.
- Ability to estimate the optimum cost/distance in transporting the goods.
- Able to apply the different types of strategies of game theory in decision making.
- Able to design and develop the analytical models like PERT and CPM for planning, scheduling and controlling projects.

Teaching-Learning Process (General Instructions)
These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

MODULE-1

System Engineering: Introduction to systems concept, analysis and systems engineering. Models in systems analysis. Basic concepts of statistical decision theory.
Linear Programming: Definition, mathematical formulation, standard form, solution space, solution-feasible, basic feasible, optimal, infeasible, multiple, optimal, Redundancy, Degeneracy, Graphical and Simplex methods.

MODULE-2

Variants of Simplex algorithm – Artificial basis techniques. Duality, Economic interpretation of Dual, Solution of LPP using duality concept, Dual simplex method. Simulation: Simulation techniques for equipment selection and production scheduling, Significance of management information systems in controlling and managing the mining activities.
Inventory Model: Definition, deterministic models, probabilistic models and their applications to mining.

MODULE-3

Transportation Problem: Formulation of transportation model, Basic feasible solution using different methods, Optimality Methods, Unbalanced transportation problem, Degeneracy in transportation problems, Applications of Transportation problems. Assignment Problem: Formulation, unbalanced assignment problem, Travelling salesman problem.
MODULE-4
Project Management Using Network Analysis: Network construction, Network techniques for mining projects, determination of critical path and duration, floats. **PERT** –Estimation of project duration, variance. **CPM** – Elements of crashing, least cost project scheduling. Flow in networks: Determination of shortest route, Determination of Maximum flow through the networks for mining project.
MODULE-5
Queuing Theory: Queuing system and their characteristics. The M/M/I Queuing system, Steady state performance analyzing of M/M/I and M/M/C queuing model. **Game Theory:** Formulation of games, Two Person - Zero sum game, games with and without saddle point, Graphical solution (2xn, mx2game), and dominance property.

PRACTICAL COMPONENT OF IPCC*(May cover all / major modules)*

Sl.NO	Experiments
1	Determine cut-off grade of ore in a mine
2	Optimize cost of transportation for supplying coal from mines to various destinations
3	Determine the optimal assignment of 'm' jobs or workers to 'n' machine in a mine using Hungarian Method.
4	Scheduling of production in a mine.
5	Determine equipment replacement policy in a mine
6	Optimize mining project completion time.
7	Optimize shovel-dumper system in open cast mine by Queuing System
8	Optimization of scheduling of drilling, blasting, loading and support operation in development heading.
9	Optimize drilling and blasting cost for surface mine.
10	Determine optimum level of inventory to be maintained in a mine.

Course outcomes (Course Skill Set):

At the end of the course, the student will be able to:

- Mine Systems Engineering presents the theoretical principals and practical applications for strategic mine planning in surface and underground mining operations.
- It covers planning and valuation methodologies applicable to metal and coal mining projects.
- The students will explore and apply basic manual procedures, algorithms, computer applications and mathematical models for strategic mine planning.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scoredby the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:

Books

1. Mining Engineers Handbook, Vol. II SME Cummins AIME, New York, 1979.
2. Mathematical Models in Operations Research. Sharma J.K, Tata Mcgraw-Hill, New Delhi, 1989.
3. Operations Research and Introduction, Taha H.A .Mc. Millan. ISBN -0-02- 418940-5.
4. Introduction to Operation Research Hiller and Liberman Mc. GrawHill V Edition.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/110106062

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Demonstrations of Videos
- Group Discussion
- Quizzes

MINERAL PROCESSING		Semester	VII
Course Code	**BMN702**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory		

Course objectives:

- To know the grade and quality of minerals found in earth crust and how to improve them so that the metallurgists can use the same for extraction purpose.
- To know up to what extent the improvement should be done so that it will be economic.

Teaching-Learning Process (General Instructions)
These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

MODULE-1

Introduction: Scope, objectives and limitations of mineral processing; Liberation and beneficiation characteristics of minerals and coal. Laboratory sampling.
Comminution and Liberation: Theory and practice of crushing and grinding; Different types of crushing and grinding equipment - their application and limitations.

MODULE-2

Size separation: Laboratory size analysis and interpretation; Settling of solids in fluids; Industrial screens; Mechanical classifiers and hydro-cyclones: Numerical problems.

MODULE-3

Concentration: Theory and practice of classification, Classifiers- their performance and choice, Picking and washing techniques. Theory and application of sink and float, jigging and flowing film concentration- methods and equipment used.

MODULE-4

Froth Flotation: Physico-chemical principles, flotation reagents, flotation machines and circuits, application to common sulphides, oxides and oxidized minerals.
Electrostatic and Electro-magnetic Separation - Principles, operations and fields of applications.

MODULE-5
Dewatering: Thickener and filter. **Hydro-metallurgical methods of recovery**: Leaching – principle, various methods and applications. **Flow Sheets:** Simplified flow sheets for the beneficiation of beach sand, coal and typical ores of copper, lead, zinc and manganese with special reference to Indian deposits.

PRACTICAL COMPONENT OF IPCC*(May cover all / major modules)*

Sl.NO	Experiments
1	Sampling: a) Coning and quartering b) Riffle Sampling
2	Sieve analysis and interpretation of data
3	Determination of actual capacity of a jaw crusher.
4	Determination of actual capacity of a roll crusher.
5	Determination of grindability index of the given ore.
6	Determination of free settling velocities of quartz particle and comparison of the results with theoretical results.
7	Separation of heavier from the given feed using mineral jig and calculation of ratio of concentration.
8	Study of the particle movement on the deck of an operating table.
9	Separation of ferrous minerals using magnetic separator.
10	Study of the flotation of characteristics of the sulfide and oxide ore and, calculate the ratio of concentration.

Course outcomes (Course Skill Set):

At the end of the course, the student will be able to:

- understand the Laboratory techniques of Mineral Beneficiation.
- study various methods and equipment used for concentration.
- give exposure to flow sheets for the beneficiation of various ore/minerals with special reference to Indian deposit.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scoredby the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Suggested Learning Resources:
Books

1. A. M. Gaudin, *Principles of Mineral Dressing*, Tata McGraw & Hill,
2. R. H. Richard and C. E. Locky, *A text Book on Ore Dressing,*, A A Balkema
3. B. A. Wills, *Mineral Processing Technology*, Willy & Sons

Web links and Video Lectures (e-Resources):

- **https://onlinecourses.nptel.ac.in/noc22_ce30/preview**

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Demonstrations of Videos
- Group Discussion
- Quizzes

MINE LEGISLATION		Semester	VII
Course Code	**BMN703**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	4:0:0:0	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

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

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Introduction: Brief historical perspective legislation in Indian Mines.

The Mines Act, 1952: Preliminary, Inspectors and Certifying surgeons, committee, mining operations and management of mines. Provisions to health and safety. Hours and limitations of employment Leave with wages, Regulations and bylaws, penalties and procedures.

Module-2

The Mines Rules,1955: Preliminary, committee, court of enquiry, certifying surgeons, Medical Examination of persons employed. Workmen's inspector and safety committee, health and sanitation provision, first aid and medical appliance. Employment of persons, leave with wages and overtime. Welfare amenities, registers and notices.

General provisions of: Mines and Minerals (Regulation and Development) Act 1957, Mineral Concession Rules 1960, Mineral Conservation and development Rules 1988.

Module-3

The Metalliferous mines regulation,1961 and The Coal mines regulations,2017: Preliminary returns, notices and records, inspectors and mine officials, duties and responsibilities of work men, plans and sections, means of access, ladders and ladder ways, transport of men and materials, winding in shafts, transport of men and material haulage, mine workings, precaution against dangers from fire, dust gas and water, ventilation, lighting and

safety lamps, Explosives and shot firing, machinery, plants and equipments.

Module-4

Salient Features of : The Mines Creche Rules, 1966, Maternity Benefit Act and Rules; Indian electricity Rules, 1956.

Accidents: Their causes and prevention, accident statistics, rates of accidents, relation between accidents and efficiency, accident reports, cost of accidents.

Module-5

Safety risk assessment and management, Safety Audit, Occupational health and safety in mines. Mine safety management systems, Safety education and training.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. General principles of Mining Laws and their history
2. Salient features of Mines Act and mines rules
3. General provisions of CMR 1961 and MMR 1961
4. Legal aspects of safety and health of Mine workers.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Indian Mining Legislation – A Critical Appraisal by Rakesh & Prasad
2. NIOSH Publications
3. DGMS Circulars by L.C.Kaku
4. Safety in Mines: A survey of accidents, their causes and prevention by Prof. Kejriwal.

Web links and Video Lectures (e-Resources):

- https://www.dgms.gov.in/writereaddata/UploadFile/Mines%20Act,%201952.pdf
- https://www.dgms.gov.in/writereaddata/UploadFile/Mines_Rules_1955.pdf
- https://www.dgms.net/Coal%20Mines%20Regulation%202017.pdf
- https://www.dgms.gov.in/writereaddata/UploadFile/Metalliferous%20Mines%20Regulation,%201961.pdf

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Demonstrations of Videos
- Group Discussion
- Quizzes

SURFACE MINE PLANNING AND DESIGN		Semester	VII
Course Code	**BMN714A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- To be familiar with basic elements of surface mine planning
- To understand the concept of open pit planning and also production planning
- To understand the closure aspect of surface mine

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Introduction : Stages/Phases of mine life; Preliminary evaluation of surface mining prospects; Mine planning and its importance; Mining revenues and costs - calculation of FW, PV, NPV, IRR, payback period, depreciation by different methods, cash flow and ACFC; Mine planning components, planning steps and planning inputs.

Ore reserve estimation : Ore zone and bench/level compositing; Objectives and principles of ore reserve estimation; Classification of ore reserves, Estimation of grade at unknown point; Methods of ore reserve estimation - vertical cross section method, horizontal cross section method and 3-D geological block method;

Module-2

Stripping ratio: Concept of stripping ratio; Types of stripping ratios and their significance; Choice between surface and underground mining.

Geometrical considerations: Basic bench geometry; Pit layouts.

Module-3

Pit Planning: Development of economic block model; Pit Cut-off grade and its estimation; Ultimate pit configuration and its determination – hand method, floating cone technique, Lerchs-Grossmann algorithm, and computer assisted hand method.

Production planning: Determination of optimum mine size and Taylor's mine life rule; Sequencing by nested pits; Cash flow calculations; Mine and mill plant sizing, Lanes algorithm for estimation of optimum mill cut-off grade; Introduction to production scheduling.

Module-4

Analysis and design of highwall slopes and waste dumps: Pit slope geometry; Influence of pit slope on mine economics; Highwall slope stability analysis and design methodology; Stability analysis and design methodology for waste dumps.

Module-5

Design of haul roads Addition of haul road on pit plan; Design of road cross section; Design of road width, curves and gradient; Haul road safety features and their design.

Design of drainage system in surface mines.

Selection of mining system vis-a-vis equipment system.

Closure of surface mines.

Feasibility Report - Contents and preparation.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Understand basic components of surface mine planning
2. Estimate ore reserve using various methods
3. Plan open pit mine given the ore reserve and economic condition

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Open Pit Mine Planning and Design-W. Hustrulid and M. Kuchta
2. SME Mining Engineering Hand book-H.L. Hartman

Reference Books:

3. Surface and underground excavations – R. R. Tatiya

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_mm40/preview

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Demonstrations of Videos
- Group Discussion
- Quizzes

MINE SAFETY ENGINEERING		Semester	VII
Course Code	**BMN714B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- comprehensive understanding of philosophy of safety engineering approach at mines to achieve target production with no or insignificant accident cost which is very important for Indian mining industry to survive in the competitive global market.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Introduction: Historical Developments of Mine Safety in India and Abroad; Need for Approving Safety Engineering Approach in Mining Industry; Engineering Safety Goals; Mine Safety Facts and Figures; Worldwide Major Mine Disasters.

Module-2

Risk Management: Risk Management Related Terms and Definitions; Basic Concept of Risk, Reliability and Hazard Potential; Risk Components and Types; Risk Management Objectives; Risk Management Process; Functions of a Risk Manager; Common Errors in Risk Management; Risk Estimates for Selective Events; Hazards Identification and Risk Assessment (HIRA) Methodology; Implementation of HIRA and its Controls & Review; Advantages of Risk Management.

Module-3

Statistical Methods of Risk analysis: Basic Risk Analysis Methods based on Frequency Rates and Severity of Accidents Appraisal of advanced techniques - Preliminary Hazards Analysis (PHA); Hazards and Operability Analysis (HAZOP); Failure Mode and Effect Analysis (FMEA); Failure Mode Effect and Critical Analysis (FMECA); Job Safety Analysis (JSA); Fault Tree Analysis (FTA); Markov Model (MM) – An Important Risk analysis Tool.

Module-4
System Safety Engineering Concept in Mine Safety: An Introduction to Systems Safety Engineering; Different School of Thoughts in Accident Causations - Domino Model; Behavioural Accident Model based on the human perception; Epidemiological Accident Models, Normal Accident Theory; The Swiss Cheese Model; Systems-Theoretic Accident Modeling and Process (STAMP); In-depth Study of Accidents Due to Various Causes; Application of Structural Equation Modelling (SEM) and Artificial Neural Network (ANN) in Determining the Accident Causation in Mines.
Module-5
Safety audits and control: Objectives of safety audit in mines; Different steps in safety audit; Risk control procedures. **Mine Ergonomics:** Domain, Philosophy and Objective of Mine Ergonomics; Ergonomics/ human Factors fundamentals; Work physiology and stress; Human body- structure and function, anthropometrics; Posture and movement; Posture and Job Relation – Work Posture Analysis using OWAS Method; Oxygen Consumption and Workload Analysis of Mine Workers.
Course outcome (Course Skill Set) At the end of the course, the student will be able to : 1. understand the historical developments of mine safety in India and abroad. 2. understand the hazards, risk associated with hazards, assessment and evaluation of risk due to the presence of hazards and mitigation & control of risk associated with existing hazards. 3. Apply bivariate and multivariate statistical methods in quantitative risk analysis. 4. understand different statistical modeling in determining the accident causation in mines. 5. understand the workplace design in respect to the body dimension and workload capacity of the mine workers/equipment operators. 6. understand the different risk control procedures that is required to be applied to manage the risk in a system.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Engineering Safety: Fundamentals, Techniques and Applications by B. S. Dhillon; World Scientific Publisher
2. Mine Health and Safety Management – Edited by Michael Karmis
3. Safety Engineering by B. S. Dhillon, Springer
4. Mine Safety by B. S. Dhillon, Springer

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/110/105/110105160/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Demonstrations of Videos
- Group Discussion
- Quizzes

ADVANCED MINE VENTILATION		Semester	VII
Course Code	**BMN714C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- To impart theoretical and practical knowledge for solving the real life ventilation problems both in coal and hard rock underground mines.
- In addition, the students will be acquainted with a number of case studies demonstrating the intricate ventilation problems faced in Indian underground mines and development of methods for solving those problems.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Introduction and basics of Mine Thermodynamics: Overview and Importance of Advanced Mine Ventilation; Basics of mine thermodynamics, earth crust-infinite reservoir of heat and variation of strata temperature with depth; Computation of thermodynamic properties of mine air. Heat transfer in mine airways: Unsteady/Transient state, Quasisteady state and Steady state heat transfer, Heat transfer due to conduction, logarithmic mean area approach and related problems, Heat transfer due to convection and radiation in mines and related problems, Heat transfer at wet surfaces, computation of rate of condensation and evaporation in mine air airways and conceptual problems; Computation of heat transfer in tunnels depending upon age factor with numerical problems.

Module-2

Heat flow into bord and pillar, and longwall workings: Heat and mass transfer in bord and pillar panels, development of equations and calculations for designing climatic condition; Heat and mass transfer in longwall panels : Sources of heat in longwall panels, Computation of heat load and climatic conditions in mine workings, Mitigative measures for hot and humid workings, longwall ventilation practices : Global experience, A case study of a deep, hot and humid mine of the country.

Module-3

Incompressible flow ventilation network analysis: Computation of volume flow using equivalent resistance method and numerical examples, Computation of volume flow using direct analysis : Application of Kirchoff's first and second laws to solve field problems, Derivation of Hardy Cross Iterative method, Application of Hardy Cross Iterative method to solve complex mine ventilation network problems, Some typical case studies on the design of ventilation system through ventilation network analysis from Indian coal and hard rock mines.

Module-4

Compressible flow mine ventilation network analysis: Thermodynamic principles applied to mine ventilation network analysis : Development of equation considering no change of moisture content and application of these equations, Comparison of these equations with Bernauli's equation and concept of pseudo-pressure equation, Application of these equations to complete mine circuit, Development of equation considering change in moisture content, Application of these equations to complete mine circuit, Computation of resistance of mine roadways with change in moisture content using Atkinson's equation and Darcy weisbach equation with related numerical problems.

Module-5

Mine air conditioning: Improvement of workplace environment in underground: Basic vapour compression cycle, pressure-enthalpy diagram and superimposition of pressure-enthalpy diagram on vapour compression cycle, A case study of design mine air-conditioning/cooling system.

Automation and control: Advanced underground environment monitoring systems, automation and control.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. have a broad understanding of heat flow problems as existing in underground (UG) mines.
2. detailed understanding of all the methods of heat and mass transfer to ventilating air.
3. be able to compute the resultant thermodynamic properties of ventilating air in bord and pillar, and longwall panels.
4. be in a position to take ameliorative measures for improvement of workplace environment in UG mines.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Subsurface Ventilation and Environmental Engineering : Prof. M. J. McPherson
2. Mine Ventilation and Air Conditioning : Prof. H. L. Hartman, Prof. Jan Mutmansky and Prof. Y. J. Wang
3. Mine Environmental Engineering, Vol. 1 & Vol. 2 : Prof. Mritunjoy Sengupta
4. Environmental Engineering in Mines : Dr. V. S. Vutkuri and Dr. R. D. Lama
5. Mine Ventilation : Prof. S. P. Banerjee
6. Mine Environment and Ventilation : Prof. G. B. Mishra
7. 1 st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th, 10th and 11th International Mine Ventilation Congress Volumes

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/123106002
- https://nptel.ac.in/courses/112105123
- https://nptel.ac.in/courses/112103294

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Demonstrations of Videos
- Group Discussion
- Quizzes

MINE GEO-STATISTICS		Semester	VII
Course Code	**BMN714D**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- To understand of ore body evaluation by conventional methods.
- To understand basics of classical statistics.
- To understand the application of geostatistics in ore body modelling.
- To understand the problems associated with geostatistical tools.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Introduction to Geo-statistics: Definition, Schools of geostatistics. Estimation models for mine evaluation – average method, polygonal or triangular method.

Module-2

Classical Statistics: Definitions, Normal distribution – Mean, variance and confidence interval estimation, Graphical estimation of mean and standard deviation; Lognormal distribution – parameter estimation and confidence intervals, graphical estimation

Module-3

Correlated Random Theory-1: Semi Variogram: Definition of semi variogram, mathematical models of semi-variogram.

Practical problems – Isotropy and anisotropy, stationarity, regularization, nugget effect.

Module-4

Correlated Random Theory- 2: Extension Variance and Estimation Variance: Extension and estimation variance, calculation of estimation variance, the nugget effect and estimation variance, examples, auxiliary functions.

Correlated Random Theory – 3: Kriging: Kriging and optimal valuation, kriging equations in general cases.

Module-5

The Integrated Geological – Geostatistical System: Statistical analysis, comparative statistical analysis, geostatistical structural analysis, trend analysis, point kriging cross validation, block kriging, mineral inventory, grade – tonnage relations, examples to assess ore and metal recoveries. Example to calculate planning cut-off grade. Optimization of drilling programme. Misclassified tonnages – actual Vs estimated. Grade control.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Illustrate various methods of ore reserve estimation – conventional and geostatistical.
2. Solve problems of grade and ore reserve estimation and associated variance.
3. Analyze the applicability of geostatistical tools for ore reserve estimation.
4. Evaluate ore body in terms of grade and tonnage to develop mineral inventory and to
5. establish methodology for grade control.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. An Introduction to Applied Geostatistics, Issaks and Srivastava, Oxford, IBH, 1990.
2. Mining Geostatistics, Journel, A. G. and Huigbregts, Ch. J., John Willey and Sons, 1978.
3. An Introduction to Geostatistical Methods of Mineral Evaluation, Rendu J. M., John Willey and Sons, 1981.
4. Geostatistical Ore Reserve Estimation, David, Michel, McGraw Hill, 1977

Web links and Video Lectures (e-Resources):

- **https://www.youtube.com/watch?v=QqZcFJ7ya6Y**

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Demonstrations of Videos
- Group Discussion
- Quizzes

INTRODUCTION TO MINE SURVEYING		Semester	VII
Course Code	**BMN755A**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

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

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Surveying: Definition, objective, classification and principles of surveying.

Linear Measurement: Instruments for measuring distances, ranging survey lines. EDM: Principle of measurement.

Angular measurement 1: Prismatic compass - principle and construction; bearing of lines; local attraction; magnetic declination.

Module-2

Angular Measurement 2: Essentials of the micro-optic theodolite; Measurement of horizontal and vertical angles; Temporary and permanent adjustments; Theodolite traversing; Computation of co-ordinates; Adjustment of traverse.

Triangulation: classification, reconnaissance, measurement, procedures for angles and base-line; GPS and its application in mine surveying.

Module-3

Levelling & Contouring: Types of levels, setting of level instruments and levelling staff, types of levelling methods- reciprocal levelling, profile levelling, differential levelling, reduction of levels by height of instrument method and rise and fall method.
Concept of contour, Methods of contouring and uses of contours.
Tacheometry: Principle and classification of tachometry; stadia tachometry; distance and elevation formulae.

Module-4

Mine Surveying – Statutory Requirements: General requirements about mine plans and sections, Types of plans and sections, Specification of Limits of Error.
Correlation and Alignment: Correlation of surface and underground surveys: Verticality of shafts, shaft depth measurement, Direct traversing in inclined shaft, correlation in vertical shaft – single and two shafts. Underground Levelling. Determination of Gyro-north, Modern Gyro-Laser combination Correlation.

Module-5

Development and Stope Surveying: Control of direction and gradient in drifts, tunnels, raises, winzes, Methods of survey in moderately and steeply inclined ore bodies, flat and vertical ore bodies/seams.
Subsidence Monitoring: Subsidence Monitoring of subsidence due to underground mining activities.
Setting out curves – surface and underground.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Understanding of basic principles and need of surveying.
2. Knowledge on measurement tools and techniques for mining applications.
3. Plans and sections to be maintained as per statutory requirements, Accuracy assessment of surveying work including required accuracy of plans and sections.
4. Orientation and alignment surveys for mine development, depillaring, stoping and tunnelling operations.
5. Underground stope surveying techniques.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Punmia, B. C. (2005), Surveying Vol. 1 and II
2. Schofield, W. and Breach M. (2006), Engineering Surveying
3. S. K. Roy, *Fundamentals of Surveying*, Printice Hall of India Pvt., New Delhi , Third Printing, 2004.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105107122
- https://nptel.ac.in/courses/105104101

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Demonstrations of Videos
- Group Discussion
- Quizzes

INTRODUCTION TO ROCK BREAKAGE		Semester	VII
Course Code	**BMN755B**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- To understand the rock breakage concepts and methods such as drill and blast.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Explosives and Initiating Systems: Types of explosives, their composition and properties, classification; Selection of explosives; transport, storage and handling of explosives; Types of initiating systems – Electrical Detonators, Detonating cord, Detonating Relays, NONEL, Electronic Detonators, Blasting accessories, exploders.

Module-2

Drilling in Surface Mines: Blasthole drills – types, classification, applicability and limitations; Mechanics of drilling, performance parameters, drilling cost, drilling errors, Selection of drilling systems, organization of drilling.

Module-3

Blasting in Surface Mines: Mechanics of rock fragmentation; Livingston theory of crater formation; factors affecting blast design, Blast design - estimation of burden and spacing, estimation of charge requirement; initiation patterns; secondary blasting techniques; problems associated with blasting and remedies, ground vibration and air over pressure.

Module-4

Coal mines: Drilling systems and their applicability, blasting-off-solid, different blasting cuts, calculation of specific charge, specific drilling and detonator factor, initiation patterns.

Module-5

Drilling & Blasting in Underground Metal mines: Drilling systems and their applicability, blast design for horizontal drivages, different blasting cuts, long hole blasting, vertical crater retreat blasting.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Understanding about the explosives and initiating systems used in rock breakage.
2. Blast hole drilling mechanism and selection of a drill for surface excavation.
3. Ability to design the surface blast round and predict the outcomes of the blast design.
4. Ability to design underground blast round and predict the outcomes of the blast design.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Drilling and blasting of rocks – Jimeno, Carcedo, Jimeno, T&F, 1995
2. Rock Blasting and Overbreak Control- C.J. Konya, 1991

3. Surface and underground excavations – R. R. Tatiya, 2010
Web links and Video Lectures (e-Resources):
• **https://onlinecourses.nptel.ac.in/noc22_mm02/preview**
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Demonstrations of Videos • Group Discussion • Quizzes

UNDERGROUND CONSTRUCTION ENGINEERING		Semester	VII
Course Code	**BMN755C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

- to supplement an engineering background with a formal approach to subsurface construction engineering that includes site characterization, design and construction of underground infrastructure, including mining, water, highway or subway tunnels.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module-1

Types of Underground Excavations: Mining and Construction, Tunnels/Shafts; Parameters influencing location, shape and size; construction planning, factors affecting choice of excavation technique.

Geological and geotechnical investigations: Planning, techniques for subsurface excavations in mining and tunneling in soft ground, hard rock, shallow and deep seated.

Module-2

Excavation by Drilling and Blasting:

Drilling – drilling principles, drilling equipment, drilling tools, drill selection,

Blasting - explosives, initiators, blasting mechanics, types of cuts-fan, wedge and others; blast design,

Tunnel blast performance - powder factor, parameters influencing, models for prediction; Controlled blasting techniques, over break estimation and control, problems of drilling and blasting for large tunnels/shafts.

Module-3

Mechanized Excavation Techniques:

Tunneling by Roadheaders and Impact Hammers: Cutting principles, method of excavation, selection, performance, limitations and problems.

Tunneling by Tunnel Boring Machines: Boring principles, method of excavation, selection, performance, limitations and problems; TBM applications.

Module-4

Supports: Principal types of supports and applicability, Rock bolts, Wiremesh, Lattice Girders, Segment Lining, Water seepage, Ground Treatment for adverse conditions, Support Design examples.

Mucking and transportation: Systems, selection and operational efficiency assessment in different construction operations.

Module-5

Services: Ventilation, lighting, drainage & pumping, transportation.

Excavation of large and deep mines/tunnels/shafts: Introduction; excavation issues; excavation methods, different equipment, case studies from hydel, road and rail tunnels.

Risks/hazards involved in underground construction: Types with their mitigation measures (Fires, Inundation, Gases, Collisions), Risk Assessment and Management Strategies.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to :

1. Different types of underground excavations and their choices as per need.
2. Students will learn the effect of rock geology and geotechnical parameters with respect to safe underground construction.
3. Students will learn safe practices in drilling and blasting technology for underground construction.
4. Students will learn the mechanized methods for underground construction.
5. Students will learn various risks or hazards that may occur during underground construction with their mitigation.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

1. Design and construction of tunnels by Pietro Lunardi, Springer-Verlag Berlin Heidelberg 2008.
2. Planning design and construction of tunnels – Whittaker and Frith
3. Drilling and blasting of rocks – Jimeno, Carcedo, Jimeno

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Demonstrations of Videos
- Group Discussion
- Quizzes