

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY

UTTAR PRADESH, LUCKNOW



Evaluation Scheme & Syllabus
For

B.Tech. 3rd Year

MINING ENGINEERING

[Effective from the Session: 2025-26]

PLEASE NOTE: The Mini Project or internship (4 weeks) will be done during summer break after 6th Semester and will be assessed during 7th semester.

B.tech Mining Engineering , IIIrd Year (Vth Semester)

Course Structure

SN	Subject Code	Subject	Type	Periods			Sessional Component		Sessional (SW) (TS/PS)	End Semester Examination (ESE)	Total SW+ESE	Credit CR
				L	T	P	CT	TA				
1	BMN-501	Mine Environmental Engineering	T	3	1	0	20	10	30	70	100	4
2	BMN-502	Underground Coal Mining	T	3	1	0	20	10	30	70	100	4
3	BMN-503	Rock Mechanics	T	3	1	0	20	10	30	70	100	4
4		Departmental Elective-1	T	3	0	0	20	10	30	70	100	3
5		Departmental Elective-2	T	3	0	0	20	10	30	70	100	3
6	BMN-551	Mine Environmental Engineering Lab	P	0	0	2		50	50	50	100	1
7	BMN-552	Underground Coal Mining Lab	P	0	0	2		50	50	50	100	1
8	BMN-553	Rock Mechanics Lab	P	0	0	2		50	50	50	100	1
9	BMN-554	Mini Project or Internship Assessment*	P	0	0	2			100	0	100	1
10	BNC501/ BNC502	Constitution of India/ Essence of Indian Traditional Knowledge	T	2	0	0	20	10	30	70		NC
11		Minor/Honors Degree Track Subject										
		Total		17	3	8					900	22

* The Mini Project or Internship (4weeks) conducted during semester break after IVth semester and will be assumed during Vth semester.

NOTE:

1. Regular classroom interaction with industry experts is to be ensured in all the theory courses (minimum two expert talks from relevant industry)
2. Working on experiments using virtual lab is to be ensured in lab courses.
3. Students visit to Industry/Industry Expert's project site must be arranged as & when possible.

B.tech Mining Engineering , IIIrd Year (VIth Semester)

Course Structure

SN	Subject Code	Subject	Type	Periods			Sessional Component		Sessional (SW) (TS/PS)	End Semester Examination (ESE)	Total SW+ESE	Credit CR
				L	T	P	CT	TA				
1	BMN-601	Underground Metal Mining	T	3	1	0	20	10	30	70	100	4
2	BMN-602	Mine Ventilation	T	3	1	0	20	10	30	70	100	4
3	BMN-603	Mine Legislation and Safety	T	3	1	0	20	10	30	70	100	4
4		Departmental Elective-3	T	3	0	0	20	10	30	70	100	3
5		Open Elective-1	T	3	0	0	20	10	30	70	100	3
6	BMN-651	Underground Metal Mining Lab	P	0	0	2		50	50	50	100	1
7	BMN-652	Mine Ventilation Lab	P	0	0	2		50	50	50	100	1
8	BMN-653	Computer Aided Mine Planning Lab	P	0	0	2		50	50	50	100	1
9	BNC601/ BNC602	Constitution of India/ Essence of Indian Traditional Knowledge	T	2	0	0	20	10	30	70		NC
		Total		17	3	6					800	21

NOTE:

1. Regular classroom interaction with industry experts is to be ensured in all the theory courses (minimum two expert talks from relevant industry)
2. Working on experiments using virtual lab is to be ensured in lab courses.
3. Students visit to Industry/Industry Expert's project site must be arranged as & when possible.

Departmental Electives

Vth Semester	Departmental Elective-1	BMN 051	BMN 052	BMN 053
		Blasting Engineering	Eco-Friendly Mining	Physical And Numerical Simulation
	Departmental Elective-2	BMN 054	BMN 055	BMN 056
		Surface Mining	Environmental Hazards and Disaster Management in Mines	Clean Coal Technology
VIth Semester	Departmental Elective-3	BMN 061	BMN 062	BMN 063
		Mine Planning	Geo-Informatics	Global Environmental Issues

BMN - 501 MINE ENVIRONMENTAL ENGINEERING

Course outcome: Students will be able to:

1. Understand the fundamental principles of environmental science as applied to mining.
2. Identify and characterize various sources of environmental pollution in mining operations.
3. Analyze the impacts of mining activities on air, water, land, and biodiversity.
4. Design and implement effective engineering solutions for environmental control and pollution abatement in mines.
5. Develop comprehensive environmental management plans for sustainable mining operations.
6. Appreciate the legal, regulatory, and socio-economic aspects of mine environmental management in India.

UNIT 1: INTRODUCTION TO MINE ENVIRONMENT AND POLLUTION SOURCES

Introduction to Mine Environmental Engineering: Definition, scope, and interdisciplinary nature. Sources and Types of Mine Pollution: Air Pollution: Dust (particulate matter PM₁₀, PM_{2.5}), gaseous emissions (NO_x, SO_x, CO, CH₄), noise, vibrations. Water Pollution: Acid Mine Drainage (AMD), heavy metals, suspended solids, dissolved solids, process chemicals, oil and grease. Land Pollution: Overburden, waste rock, tailings, hazardous waste, soil degradation, land subsidence. Biodiversity Impacts: Habitat destruction, fragmentation, loss of flora and fauna, invasive species. Environmental Impacts of Mining: Impact on air quality, human health, and climate. Impact on surface water and groundwater quality and quantity. Impact on soil fertility, land stability, and landscape aesthetics. Impact on ecosystems, biodiversity, and ecosystem services. Basic Environmental Impact Assessment (EIA) in Mining: Purpose and components of EIA for mining projects. Baseline data collection and impact prediction (conceptual overview).

UNIT-2: MINE WATER MANAGEMENT AND TREATMENT

Mine Hydrology and Hydrogeology: Impact of mining on surface and groundwater regimes. Water balance in mining areas. Dewatering techniques for open-pit and underground mines. Water conservation strategies: Rainwater harvesting, water recycling and reuse. Acid Mine Drainage (AMD) Management: AMD Formation: Pyrite oxidation, role of bacteria, chemical reactions. Prediction of AMD: Static and Kinetic tests (conceptual). AMD Prevention Techniques: Encapsulation of reactive wastes, dry covers, anoxic limestone drains (ALD), passive reactive barriers. Mine Water Treatment Technologies: Active Treatment: Neutralization (lime, caustic soda), precipitation of heavy metals, coagulation-flocculation, sedimentation. Passive Treatment: Constructed wetlands, anoxic limestone drains, successive alkalinity producing systems (SAPS), bioreactors. Advanced Treatment: Membrane filtration (RO, UF), ion exchange, adsorption (conceptual). Tailings Dam Safety and Management: Types of tailings dams and their construction. Causes of tailings dam failures (liquefaction, overtopping, foundation failure). Design considerations for stability and environmental protection. Monitoring and surveillance of tailings storage facilities.

UNIT 3: MINE AIR QUALITY, VENTILATION, AND NOISE CONTROL

Mine Air Pollutants and Health Impacts: Dust: Types (respirable, inhalable), sources (drilling, blasting, crushing, haulage), health effects (pneumoconiosis). Gases: Methane (CH₄), Carbon Monoxide (CO), Carbon Dioxide (CO₂), NO_x, SO_x, Hydrogen Sulphide (H₂S). Sources of gases: Blasting, diesel engines, spontaneous combustion, strata gases. Physiological effects of mine gases. Mine Ventilation Principles: Objectives of mine ventilation: Dilution of pollutants, temperature control, provision of fresh air. Dust Control Measures: Prevention: Wet drilling, water infusion, proper blasting techniques. Suppression: Water spraying, chemical suppressants, dust collectors (wet scrubbers, bag filters). Personal Protective Equipment (PPE): Respirators. Dust sampling and monitoring. Mine Gas Control and Fire Management: Gas Drainage: Methane drainage systems. Dilution and Removal: Ventilation strategies. Spontaneous Combustion: Causes, detection, and prevention methods (sealing, inertization). Mine Fires: Types, causes, detection, and suppression techniques. Noise and Vibration Control: Sources of noise and vibration in mining (machinery, blasting). Health impacts of noise. Noise abatement measures: Enclosures, silencers, anti-vibration mounts, operational controls. Vibration monitoring and control.

UNIT 4: MINE WASTE MANAGEMENT AND LAND RECLAMATION

Mine Solid Waste Characterization and Management: Overburden and Waste Rock: Geochemical characterization, volume estimation, disposal strategies. Tailings: Physical and chemical properties, dewatering, disposal methods (dry stacking, paste fill, filtered tailings). Other Wastes: Hazardous waste (e.g., used oil, chemicals), scrap metal, domestic waste. Principles of waste minimization and resource recovery from mine waste. Design of Waste Dumps and Tailings Storage Facilities: Geotechnical stability analysis of dumps and impoundments. Drainage design for dumps and tailings facilities. Progressive backfilling and co-disposal techniques. Environmental considerations in design (e.g., leachate collection, liner systems). Mine Land Reclamation and Rehabilitation: Principles of Reclamation: Restoring land to a stable, non-polluting, and productive state. Topsoil Management: Stripping, stockpiling, and replacement. Landform Design: Creating stable and aesthetically pleasing landforms. Soil Amelioration: Improving soil fertility and structure (e.g., liming, organic matter addition). Revegetation Techniques: Selection of appropriate plant species (native, fast-growing, nitrogen-fixing). Seeding methods: Direct seeding, hydroseeding. Planting techniques: Seedlings, saplings. Monitoring of vegetation establishment and success. Post-Mining Land Use and Biodiversity Restoration: Planning for diverse and sustainable post-mining land uses (e.g., agriculture, forestry, recreation, conservation). Restoration of natural drainage patterns and water bodies. Strategies for re-establishing ecological connectivity and wildlife habitats. Long-term monitoring and maintenance of rehabilitated sites.

UNIT 5: ENVIRONMENTAL MANAGEMENT SYSTEMS, REGULATIONS, AND SUSTAINABLE MINING

Environmental Management Systems (EMS) in Mining: Introduction to ISO 14001 and its application. Elements of EMS: Environmental policy, planning, implementation, checking, and management review. Environmental performance indicators and reporting. **Indian Environmental Laws and Regulations for Mining:** Environmental (Protection) Act, 1986, and associated rules (e.g., Hazardous Waste Management Rules). Water (Prevention and Control of Pollution) Act, 1974, and Air (Prevention and Control of Pollution) Act, 1981. Forest

(Conservation) Act, 1980, and Wildlife (Protection) Act, 1972. Mines Act, 1952, and relevant regulations (e.g., Coal Mines Regulations, Metalliferous Mines Regulations) related to environmental safety. Environmental Clearance process for mining projects (revisited). **Environmental Monitoring and Auditing:** Purpose and types of environmental monitoring (compliance, impact, baseline). Environmental auditing: Objectives, types, and methodology. Role of regulatory bodies in monitoring and enforcement. **Corporate Social Responsibility (CSR) and Sustainable Mining:** Ethical considerations and social license to operate. CSR initiatives in the Indian mining sector. Community engagement, benefit sharing, and grievance redressal mechanisms. Principles of responsible mining and global initiatives (e.g., ICMM, TSM). **Emerging Trends and Challenges:** Climate change impacts on mining (e.g., water stress, extreme weather). Digitalization and automation for environmental management (IoT, AI, remote sensing). Circular economy principles in mining (resource recovery from waste). Deep-sea mining and its environmental implications. Challenges in managing legacy mine sites.

Reference Books:

1. The air (prevention and control of pollution) act, 1981
2. The water (prevention and control of pollution) act, 1974
3. Noise Pollution (regulation And Control) Amendment Rules, 2017
4. The environment (protection) act, 1986
5. The Indian Forest act, 1980
6. Legislation in Indian Mines - A Critical appraisal by Rakesh and Prasad
7. Env. Impact of Mining by Down and Stokes
8. Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India. (Relevant Acts, Rules, and Notifications).
9. International Council on Mining and Metals (ICMM). (Publications on sustainable mining, CSR).
10. United Nations Environment Programme (UNEP). (Publications on mining and environment).
11. International Council on Mining and Metals (ICMM). (Publications on mine waste management and mine closure).
12. Schuman, G. E., & Power, J. F. (1999). *Mine Spoil Reclamation*. Soil Science Society of America.
13. Ghose, A. K., & Ghose, S. (2014). *Mine Environment and Ventilation*. CRC Press.
14. McPherson, M. J. (1993). *Subsurface Ventilation and Environmental Engineering*. Chapman & Hall.
15. Younger, P. L., & Wolkersdorfer, C. (2004). *Mine Water: Hydrology, Pollution, Remediation*. Springer.
16. Lottermoser, B. G. (2010). *Mine Wastes: Characterization, Treatment and Environmental Impacts*. Springer.
17. Ghose, A. K., & Ghose, S. (2014). *Mine Environment and Ventilation*. CRC Press.
18. Lottermoser, B. G. (2010). *Mine Wastes: Characterization, Treatment and Environmental Impacts*. Springer.
19. Bell, F. G. (2007). *Engineering Geology*. Butterworth-Heinemann.

BMN - 502 UNDERGROUND COAL MINING**Course outcomes**

1. Identify suitable underground mining methods for different geological conditions.
2. Apply safety standards and protocols to prevent and manage underground mining hazards.
3. Operate and maintain underground mining equipment effectively and efficiently.
4. Design basic mine layouts and ventilation systems for underground coal extraction.
5. Evaluate environmental and economic aspects of underground coal mining operations.

UNIT-1 INTRODUCTION

Origin Of Coal, Theories of Coal Formation, Classification of Coal, Coaking Coal, Coal Seam and its Classification, Coal Seam Structures and Abnormalities like Faults, Joints, Folds etc.; Indian Coal Mining Industry; Choice of Coal Mining Methods.

UNIT-2 BORD AND PILLAR METHOD

Important Terminology, Development Size and Shape of The Pillar, Galleries, Panel System and Without Panel System of Development, Size of Panel, Cycle of Operation, Depillaring, Problems in Depillaring, Depillaring by Stowing, Depillaring by Caving Methods, Pillar Extraction Techniques, Dangers Associated with Depillaring.

UNIT-3 LONGWALL MINING

Important Terminology, Types of Longwalls Faces and Their Choice, Merits and Demerits of Longwall Mining, Development Of Longwall Panels and Faces, Longwall Advancing Method, Length Of Longwall Faces, Double Unit Longwall Faces, Face Organization and Material Supply.

UNIT-4 THICK SEAM MINING

Problem in Mining of Thick Seams, Choice of Thick Seam Mining Methods, inclined Slicing, Horizontal Slicing, Diagonal Slicing, Transverse Slicing, Sublevel Caving, Blasting Gallery Method, Cable- Bolting Method of Thick Seam Extraction.

UNIT-5 ROOM AND PILLAR MINING

Vermelles Method, Slant Method, Sublevel Method, Coal Saw Method, Mining of Contiguous Seams, Mining of Steeply Inclined Seam, Mining Under Water.

Text Books:

1. Elements of Mining Technology (Vol. 1 & 3): D. J. Deshmukh, Publisher : Denett & Co.
2. Coal Mining: R.D.Singh, Publisher : NEW AGE; First Edition (1 January 1997)
3. Modern Coal Mining: Samir Das, Publisher: Lovely Prakashan, Opp D.G.M.S. Office, Main Road, Hirapur, Dhanbad - 826001 (Jharkhand)
4. Principles and Practices of Modern Coal Mining, Author(s): R. D. Singh, Publisher: New Age International (P) Ltd. Publishers
5. Ground Engineering - Principles and Practices for Underground Coal Mining, Author(s): J. M. Galvin (Jim Galvin), Publisher: Springer International Publishing
6. Coal Mine Ground Control, Author(s): Syd S. Peng, Publisher: Society for Mining, Metallurgy & Exploration (SME) / John Wiley & Sons (for earlier editions)
7. Longwall Mining, Author(s): Syd S. Peng, Publisher: CRC Press (Taylor & Francis Group)

8. Underground Coal Mining Methods, Author(s): J. G. Singh, Publisher: Braj-Kalpa Publishers

Reference Books:

1. Mining Engineer's Handbook (Vol. 1 & 2), 2nd Edition: Edited by Harold Hartman
2. Coal Mines Regulations 2017 / The Mines Act 1952 / The Mines Rules 1955, Author(s): C.H.R.S. Sharma, S.N. Raju, L.C. Kaku, etc. (These are compilations/commentaries by various authors), Publisher: Various Indian legal/academic publishers (e.g., Eastern Book Company, Professional Book Publishers, Lovely Prakashan)

BMN - 503 ROCK MECHANICS

Course outcomes

1. Understand the physical and mechanical properties of rocks relevant to mining engineering.
2. Analyse stress and strain behaviour of rock masses under various loading conditions.
3. Apply laboratory and field-testing methods to determine rock strength and deformation characteristics.
4. Design rock support systems such as bolting, shotcrete, and grouting for underground excavations.
5. Evaluate the stability of rock slopes, tunnels, and underground openings using rock mass classification systems.
6. Use numerical and empirical methods for modelling rock behaviour and predicting failure mechanisms.

UNIT-1

Application of rock mechanics in mining, Classification of rock mass, Parameters of rock mass classification, Importance of rock mass classification, RQD, Q-system and Bieniskiw's Geomechanics, classification of rock mass.

UNIT-2

Rock properties, Physico-mechanical properties of rock, Determination of Physico-Mechanical properties of rock as per ISRM standard testing procedures, Strength indices and their importance. Point load, Protodyaknov, Impact and Cone-Indenter strength Index.

UNIT-3

Rock as an elastic medium, Principle of elastic analysis, Rheological properties of rock, Importance of rheological models, Different types of rheological models, Dynamic properties of rocks.

UNIT-4

Principal stress and Principal plane, Analytical method of determining the magnitudes and directions of normal and shear stress on failure plane, Mohr's circle, Theories of failure of rock, Mohr's theory, Empirical theories of failure of rock, Different modes of failure of rock.

UNIT-5

Earth stresses, Importance of measurements of in situ stress, measurements of in situ stress by Flat jack, Over coring and Hydraulic fracturing technique. Design of circular and elliptical openings. Determination of safe span of roof.

Recommended books:

1. Rock Mechanics by Obert and Duvall, Publisher: John Wiley & Sons Inc (1 December 1967)
2. Rock Mechanics by Goodman, Publisher: Wiley India Pvt Ltd; Second edition (16 March 2010)
3. Rock Mechanics by Jager & Cook, Publisher: Blackwell Pub; 4th edition (4 May 2007)
4. Rock Mechanics by B.P. Verma, Publisher: Khanna Publishers
5. Rock Mechanics (Sivakugan, Nagaratnam Shukla, Sanjay Kumar Das, Braja M.), Publisher: CRC Press

DEPARTMENTAL ELECTIVE – 1

BMN - 051 BLASTING ENGINEERING

Course outcomes:

1. Understand the principles of rock breakage and explosive mechanics used in mining and construction.
2. Select appropriate explosives and initiation systems based on site conditions and blasting objectives.
3. Design blast patterns and charge calculations for both surface and underground operations.
4. Analyse blasting results including fragmentation, ground vibration, air blast, and fly rock control.
5. Implement safety regulations and environmental practices in blasting operations.

UNIT-1 COMMERCIAL EXPLOSIVES

Type of explosives, Various Commercial Explosives and their properties, Bulk Explosive Systems, Selection of explosive. Testing, Transportation and Handling of explosives.

UNIT-2 INITIATION SYSTEM & BLASTING ACCESSORIES

Various types of Exploder and Detonators. Detonating cord, Safety fuse, detonating relays Non electric initiation and blasting accessories.

UNIT-3 SURFACE BLAST DESIGN

Factors affecting blast design, Selection of various blast parameters Burden, Spacing, Stemming distance, Sub-grade drilling, Depth of hole, Bench height, Diameter of hole, Safe charge calculation, Deck Charging, Drilling patterns, Inclined hole drilling, Secondary blasting.

UNIT-4 UNDER GROUND BLAST DESIGN

Various cut patterns, U/G blast design, Series & Parallel connection of detonators, Precautions during blasting.

UNIT-5 ROCK BREAKAGE MECHANISM

Breakage mechanism, rock fragmentation, Factors affecting rock fragmentation. Adverse effects of Blasting: Back break, over break, Fly rock, Ground Vibration and Noise.

References:

1. Explosives and Blasting Technology: G. K. Pradhan
2. Surface Blast Design: C. J. Kanya
3. Rock Blasting: Sushil Bhandari
4. Indian Explosive Act 1884
5. Legislation in Indian Mines -A Critical Appraisal : Rakesh and Prasad

BMN-052 ECO-FRIENDLY MINING

Course Outcome: After the end of the course the student will be able to

1. Students will be able to identify and select eco-friendly mining equipment and operational practices that minimize environmental impact.
2. Students will be able to analyze and assess key environmental parameters (water, air, soil) related to mining operations and propose mitigation strategies for pollution.
3. Students will gain proficiency in managing various mining wastes, including wastewater, acid mine drainage, and solid spoils, using appropriate treatment and disposal techniques.
4. Students will understand the principles and legal frameworks of mine closure, enabling them to plan and implement effective post-mining land rehabilitation and management strategies.

UNIT- 1 Foundations of Mining and Environmental Footprint:

Global and Indian Mining Landscape: Significance of minerals and metals in national development. Overview of major mineral resources and their extraction in India. Classification of mining methods, Mine Life Cycle and Associated Impacts: Stages: Prospecting & Exploration, Planning & Design, Construction, Operation, Closure, and Post-Closure. Environmental Impacts: Land Use Change: Deforestation, habitat destruction, soil erosion, land subsidence. Water Quality & Quantity, Air Quality, Noise & Vibration, Waste Generation: Overburden, waste rock, tailings, processing waste, and their characteristics. Social Impacts: Displacement, livelihood loss, health issues, cultural disruption, community conflicts.

UNIT - 2 Environmental Governance and Impact Assessment in Mining:

Environmental Management Systems (EMS) in Mining, Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA), Indian Environmental Regulatory Framework for Mining, Environmental Risk Assessment and Management: Methodologies for hazard identification, risk analysis, and risk evaluation in mining, Development of risk mitigation hierarchies and strategies, Emergency preparedness and response plans for environmental incidents (e.g., tailings dam failure, chemical spills).

UNIT- 3 Eco-Friendly Mining Operations and Technologies:

Sustainable Mine Waste Management, Overburden and Waste Rock, Tailings Management, Waste Utilization, Advanced Water Management and Pollution Control, Water Conservation, Acid Mine Drainage (AMD) Control, Prevention, Treatment, Cleaner Extraction and Mineral Processing, Selective Mining, In-situ Leaching (ISL), Bio-mining and Phyto-mining, Dry Processing and Waterless Technologies, Digitalization for Process Optimization, Energy Efficiency and Emission Reduction

UNIT- 4: Mine Closure, Reclamation, and Post-Mining Land Use:

Strategic Mine Closure Planning, Landform Design and Geotechnical Stability, Soil Reconstruction and Ecological Revegetation, Water Body Rehabilitation and Biodiversity Restoration, Sustainable Post-Mining Land Use

UNIT -5 Social Responsibility, Policy, and Future of Eco-Friendly Mining:

Social Aspects and Community Development, Corporate Social Responsibility (CSR) and Ethical Mining, International Frameworks and Best Practices, Emerging Technologies and Future Trends

in Eco-Friendly Mining, Digitalization & Automation, Deep-Sea Mining, Urban Mining & Circular Economy, Carbon Neutrality in Mining, Critical Minerals & Sustainable Sourcing.

Suggested Readings:

- Hilson, G. (Ed.). (2015). *The Handbook of Research on Mining and Minerals in Developing Countries*. Edward Elgar Publishing.
- Auty, R. M. (2001). *Resource Abundance and Economic Development*. Oxford University Press.
- United Nations Environment Programme (UNEP) and International Council on Mining and Metals (ICMM) publications on sustainable mining.
- Recent reports and articles on emerging technologies in mining from industry associations and research institutions.
- Hartman, H. L., & Mutmansky, J. M. (2002). *Mining Engineering Analysis*. Society for Mining, Metallurgy, and Exploration (SME).
- Ramani, R. V. (Ed.). (2009). *SME Mining Engineering Handbook*. Society for Mining, Metallurgy, and Exploration (SME).
- Hilson, G. (2016). *The Social License to Operate: An Introduction*. Routledge.
- Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India. (Latest versions of relevant Acts, Rules, and Notifications).
- Glasson, J., Therivel, R., & Chadwick, A. (2012). *Introduction to Environmental Impact Assessment*. Routledge.
- Vanclay, F., & Esteves, A. M. (Eds.). (2011). *New Frontiers in Social Impact Assessment*. Edward Elgar Publishing.
- Lottermoser, B. G. (2010). *Mine Wastes: Characterization, Treatment and Environmental Impacts*. Springer.
- Young, C. A., & Williams, M. (Eds.). (2015). *Biohydrometallurgy: A Sustainable Approach to Metal Extraction*. CRC Press.
- International Council on Mining and Metals (ICMM). (Various publications on sustainable mining practices).
- International Council on Mining and Metals (ICMM). (Various publications on mine closure and rehabilitation).
- Bell, F. G. (2007). *Engineering Geology*. Butterworth-Heinemann. (For geotechnical aspects of landforms).
- Society for Ecological Restoration (SER). (Principles and Standards for Ecological Restoration).

BMN-053 PHYSICAL AND NUMERICAL SIMULATION

Course Outcome: After the end of the course the student will be able to

1. Students will understand the fundamental concepts and principles underlying both physical and numerical simulation techniques.
2. Students will be able to apply dimensional analysis and understand the methodology and material selection for physical modelling in engineering problems.
3. Students will gain proficiency in the theoretical foundations and application of the Boundary Element Method (BEM), including specific techniques like the displacement-discontinuity method.
4. Students will comprehend the Finite Difference Method (FDM) and its mesh generation, along with the ability to identify and apply both FDM and Finite Element Method (FEM) to solve relevant mining-related problems.

UNIT-1 Introduction to Simulation and Physical Modeling Fundamentals:

Introduction to Simulation: Definition and purpose of simulation in engineering and science, Role of modelling, Classification of simulation types: Physical vs. Numerical, Deterministic vs. Stochastic, Static vs. Dynamic, Overview of the simulation process: Problem definition, model formulation, Fundamentals of Physical Modeling: Concept of physical models and their applications, Dimensional Analysis: Dimensions and units, homogeneity of equations, Buckingham Pi Theorem and its application, Similitude and Model Laws: Geometric, Kinematic, and Dynamic Similitude, Scaling laws for various physical phenomena (fluid flow, heat transfer, structural mechanics), Distorted models and their implications.

UNIT-2 Experimental Design and Data Analysis in Physical Simulation:

Experimental Design for Physical Models: Planning and execution of physical experiments, Selection of model scales and materials, Measurement Techniques and Instrumentation: Sensors for measuring physical quantities, Data acquisition systems (DAS) and signal conditioning, Calibration of instruments and measurement accuracy, non-intrusive measurement techniques, Data Analysis and Interpretation: Statistical analysis of experimental data, Error analysis and uncertainty quantification, Regression analysis and curve fitting, Visualization of experimental results, Comparison of model results with prototype behavior.

UNIT- 3 Fundamentals of Numerical Simulation: Mathematical Modeling and Discretization:

Mathematical Modeling of Physical Systems: Conservation laws: Mass, Momentum, Energy, Derivation of governing partial differential equations (PDEs) for: Heat Conduction (Diffusion Equation), Fluid Flow (Navier-Stokes Equations, Continuity Equation), Solid Mechanics (Stress-Strain relations, Equilibrium Equations), Introduction to Numerical Methods: Concept of discretization: Transforming continuous problems into discrete algebraic equations, Finite Difference Method (FDM): Taylor series expansion for approximating derivatives, Forward, Backward, and Central difference schemes, Finite Element Method (FEM): Concept of elements and nodes, Shape functions and interpolation, Weak formulation and weighted residual methods (Galerkin method), Application to 1D bar and heat transfer problems.

UNIT- 4 Advanced Numerical Simulation Techniques and Applications:

Computational Fluid Dynamics (CFD): Navier-Stokes equations and their challenges, Discretization of convective and diffusive terms, Pressure-velocity coupling algorithms (e.g.,

SIMPLE, PISO), Turbulence modeling (RANS, LES, DNS - conceptual overview), Grid generation and meshing strategies, Applications: Aerodynamics, hydrodynamics, heat exchangers, combustion, Finite Element Analysis (FEA): Review of FEM for 2D problems (plane stress/strain, axisymmetric problems), Discrete Element Method (DEM) for granular materials, Molecular Dynamics (MD) for atomic/molecular level simulations, Boundary Element Method (BEM), Meshless methods, Introduction to Commercial Simulation Software: Overview of popular software packages (e.g., ANSYS, ABAQUS, COMSOL, Open FOAM).

UNIT -5 Validation, Verification, and Advanced Topics:

Verification and Validation (V&V) of Simulations: Verification: Ensuring the numerical model correctly solves the mathematical model, Validation: Ensuring the mathematical model accurately represents the real physical system (comparison with experimental data, analytical solutions), Uncertainty quantification in simulation. Accuracy, Stability, and Convergence: Consistency, stability, and convergence criteria for numerical schemes, Hybrid Simulation: Concept of combining physical and numerical models, Advantages and challenges of hybrid approaches, Examples of coupled simulations (e.g., fluid-structure interaction, thermo-mechanical coupling), Challenges and Future Trends in Simulation: Computational cost and high-performance computing (HPC), Multiphysics and multiscale simulations, Artificial Intelligence and Machine Learning in simulation, Digital Twin concept, Ethical considerations in simulation.

Suggested Readings:

- Roache, P. J. (1998). *Verification and Validation in Computational Science and Engineering*. Hermosa Publishers.
- Oden, J. T., & Carey, G. F. (1999). *Finite Elements: Mathematical Aspects*. Dover Publications.
- Recent research papers and review articles on simulation and modeling.
- Muralidhar, K., & Sundararajan, T. (2018). *Computational Fluid Flow and Heat Transfer*. Narosa Publishing House.
- Logan, D. L. (2017). *A First Course in the Finite Element Method*. Cengage Learning.
- ANSYS/ABAQUS/COMSOL/OpenFOAM User Manuals and Tutorials.
- Versteeg, H. K., & Malalasekera, W. (2007). *An Introduction to Computational Fluid Dynamics: The Finite Volume Method*. Pearson Education.
- Reddy, J. N. (2019). *An Introduction to the Finite Element Method*. McGraw-Hill Education.
- Hoffman, J. D., & Frankel, S. (2001). *Numerical Methods for Engineers and Scientists*. CRC Press.
- Holman, J. P. (2001). *Experimental Methods for Engineers*. McGraw-Hill Education.
- Figliola, R. S., & Beasley, D. E. (2015). *Theory and Design for Mechanical Measurements*. John Wiley & Sons.
- Cengel, Y. A., & Cimbala, J. M. (2014). *Fluid Mechanics: Fundamentals and Applications*. McGraw-Hill Education. (For dimensional analysis and similitude)
- White, F. M. (2016). *Fluid Mechanics*. McGraw-Hill Education. (For dimensional analysis and similitude).

DEPARTMENTAL ELECTIVE – 2

BMN - 054 SUR FACE MINING

Course Outcome: After the end of the course the student will be able to

1. Understanding the various methods of surface mining techniques
2. Application of design principles for stable benches and overall pit slopes
3. Orient with different equipment for surface mining
4. Apprehend the impact of surface mining on environment

UNIT-1 Introduction to Surface Mining

Definition of important terms, Advantages and disadvantages of surface mining, Various surface mining methods, introduction to unit operations in surface mining. Introduction to various types of machineries used in surface mining.

UNIT-2 Open Pit Design and Layouts

Important parameters of Open pit design; Design of Benches, Ultimate pit, stripping ratio, Break even stripping ratio, Different methods of opening up the deposits; Box cuts, internal and external box cut, Methods of driving Box cuts; Layout of open pits; Layout of waste dumps.

UNIT-3 Drilling and blasting

Different Types of Drill Machines Used in Open Pits; Rotary, Percussive and Rotary Percussive Drilling, Selection of Drill Machines on the basis of Drill-ability; Inclined Drilling; their Advantages and Disadvantages.

Terminology for bench blasting; parameter affecting surface blasting; designing surface blasting.

UNIT-4 Pit preparation, Loading and Excavation

Dozers, Scrapers, Front-End Loaders, Grader, Back Hoe, their Construction, Operation, Suitability and applicability; Shovel, Dragline, Hydraulic Excavators, Multi Bucket Excavators, their Construction, Specifications, Operation, Suitability and Applicability.

UNIT-5 Transport in open pits

Automobile Transport, Rail Transport and Conveyors; their Suitability; Computation of their Productivity; Automation in Open Pit transport such as Truck Dispatch System.

Text Books:

1. Surface Mining Vol 1, Author G. B. Misra, Publisher Dhanbad Publishers, 1979
2. Surface mining equipment: Martin, Publisher Martin Consultants
3. SME Mining Engineering Handbook, Editor(s): Peter Darling (Editor-in-Chief for 3rd Edition), Arthur B. Cummins (2nd Ed.), Ivan A. Given (1st Ed.), Publisher: Society for Mining, Metallurgy, and Exploration (SME)
4. Surface Mining, Editor(s): B.A. Kennedy (Bruce A. Kennedy / Barbara A. Kennedy), Publisher: Society for Mining, Metallurgy, and Exploration (SME)
5. Surface Mining Technology, Author(s): Mostafa Mohamed Ali Elbeblawi, Hassan Ali Abdelhak Elsaghier, Mostafa Tantawy Mohamed Amin, Wael Rashad Elrawy Abdellah, Publisher: Springer

Recommended books:

1. Elements of Mining Tech. (Vol- 1), D. J . Deshmukh.
2. Surface Mining Technology, Samir Kumar Das.
3. Elements of Mining Tech. (Vol- 1), D. J . Deshmukh.
4. Surface Mining Technology, Samir Kumar Das.
5. Heavy Earth Moving Machines, Amitosh de. U M S

BMN - 055 ENVIRONMENTAL HAZARDS AND DISASTER MANAGEMENT IN MINES

Course Outcome: After the end of the course the student will be able to

1. Students will be able to identify the causes and mechanisms of common mining hazards such as mine fires, explosions, and inundations, and apply appropriate preventive and control measures.
2. Students will gain comprehensive knowledge of various mine occupational diseases, understanding their causes, symptoms, and the necessary preventive strategies for worker health.
3. Students will develop the ability to plan and implement effective disaster management strategies in mines, including emergency organization, rescue operations, and the use of specialized equipment.
4. Students will understand the legal and procedural requirements for disaster investigation and mine rescue rules, enabling them to contribute to a safer mining environment.

UNIT- 1: Introduction to Environmental Hazards in Mining:

Fundamentals of Environmental Hazards and Disasters, Geological and Geotechnical Hazards: Slope Instability, Seismicity, Groundwater Issues, Soil Erosion and Sedimentation, Hydrological and Hydrogeological Hazards: Acid Mine Drainage (AMD): Formation mechanisms, prediction, and impacts on water bodies. Tailings Dam Failures: Causes (e.g., liquefaction, overtopping), impacts of spills. Mine Flooding: In open-pit and underground mines, impacts on operations and environment. Water Contamination: Heavy metals, dissolved solids, process chemicals. Atmospheric and Air Quality Hazards: Dust Emissions, Gaseous Emissions: NO_x, SO_x, CO from machinery and blasting. Spontaneous Combustion of Coal: Hazards, detection, and control. Biological and Ecological Hazards: Habitat Loss and Fragmentation: Impact on biodiversity. Invasive Species: Introduction through mining activities. Contamination of Food Chains: Bioaccumulation of heavy metals.

UNIT- 2: Risk Assessment and Monitoring of Environmental Hazards in Mines:

Environmental Risk Assessment Methodology: Hazard identification, consequence analysis, likelihood assessment, Quantitative and qualitative risk assessment approaches. Integration of environmental risk assessment into mine planning, Geotechnical and Hydrological Monitoring: Slope Stability Monitoring: Geodetic surveys (GPS, Total Station), inclinometers, extensometers,

radar, Groundwater Monitoring: Piezometers, monitoring wells, flow meters, Surface Water Monitoring: Flow gauges, water quality sensors (pH, EC, heavy metals). Tailings Dam Monitoring: Piezometers, settlement markers, visual inspections. Air Quality and Dust Monitoring: Ambient air quality monitoring stations (PM, SO₂, NO₂). Personal dust samplers. Noise level monitoring. Meteorological data collection for dispersion modeling. Ecological and Biodiversity Monitoring: Baseline ecological surveys. Monitoring of flora and fauna populations. Bio-indicators for environmental health. Data Management and Analysis for Monitoring: Use of GIS for spatial data management and visualization of monitoring results. Statistical analysis of environmental data. Reporting and communication of monitoring outcomes.

UNIT- 3: Disaster Management Principles and Frameworks:

Disaster Management Cycle: Prevention/Mitigation: Long-term measures to reduce risk, Preparedness: Planning and readiness for response, Response: Actions during and immediately after a disaster. Recovery/Rehabilitation: Long-term restoration, Institutional Framework for Disaster Management in India: National Disaster Management Authority (NDMA). State Disaster Management Authorities (SDMAs). District Disaster Management Authorities (DDMAs). Role of Ministry of Home Affairs, Ministry of Mines, DGMS. Legal Framework for Disaster Management: Disaster Management Act, 2005. Relevant provisions in Mines Act, 1952; Mines Rules, 1955; Coal Mines Regulations, 2017; Metalliferous Mines Regulations, 1961 (with focus on safety and environmental aspects). Environmental (Protection) Act, 1986, and rules related to hazardous waste management Types of Disaster Management Plans: National Disaster Management Plan. State and District Disaster Management Plans. On-site and Off-site Emergency Plans for Mines. Crisis Management Plans, Coordination and Communication.

UNIT- 4: Mitigation and Preparedness for Mining Disasters:

Mitigation of Geotechnical Hazards: Slope Stability Measures, Subsidence Control, Seismic Hazard Mitigation: Blasting design, monitoring. Mitigation of Hydrological Hazards: AMD Prevention, Tailings Dam Safety, Mine Water Management, Mitigation of Air Quality Hazards: Dust Control, Ventilation Systems, Fire Prevention, Emergency Preparedness in Mines: Emergency Response Plans (ERP), Mock Drills and Training, Emergency Equipment and Infrastructure: Rescue teams, medical facilities, communication systems, Early Warning Systems, Role of Technology in Preparedness: Remote sensing and GIS for hazard mapping and vulnerability assessment, Real-time monitoring systems and automated alarms, Predictive modeling for environmental phenomena (e.g., AMD plume dispersion).

UNIT-5: Emergency Response, Rehabilitation, and Policy Framework:

Emergency Response Operations, Post-Disaster Recovery and Rehabilitation: Short-term recovery measures, Long-term environmental rehabilitation: Landform reconstruction, soil amelioration, revegetation, water body restoration, Socio-economic recovery and livelihood restoration for affected communities, Psychological support for victims, Legal and Policy Aspects of Disaster Risk Reduction (DRR) in Mining: Integration of DRR into environmental impact assessments and mine closure plans, Importance of robust regulatory oversight, Community-Based Disaster Management (CBDM): Empowering local communities in hazard identification, preparedness, and response, Ethical Considerations and Future Directions: Corporate responsibility in disaster prevention and response. Accountability for environmental damages, Climate change and its implications for mining hazards (e.g., extreme rainfall, droughts), Role of technology (AI, IoT, Big Data) in future disaster management.

Text Books:

1. "Mine Safety Science and Engineering: Health and Disaster Management"
 - Author: Debi Prasad Tripathy
 - Publisher: CRC Press (Taylor & Francis Group)
2. "Mine Disasters and Mine Rescue"
 - Author: M.A. Ramlu
 - Publisher: Universities Press (India) / Taylor & Francis (International editions might be available under this publisher)
3. "Process Safety in Coal Mining" (Possibly an edited volume)
 - Editors: F.D. Feng Du, A.Z. Aitao Zhou, B.L. Bo Li
 - Publisher: MDPI Books
5. "Water Management at Abandoned Flooded Underground Mines: Fundamentals, Tracer Tests, Modelling, Water Treatment"
 - Author: Christian Wolkersdorfer
 - Publisher: Springer
6. "Modern Occupational Diseases: Diagnosis, Epidemiology, Management and Prevention" (Often an edited volume with multiple contributors)
 - Publisher: Bentham Books
7. "Occupational Health and Safety Management: A Practical Approach"
 - Author: Charles D. Reese
 - Publisher: CRC Press (Taylor & Francis)
8. "Elements of Mining Technology (Volume 2)" (often covers safety aspects in detail)
 - Author: D.J. Deshmukh (and R.T. Deshmukh for later editions/volumes)
 - Publisher: Standard Publishers Distributors (or similar Indian publishers)

BMN-056 CLEAN COAL TECHNOLOGY

Course Outcome: After the end of the course the student will be able to

1. Students will be able to analyze global coal production and utilization trends, understanding the impact of coal quality on the selection of eco-friendly utilization methods.
2. Students will gain proficiency in evaluating the necessity, scope, and environmental implications of pre-combustion coal cleaning technologies, including their principles, operations, and performance assessment.
3. Students will comprehend the principles, operating features, and environmental benefits/challenges of various clean coal combustion and post-combustion technologies, enabling their selection and performance evaluation.
4. Students will be able to characterize, assess the impact of, and propose effective control, treatment, disposal, and utilization strategies for wastes and pollutants generated throughout the coal utilization process.

UNIT-1 Coal Utilization:

Coal production and utilization trends. Status of coal utilization technology and related operating and environmental problems. Coal qualities and their effect on selection of efficient methods for eco-friendly utilization of coal.

UNIT-2 Pre-Combustion Technology:

Necessity, scope and limitations of pre-combustion coal cleaning technology. Washability characteristics and preparation problems related to coal quality. Principles, operations and selection of processes for coal preparation. Plant performance evaluation and forecasting of cleaning results. Environmental problems and related mitigating measures.

UNIT-3 Combustion and Post-Combustion Technology:

Necessity, scope and limitations of combustion and post-combustion clean coal technologies. Developments, basic principles, operating features of clean coal technologies. Selection, performance and related environmental problems and their control.

UNIT-4 Carbon Utilization, Storage, and Policy Aspects:

Carbon Dioxide Utilization (CDU): Enhanced Oil Recovery (EOR) using CO₂. Mineral carbonation. Biological utilization, Carbon Dioxide Storage (CCS - Storage): Geological storage options: Saline aquifers, unmineable coal seams. Storage mechanisms: Structural, residual, solubility, mineral trapping, Integrated CCUS Systems and Policy: Techno-economic analysis of CCUS projects. Cost of electricity from CCUS power plants. Government policies, incentives, and regulations for clean coal and CCUS. Future outlook and research directions in clean coal technology.

UNIT-5 Wastes and Pollutants:

Characterization, impacts, control, treatment and safe disposal of wastes and pollutants released from various stages of clean coal technologies. Utilization of wastes and pollutants.

Text Books:

1. "Clean Coal Technologies: Beneficiation, Utilization, Transport Phenomena and Prospective"
 - Editors: Rajesh Kumar Jyothi, Pankaj Kumar Parhi
 - Publisher: Springer International Publishing
2. "The Coal Handbook (Volume 2: Towards Cleaner Coal Utilization)"
 - Editor: Dave Osborne
 - Publisher: Woodhead Publishing (an imprint of Elsevier)
3. "An Introduction to Coal Technology"
 - Author: N. Berkowitz
 - Publisher: Academic Press (an imprint of Elsevier)
4. "Coal Preparation" (Often a multi-volume series)
 - Editors: Joseph W. Leonard, Joseph W. Leonard III
 - Publisher: Society for Mining, Metallurgy, and Exploration (SME)
5. "Advanced Coal Preparation and Beyond"
 - Author: S. Komar Kawatra
 - Publisher: Taylor & Francis Ltd.
6. "Clean Coal Technologies: A Review "
 - Author: S.K. Singh and A.K. Singh
 - Publisher: academic or technical publishers in India
7. "Coal Ash: Characterization, Utilization and Disposal"
 - Authors: S.P. Singh, B.B. Dhar
 - Publisher: Scientific Publishers (India) / NIPA (New India Publishing Agency)

LAB

BMN - 551 MINE ENVIRONMENTAL ENGINEERING LAB**Water Quality Analysis:**

1. Determination of Hardness (Total, Calcium, and Magnesium Hardness): Measuring the concentration of dissolved mineral ions (primarily calcium and magnesium) that cause water hardness, usually by EDTA titration.
2. Determination of Dissolved Oxygen (DO): Measuring the amount of oxygen available in water, crucial for aquatic life and indicating organic pollution (e.g., using Winkler method or DO meter).
3. Determination of Biochemical Oxygen Demand (BOD): Measuring the amount of oxygen consumed by microorganisms while decomposing organic matter in water, indicating organic pollution load.
4. Determination of Chemical Oxygen Demand (COD): Measuring the amount of oxygen required to chemically oxidize organic and inorganic matter in water, providing a faster estimate of pollution than BOD.
5. Determination of Heavy Metals (e.g., Iron, Copper, etc.): Using methods like spectrophotometry or atomic absorption spectroscopy to quantify specific heavy metal contaminants.

Air Quality and Mine Environment Monitoring:

6. Detection of Mine Gases (Methane, Carbon Monoxide, Carbon Dioxide, Hydrogen Sulfide, Oxygen deficiency):
 - Using multi-gas detectors.
 - Using Flame Safety Lamp for methane detection (accumulation and percentage tests).
 - Demonstration of CO-detectors and Methanometers.
 - Analysis of gas samples using an Orsat apparatus (for CO₂, O₂, CO).
7. Measurement of Relative Humidity using a Whirling Hygrometer (Sling Psychrometer): Understanding psychrometric principles and calculating humidity.
8. Measurement of Air Velocity and Quantity (Anemometer and Velometer): Using various instruments to measure airflow in mine roadways and calculate air quantity.
9. Measurement of SPM (Suspended Particulate Matter) and PM₁₀ (Particulate Matter <10 micrometers) with High Volume Sampler: Assessing airborne dust levels.

Environmental Management and Impact Assessment (Demonstrations/Case Studies):

10. Field Visit to Water/Sewage Treatment Plant or Mine Site: Observing real-world environmental control measures.
11. Study of Mine Air-Conditioning Plants: Understanding methods for controlling temperature and humidity in deep mines.
12. Layout of Lamp Rooms: Understanding safety equipment and their maintenance.

Course outcomes: Upon successful completion of this course, students will be able to:

1. Understand and Analyze Environmental Parameters: Water Quality, Air Quality, Thermal Environment, Noise and Vibration
2. Apply Principles of Environmental Control: Ventilation, Pollution Control, Waste Management
3. Operate and Calibrate Laboratory Equipment
4. Interpret Data and Report Findings

5. Develop Problem-Solving Skills
6. Understand Safety and Ethical Considerations

BMN - 552 UNDERGROUND COAL MINING LAB

List of Experiments:

1. Study of layouts of Board and Pillar development working by without panel system.
2. Study of layouts of Board and Pillar development working by panel system.
3. Study of layout of long wall Advancing system.
4. Study of layout of Longwall Retreating system.
5. Study of various line of extraction used for pillar extraction.
6. Study of stook extraction methods under difficult roof conditions.
7. Study of sublevel caving method of thick seam mining.
8. Study of layout of Blasting Gallery method.
9. Study of layout of Hydraulic Mining.
10. Study of Coal Bed Methane extraction.

Course outcomes: Upon successful completion of this course, students will be able to:

1. Analyze and Differentiate Mining Layouts: Differentiate and analyze the various layouts employed in Board and Pillar mining, distinguishing between systems with and without panel development.
2. Evaluate Longwall Mining Systems: Evaluate and compare the layouts and operational considerations of both Longwall Advancing and Longwall Retreating mining systems.
3. Understand Pillar Extraction Techniques: Comprehend and identify various lines of extraction utilized for pillar recovery in underground mining.
4. Propose Solutions for Challenging Roof Conditions: Propose and assess stook extraction methods specifically adapted for mining under difficult roof conditions.
5. Describe Thick Seam Mining Methods: Describe and explain specialized methods for thick seam mining, such as sublevel caving.
6. Recognize Advanced Mining Techniques: Recognize and describe the layouts and principles of advanced mining techniques including Blasting Gallery, Hydraulic Mining, and Coal Bed Methane (CBM) extraction.
7. Compare and Contrast Mining Methods: Compare and contrast the applicability, advantages, and disadvantages of various underground coal mining methods presented in the experiments.
8. Identify Key Mining Parameters: Identify and explain the critical parameters influencing the design and operation of different underground mining layouts.

BMN - 553 ROCK MECHANICS LAB

List of Experiments:

1. Determination of moisture content of rock sample by ISRM standard method
2. Determination of porosity of rock sample by ISRM standard method
3. Determination of Density of rock sample by ISRM standard method
4. Determination of slake durability strength index of rock sample by ISRM standard method
5. Determination of point load strength index of rock sample
6. Determination of Proto-dyakov strength index of rock sample
7. Determination of Uni-axial Compressive strength of rock sample by ISRM standard method
8. Determination of Tensile strength of rock sample by Brazilian method
9. Determination of Shear strength of rock sample
10. Determination of Tri-axial Compressive strength of rock sample by ISRM standard method

Course outcomes: Upon successful completion of this laboratory course, students will be able to:

1. Characterize Physical Properties of Rocks: Accurately determine fundamental physical properties of rock samples, including moisture content, porosity, and density, using standardized laboratory procedures (e.g., ISRM methods).
2. Assess Rock Durability and Weathering Resistance: Evaluate the slake durability index of rock samples to predict their resistance to weathering and degradation in various environmental conditions.
3. Quantify Rock Strength Parameters: Determine various strength indices of rock samples, including point load strength and Proto-Dyakov strength, and interpret their significance.
4. Measure Fundamental Mechanical Strengths: Conduct laboratory tests to accurately measure the uniaxial compressive strength, tensile strength (via the Brazilian method), and shear strength of rock samples.
5. Analyze Rock Behavior Under Confining Stress: Perform triaxial compressive strength tests on rock samples to understand their mechanical behavior under simulated in-situ stress conditions.
6. Apply ISRM Standards: Demonstrate proficiency in applying International Society for Rock Mechanics (ISRM) standard methods for rock property and strength determination.
7. Interpret and Report Experimental Data: Analyze experimental data obtained from rock mechanics tests, interpret the results, and present them in a clear, concise, and professional manner.
8. Understand the Importance of Rock Properties in Engineering: Relate the determined physical and mechanical properties of rocks to their significance in various geological and geotechnical engineering applications.

BMN - 601 UNDERGROUND METAL MINING

Coures outcomes:

1. Select appropriate underground mining methods (like cut and fill, shrinkage stoping, sublevel stoping) based on ore body characteristics.
2. Analyze mine development process es including shaft sinking, drifting, and raising.
3. Operate and maintain equipment used in underground metal mining effectively.
4. Apply ventilation, drainage, and ground control techniques to ensure safe and efficient mining operations.
5. Evaluate environmental, economic, and safety aspects of underground metal mining projects.

UNIT-1 General:

Status and scope of Underground metal mining methods; various types of ore deposit; Definitions of Important terms used in underground metal mining methods. Comparison between coal mining & metal Mining

UNIT-2 Development:

Mode of access; Variables affecting the choice of mode of access; Crosscuts, Levels, Raises; Their Method of drivages with the description of various unit operations; Introduction to Raise boring and Introduction to tunnel boring.

UNIT-3 Stoping Methods -I:

Classification of mining methods; Factors affecting the choice of mining methods; Overhand, Underhand and Breast stoping methods; Open stoping; Vertical Crater Retreat method; Sub level stoping; Room and Pillar method.

UNIT-4 Stoping Methods - II:

Shrinkage stoping method; Cut and fill stoping method, Introduction to Square set stoping method, Sub Level caving, Block caving, & Top slicing method.

UNIT-5 Support Systems:

Pillars; Back f ill, Cable bolting, Steel Rock bolts, Grouting, Shotcreting etc., code of timbering rules.

Recommended books:

1. Underground Mining Methods: Engineering Fundamentals and International Case Studies, Editor(s): William A. Hustrulid, Richard L. Bullock, Publisher: Society for Mining, Metallurgy, and Exploration (SME)
2. SME Mining Engineering Handbook, Editor(s): Peter Darling (Editor-in-Chief for 3rd Edition), Arthur B. Cummins (2nd Ed.), Ivan A. Given (1st Ed.), Publisher: Society for Mining, Metallurgy, and Exploration (SME)
3. Underground Mining Technology, Author(s): J. F. Westrick

BMN - 602 MINE LEGISLATION & SAFETY

Upon successful completion of this course, students will be able to:

1. Understand and Interpret Mining Legislation
2. Identify and Assess Mine Hazards
3. Apply Principles of Mine Environmental Control
4. Analyze Machinery and Electrical Safety
5. Formulate Accident Prevention and Emergency Response Strategies
6. Promote Occupational Health and Safety Culture

UNIT 1: INTRODUCTION TO MINE LEGISLATION & REGULATORY FRAMEWORK

Historical Evolution of Mine Legislation in India: Pre-independence regulations, post-independence acts, international influences (e.g., ILO conventions).

Constitutional Provisions Related to Mines: Entry 54 of Union List, State List, Concurrent List – powers of Central and State Governments.

The Mines Act, 1952: Objectives and scope of the Act, Definitions of key terms (mine, owner, agent, manager, competent person, serious bodily injury, etc.), Provisions related to health, safety, and welfare of workers, Employment of women and young persons, Notifiable diseases and accidents, Duties and responsibilities of owners, agents, and managers, Penalties for contravention.

The Mines Rules, 1955: General provisions related to health and sanitation (drinking water, latrines, first aid), Provisions related to medical examination and certificates, Duties of workmen.

Introduction to Key Regulatory Bodies: Directorate General of Mines Safety (DGMS) – historical background, organizational structure, powers, and functions.

UNIT 2: MINE SAFETY MANAGEMENT & HAZARDS IN MINES

Principles of Mine Safety Management: Safety policy, safety organization, safety audit, safety management plan (SMP).

Hazard Identification and Risk Assessment (HIRA) in Mines: Techniques and methodologies for identifying hazards, assessing risks, and implementing control measures.

Major Hazards in Underground Mines:

Ground Control: Roof falls, side falls, rock bursts, strata movement. Causes, prevention, and support systems, Explosions: Methane explosions, coal dust explosions. Causes, prevention (ventilation, stone dust barriers, explosion-proof equipment), and rescue, Fires: Spontaneous combustion, electrical fires. Causes, detection, prevention, and firefighting techniques, Inundation: Water inflow into mines. Causes, prevention, dewatering methods, Suffocation & Toxic Gases: Carbon monoxide, carbon dioxide, hydrogen sulphide, oxides of nitrogen. Sources, detection, and control.

Major Hazards in Opencast Mines:

Slope Stability: Highwall and dump stability issues. Causes and remedial measures, Haulage and Transport Accidents: Dumpers, shovels, excavators. Causes, safe operating procedures, traffic management, Blasting Hazards: Flyrock, ground vibrations, air blast. Safe blasting practices, Dust & Noise Pollution: Health effects, control measures.

UNIT 3: MACHINERY SAFETY & ELECTRICAL SAFETY IN MINES

Safety Features of Mining Machinery: Design considerations for safety, interlocks, emergency stops, guarding.

Safe Operation and Maintenance of Mining Equipment: Shovels, excavators, dumpers, drills, loaders, conveyors, winders.

Wire Ropes: Types, construction, inspection, maintenance, and testing.

Haulage and Winding Systems Safety: Ropes, cages, skips, winding engines. Statutory provisions for winding.

General Electrical Safety in Mines: Definitions (e.g., intrinsic safety, flameproof enclosure).

Earthing practices, Protection against overcurrent, short circuit, and earth leakage, Insulation and cabling.

Statutory Provisions for Electrical Installations: The Electricity Act, 2003 (relevant sections) and the Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations, 2010 (relevant to mines).

Maintenance of Electrical Equipment: Inspection, testing, and record-keeping.

Accident Investigation of Electrical Incidents.

UNIT 4: ACCIDENT PREVENTION, INVESTIGATION & EMERGENCY PREPAREDNESS

Accident Causation Theories: Domino theory, human error, Heinrich's triangle.

Accident Prevention Techniques: Safety training and education, safety campaigns, personal protective equipment (PPE) – selection, use, and maintenance.

Accident Reporting and Investigation: Statutory requirements for reporting accidents, Principles of accident investigation: data collection, root cause analysis, recommendations, Role of DGMS in accident investigation.

Emergency Preparedness and Response: Mine emergency plans, Mine rescue services: Organization, equipment (self-rescuers, breathing apparatus), training, Firefighting and explosion control strategies, Inundation rescue and recovery, First aid and medical facilities in mines.

Occupational Health & Hygiene in Mines: Common occupational diseases (pneumoconiosis, silicosis, noise-induced hearing loss), Prevention and control measures, Health surveillance.

Role of Trade Unions and Workers' Participation in Safety.

Recent Amendments and Future Trends in Mine Safety Legislation.

Text Books:

1. The Mines Act, 1952 and relevant Rules (latest editions).
2. DGMS Circulars and Guidelines.
3. "Elements of Mining Technology" by D.J. Deshmukh.
4. "Mine Ventilation" by M.V. Ramana Murthy.
5. "Mine Safety Management" by S.P. Mathur.
6. "Safety in Mines" by R.N. Sharma.
7. Relevant Indian Standards (BIS) related to mining equipment and safety.

BMN-603 MINE VENTILATION

Course Outcome: After the end of the course the student will be able to

1. Understand the occurrence of mine gases, dusts and methane drainage and be able to develop and explain control strategies.
2. Explain the principles and control of heat and humidity behaviour in underground airways.
3. Outline natural ventilation and explain its application in underground mines.
4. Apply the principles of mine fan selection in order to evaluate the selection and produce improved solutions. COS: Plan, design, and solve problems related to basic underground mine ventilation systems.

UNIT-1 MINE GASES:

Composition of mine gases, Their Origin, Property, Occurrence, Physiological Effects and Detection; Different methods of Methane Drainage, methane layering. Monitoring System of Mine gases, Analysis of Mine air.

UNIT-2 HEAT & HUMIDITY:

Sources of Heat and Humidity in Mine, their Effects, Cooling Power of Mine Air, Assessment of Comfort Conditions, Air Conditioning of Mines, Surface, Underground and Divided Installations, Spot Coolers.

UNIT-3 MINE ILLUMINATION:

Mechanics of airflow through mine opening; Underground lightning from mains, Illumination survey, Flame and electric safety lamps, their examinations, testing and maintenance.

UNIT-4 NATURAL VENTILATION:

Natural Ventilation and its Measurements, Applicability conditions, merits and demerits of Natural Ventilation, Thermodynamics of Natural Ventilation, Calculation of NVP.

UNIT -5 AUXILIARY VENTILATION:

Types of Auxiliary Ventilation: Forcing, Exhaust, Overlap, Reversible and Line Brattices System. Booster Fans, Purpose of Booster Fans, Disadvantage of Booster Fans.

Text Books:

1. Mine Environment and Ventilation By G.B. Misra, Publisher : OUP India (30 March 1989)
2. Mine Ventilation and Air Conditioning Author(s): Howard L. Hartman, Jan M. Mutmanský, Y. J. Wang, Raja V. Ramani (authors may vary slightly by edition) Publisher: John Wiley & Sons / Wiley-Interscience
3. Subsurface Ventilation and Environmental Engineering, Author(s): Malcolm J. McPherson, Publisher: Chapman and Hall (later reprinted by Springer)
4. Fundamentals of Mine Ventilation, Author(s): Robert J. Trent, Publisher: Taylor & Francis (CRC Press)

Reference Books:

1. H. L. Hartman, Mine Ventilation and Air Conditioning, John Wiley, Paperback edition, 1989.

2. H. L. Hartman, J. M. Mutmanský, R. V. Ramani and Y. J. Wang, Mine Ventilation And Air Conditioning, Wiley-interscience, 3rd Edition, 1997
3. S. P. Banerjee, Mine Ventilation, Lovely Prakashan, 1st Edition, 2003, M. A. Ramlu, Mine Disaster and Mine Rescue, Oxford & IBH, 1991

DEPARTMENTAL ELECTIVE – 3

BMN - 061 MINE PLANNING

Course outcomes:

1. Develop short-term and long-term mine plans based on geological, technical, and economic data.
2. Design efficient layouts for surface and underground mines, including haul roads, stopes, and access ways.
3. Apply mine scheduling techniques to optimize production and resource utilization.
4. Evaluate equipment selection and capacity planning for different mining operations.

UNIT-1: Introduction to Mine Planning and Mineral Resources:

Introduction to Mine Planning: Definition, objectives and Importance of mine planning. Interdisciplinary nature of mine planning, Mineral Resources and Deposits, Formation of mineral deposits, Classification of mineral deposits (e.g., vein, disseminated, massive, stratiform), Types of minerals, Global and Indian mineral resource scenario. Resource and Reserve Classification, Definitions, International reporting standards (e.g., JORC Code, SME Guide) and Indian standards (UNFC), Factors affecting conversion of resources to reserves (economic, technical, environmental, social, legal). Mine Life Cycle and Planning Horizon, Short-term, Medium-term, and Long-term planning horizons.

UNIT- 2: Geological Modeling and Ore Reserve Estimation:

Geological Data Collection and Interpretation, Geological Modeling: Purpose and importance of geological , Methods of geological modelling, Software tools for geological modeling (e.g., Leapfrog, Surpac, Datamine), Classical Ore Reserve Estimation Methods, Geostatistical Ore Reserve Estimation, Fundamentals of Geostatistics, Regionalized variables, stationarity, anisotropy, Variogram analysis, Estimation Techniques, Inverse Distance Weighting (IDW), Kriging: Ordinary Kriging, Simple Kriging, Universal Kriging, Co-Kriging (conceptual), Conditional Simulation, Cut-off Grade Determination.

UNIT- 3 Mine Design and Layout:

Open Pit Mine Design, Pit Limit Optimization, Lerchs-Grossmann algorithm and its application, Floating Cone method (conceptual), Pit Slope Design, Haul Road Design, Bench Design, Waste Dump Design: Stability, drainage, progressive rehabilitation. Surface Mine Layouts, Underground Mine Access and Development, Access Methods: Shafts, Adits, Ramps (declines), Development Layouts, Underground Stope Design, Ground Support Systems: Rock bolts, cable bolts, shotcrete, steel sets, timber supports.

UNIT- 4 Mine Production Planning and Scheduling:

Fundamentals of Mine Scheduling, Objectives of mine scheduling, Types of schedules, Key inputs for scheduling, Long-Term Scheduling (Strategic Planning), Medium-Term and Short-Term Scheduling (Tactical & Operational Planning), Medium-term: Annual and quarterly plans, development planning, Short-term: Monthly, weekly, and daily plans, blast design, equipment allocation, Grade control strategies, Reconciliation of planned vs. actual production. Equipment Selection and Fleet Management, Matching equipment to production requirements. Fleet sizing and optimization. Maintenance planning and reliability. Mine Production Management, Production targets and key performance indicators (KPIs). Monitoring and control of mining operations. Introduction to dispatch systems and real-time optimization.

UNIT- 5 Mine Economics, Regulations, and Software Applications:

Mine Economics and Valuation, Regulatory and Legal Framework in India, Mines and Minerals (Development and Regulation) Act, 1957 and recent amendments. Mineral Concession Rules, Mineral Auction Rules, Environmental and Forest Clearances: EIA process for mining projects (revisited from Eco-Friendly Mining course if applicable), Land acquisition and resettlement policies, Mine safety regulations (DGMS). Mine Planning Software Applications: Introduction to integrated mine planning software suites (e.g., Dassault Systèmes GEOVIA (Surpac, Whittle, MineSched), Hexagon Mining (MineSight, SmartMine), Datamine, Micromine). Practical sessions covering: Data import and visualization. Geological modeling and block modeling. Pit optimization and design. Production scheduling. Basic economic analysis within the software. Sustainable Mine Planning.

References:

- Hustrulid, W. A., & Kuchta, M. (2006). *Open Pit Mine Planning and Design*. CRC Press.
- Annels, A. E. (1991). *Mineral Deposit Evaluation: A Practical Approach*. Chapman & Hall.
- Rossi, M. E., & Deutsch, C. V. (2014). *Mineral Resource Estimation*. Springer.
- Isaaks, E. H., & Srivastava, R. M. (1989). *An Introduction to Applied Geostatistics*. Oxford University Press.
- Hustrulid, W. A., & Kuchta, M. (2006). *Open Pit Mine Planning and Design*. CRC Press.
- Darling, P. (Ed.). (2011). *SME Mining Engineering Handbook*. Society for Mining, Metallurgy, and Exploration (SME). (For underground mine design)
- Denby, B., & Schofield, D. (2009). *Mine Planning and Equipment Selection*. CRC Press.
- Atkinson, T. (2004). *Mine Planning and Design*. CRC Press.
- Mineral Laws (Amendment) Act, 2015, and subsequent notifications by the Ministry of Mines, Government of India.
- Wellmer, F.-W., & Dalheimer, M. (2018). *Economic Evaluations in Exploration*. Springer.
- Software user manuals and tutorials for specific mine planning software.

BMN -062 GEO-INFORMATICS

Course outcomes:

1. Students will understand the fundamental concepts of Geo-informatics and its diverse applications in various aspects of mining engineering, including management information and expert systems.
2. Students will be able to apply principles of Remote Sensing (RS) to acquire and interpret spatial data, and effectively utilize Geographic Information Systems (GIS) for spatial data management, analysis, and visualization in mining.
3. Students will comprehend the concepts and applications of Global Positioning Systems (GPS) for precise location and navigation, and integrate this knowledge with other geo-informatics tools.
4. Students will learn to analyze and present data related to geological discontinuities using geo-informatics tools and understand its role in advanced topics like micro-mechanics, fractal analysis, and damage mechanics within a mining context.

UNIT- 1: Introduction to Geo-informatics and Geographic Information Systems (GIS)**Fundamentals:**

Introduction to Geo-informatics, Definition, scope, and applications of Geo-informatics, Components of Geo-informatics: GIS, Remote Sensing, GPS, Photogrammetry, Surveying, Fundamentals of Geographic Information Systems (GIS), Definition and historical development of GIS, Components of GIS, Functions of GIS, Geospatial Data Concepts, Spatial Data: Points, lines, polygons, Non-Spatial (Attribute) Data, GIS Data Models, Raster Data Model, Vector Data Model, Coordinate Systems and Projections.

UNIT- 2: Remote Sensing Principles and Applications:

Fundamentals of Remote Sensing, Definition and concept of remote sensing, Electromagnetic Radiation (EMR), Remote Sensing Platforms and Sensors, Platforms, Sensors, Image Acquisition and Characteristics, Analog vs. Digital images, Remote Sensing Image Pre-processing, Radiometric correction (atmospheric correction, sensor calibration), Geometric correction (rectification, georeferencing), Image mosaicking and subsetting. Image Enhancement Techniques, Contrast stretching, histogram equalization, Filtering (spatial filtering: smoothing, edge detection), Band ratios and principal component analysis (PCA).

UNIT- 3 Global Positioning System (GPS) and Data Acquisition:

Global Positioning System (GPS) and GNSS: * Components of GPS, Working principle: Trilateration, pseudorange, Sources of error in GPS measurements, Differential GPS (DGPS) and its applications, Overview of other Global Navigation Satellite Systems (GNSS): GLONASS, Galileo, BeiDou, NavIC, Geospatial Data Acquisition Methods, Field Data Collection: GPS receivers, total stations, Drones (UAVs), Digitization, Data Conversion, Data Sharing and Exchange Formats: Shapefile, GeoJSON, KML, GML, Basic Surveying and Photogrammetry (Brief Overview), Data Quality and Metadata, Accuracy, precision, resolution, completeness, consistency, Sources of error in geospatial data, Importance of metadata for data documentation and usability.

UNIT- 4: Spatial Data Analysis and Modeling:

Spatial Analysis in GIS, Query Operations, Overlay Operations, Proximity Analysis: Buffer, Nearest Neighbor, Network Analysis: Shortest path, service area, routing, Surface Analysis:

Interpolation (IDW, Kriging), DEM generation, slope, aspect, hillshade. Remote Sensing Image Classification, Unsupervised Classification: K-means, ISODATA, Supervised Classification, Spatial Modeling, Data Visualization and Cartography, Principles of map design and cartographic representation, Thematic mapping, symbology, labelling, Map layouts and map production, 3D visualization of geospatial data.

UNIT- 5: Advanced Applications and Emerging Trends in Geo-informatics:

Advanced Applications of Geo-informatics, Urban Planning and Management: Smart cities, infrastructure management, urban sprawl analysis, Environmental Management: Disaster management, forest monitoring, pollution mapping, climate change impact assessment, Natural Resource Management, Transportation and Logistics, Public Health: Disease mapping, epidemiology. Integration of Geo-informatics with Other Technologies, Web GIS, Mobile GIS, Big Data and Cloud Computing in Geo-informatics, Artificial Intelligence (AI) and Machine Learning (ML) in Geospatial Analysis, Emerging Trends in Geo-informatics, Ethical, Legal, and Social Issues in Geo-informatics, Data privacy and security, Data ownership and intellectual property rights, Accessibility and digital divide, Misuse of geospatial data, Professional ethics in Geo-informatics.

Recommended books:

1. "Principles of Geographic Information Systems"
 - Author: Peter A. Burrough, Rachael A. McDonnell, Chris D. Lloyd
 - Publisher: Oxford University Press
2. "Remote Sensing and Image Interpretation"
 - Author: Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman
 - Publisher: John Wiley & Sons
3. "Introduction to GPS: The Global Positioning System"
 - Author: Ahmed El-Rabbany
 - Publisher: Artech House
4. "Geoinformatics and Data Mining in Earth Sciences" (Possibly an edited volume)
 - Editors: A.G. Gvishiani, B.D. Dzeboev (and others depending on the specific edition/volume)
 - Publisher: MDPI Books (often open access, which is a plus)
5. "Sensing and Monitoring Technologies for Mines and Hazardous Areas"
 - Author/Editor: (Often edited volumes with various contributors; e.g., published by Elsevier or CRC Press)
6. "GIS and Remote Sensing Applications in Geology"
 - Author: A.K. Saha
 - Publisher: Universities Press (India) / Springer
7. "Engineering Rock Mechanics"
 - Author: John A. Hudson, John P. Harrison
 - Publisher: Elsevier Science / Pergamon
8. "Geoinformatics"
 - Author: Saiful Islam
 - Publisher: Vayu Education of India

BMN -063 GLOBAL ENVIRONMENTAL ISSUES

Course outcomes:

1. Students will be able to identify and explain the causes, mechanisms, and global impacts of major environmental issues such as climate change (greenhouse effect, global warming, sea-level rise), acid rain, ozone depletion, biodiversity loss, and ocean pollution.
2. Students will understand various environmental protection strategies, including the conservation of natural resources, the application of economic instruments like carbon taxes, and the implications of international environmental summits on industrial activities, particularly mining.
3. Students will gain knowledge of national and international environmental standards for various parameters, enabling them to assess compliance and environmental performance.
4. Students will comprehend the Indian legal framework for environmental protection, including key acts and regulations, and their relevance to managing environmental challenges.

UNIT- 1: Introduction to Global Environmental Issues and Sustainable Development:

Defining Global Environmental Issues: Scope and scale of environmental problems, Historical Perspective of Environmental Concerns: Industrial Revolution and its environmental consequences, Major environmental movements and milestones, Sustainable Development: Definition and principles of sustainable development (Brundtland Report), Three pillars of sustainability: Environmental, Social, and Economic, United Nations Sustainable Development Goals (SDGs) – overview and relevance, Drivers of Environmental Change: Population growth, consumption patterns, technological advancements, Poverty and inequality as environmental stressors.

UNIT- 2: Climate Change and Global Warming:

Science of Climate Change, Evidence of climate change, Impacts of Climate Change, Mitigation Strategies: Energy efficiency and conservation, Renewable energy sources, Adaptation Strategies: Building resilience, early warning systems, Water management, climate-resilient agriculture, Coastal protection, International Climate Governance: United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol and Paris Agreement: Principles, Nationally Determined Contributions (NDCs), Role of IPCC (Intergovernmental Panel on Climate Change).

UNIT- 3: Biodiversity Loss and Ecosystem Degradation:

Understanding Biodiversity: Levels of biodiversity: Genetic, Species, Ecosystem, Threats to Biodiversity: Habitat loss and fragmentation, Pollution, Overexploitation of resources, Invasive alien species, Ecosystem Services: Provisioning services (food, water, timber), Regulating services (climate regulation, flood control), Cultural services (recreation, spiritual), Supporting services (nutrient cycling, soil formation), Valuation of ecosystem services, Biodiversity Conservation Strategies: In-situ conservation: Protected areas, Ex-situ conservation: Zoos, botanical gardens, seed banks, Restoration ecology, Role of international conventions (e.g., Convention on Biological Diversity - CBD).

UNIT- 4 Resource Depletion, Pollution, and Waste Management:

Water Scarcity and Pollution, Water pollution sources, Water quality parameters and treatment technologies (brief overview), Integrated water resource management, Air Pollution, Major air pollutants and their sources (industrial, vehicular, domestic), Smog, acid rain, ozone depletion (stratospheric and tropospheric), Transboundary air pollution, Health impacts of air pollution, Land Degradation and Desertification, Causes, Impacts, Waste Management, Types of waste: , Principles of waste management, Waste treatment technologies, Energy Resources and Environmental Impact, Environmental impacts of fossil fuel extraction and combustion, Nuclear energy: Benefits and risks (waste disposal, safety), Hydropower: Benefits and ecological impacts.

UNIT-5 Environmental Policy, Governance, and Sustainable Solutions:

Environmental Law and Policy, Principles of environmental law, National environmental policies and legislation (with focus on India: e.g., Environmental Protection Act, Water Act, Air Act), Role of environmental agencies and regulatory bodies. International Environmental Governance, Role of United Nations Environment Programme (UNEP), World Bank, NGOs, Major international environmental agreements and treaties, Global environmental conventions and their effectiveness. Environmental Impact Assessment (EIA), Purpose and process of EIA, Stages of EIA, Green Technologies and Innovation, Renewable energy technologies (revisited), Sustainable agriculture and organic farming, green building concepts, Eco-friendly materials and processes, Circular Economy and Sustainable Consumption, Principles of circular economy vs. linear economy, Corporate social responsibility and environmental ethics.

Recommended books:

1. "Global Environmental Issues"
 - Editor: Frances Harris
 - Publisher: John Wiley & Sons
2. "Environmental Science: Towards a Sustainable Future"
 - Authors: Richard T. Wright, Dorothy F. Boorse
 - Publisher: Pearson
3. "Sustainable Development: Concepts, Issues, and Challenges"
 - Author: P.K. Jha
 - Publisher: Nova Science Publishers (or similar academic publishers)
4. "Environmental Economics: An Introduction"
 - Author: Barry C. Field, Martha K. Field
 - Publisher: McGraw-Hill Education
5. "Environmental Policy and Politics"
 - Author: Michael E. Kraft
 - Publisher: Pearson / Routledge
6. "Environmental Law in India"
 - Author: P. Leelakrishnan
 - Publisher: LexisNexis / Bharat Law House
7. "Environmental Law and Policy in India"
 - Author: Shyam Divan, Armin Rosencranz
 - Publisher: Oxford University Press / Routledge

LAB

BMN - 651 UNDERGROUND METAL MINING LAB

List of Experiments:

1. Application of blast hole stoping and its comparison with sub-level open stoping
2. Cut and fill methods used in different Indian deposits
3. Sub-level caving and block caving methods for deeper deposits.
4. Square-set stoping for excavation of manganese ore deposit
5. Application of leaching technique in ore mining
6. Stopping techniques used in excavation of gold deposit at deeper depth
7. Design of Post pillar method
8. Design of Shrinkage method
9. Problem for mining for greater depth.
10. Design of block caving.
11. Design Sub level top slicing

Course outcomes: Upon successful completion of this course, students will be able to:

- **Analyze and Compare Underground Stopping Methods:** Critically compare and contrast various bulk mining methods, such as blast hole stoping, sub-level open stoping, sub-level caving, and block caving, understanding their applicability, advantages, and limitations for different ore body geometries and depths.
- **Design Support-Intensive Mining Systems:** Design and explain the principles behind support-intensive stopping methods including cut and fill, square-set stoping, post pillar, shrinkage, and sub-level top slicing, recognizing their suitability for specific ore types (e.g., manganese) and ground conditions.
- **Evaluate Specialized Mining Techniques:** Understand the application of leaching techniques in ore mining and identify specialized stopping methods used for gold deposits at greater depths.
- **Address Challenges of Deep Mining:** Identify and articulate the unique problems and challenges associated with mining at greater depths, including rock mechanics issues, heat, and logistics.
- **Apply Design Principles to Underground Layouts:** Apply design principles to create conceptual layouts for complex underground mining systems, specifically for block caving and sub-level top slicing.

BMN - 652 MINE VENTILATION LAB

List of Experiments:

1. Measurement of Air Velocity and Quantity using Vane Anemometer
2. Determination of Air Velocity using Pitot-Static Tube and Manometer
3. Study and Operation of an MSA-D6 Methanometer
4. Analysis of Mine Air Samples using Gas Detector Tubes
5. Determination of Psychrometric Properties of Air using Whirling Hygrometer
6. Estimation of Air-Cooling Power using Kata Thermometer
7. Determination of Pressure Losses due to Friction in a Straight Airway
8. Study of Fan Characteristic Curves (Pressure vs. Quantity, Efficiency vs. Quantity)

9. Demonstration of Fans in Series and Parallel Operation
10. Study of Ventilation Control Devices and their Impact on Airflow

Course outcomes: Upon successful completion of this course, students will be able to:

1. Operate and Calibrate Ventilation Instruments
2. Measure and Analyze Mine Air Parameters
3. Detect and Quantify Mine Gases
4. Understand Airflow Principles and Resistance
5. Analyze Fan Performance
6. Assess and Control Mine Climate
7. Identify and Apply Ventilation Control Devices
8. Apply Safety Protocols in Ventilation
9. Interpret Ventilation Plans and Data
10. Communicate Technical Information

BMN - 653 COMPUTER AIDED MINE PLANNING LAB

List of Experiments:

1. To learn how to import raw drillhole data into mining software, validate its integrity (e.g., check for missing data, out-of-range values, incorrect coordinates), and perform compositing to create regularly spaced samples for geological modelling, Software Focus: Surpac, Datamine, Micromine.
2. To understand geostatistical principles by calculating and plotting experimental variograms from drillhole assay data, fitting theoretical models (e.g., spherical, exponential), and determining variogram parameters (nugget, sill, range) for use in grade estimation, Software Focus: Surpac, Datamine, Micromine.
3. To create 3D wireframe models of ore bodies and geological domains from drillhole data and then construct a 3D block model of the deposit, assigning geological codes to blocks based on the wireframes, Software Focus: Surpac, Datamine, Micromine, Vulcan.
4. To estimate grades for each block in the block model using an appropriate method (e.g., Ordinary Kriging, Inverse Distance Weighting) and then calculate the total tonnage and average grade of the ore body at various cut-off grades, Software Focus: Surpac, Datamine, Micromine.
5. To apply the Lerchs-Grossmann algorithm to a block model to determine the optimal economic ultimate pit limit, considering economic parameters like metal price, mining cost, and processing cost, Software Focus: Whittle (often integrated with mine planning software like Surpac, Datamine), specific modules within main mine planning software.
6. To design detailed open pit benches, haul roads, and ramps within the optimized pit shell, ensuring adherence to design parameters such as bench height, berm width, and road gradient, Software Focus: Surpac, Datamine, Micromine, AutoCAD Civil 3D.
7. To design basic underground mine development layouts, including declines/ramps and main access drives, and to model typical stopes for a chosen underground mining method, Software Focus: Surpac, Datamine, Micromine.

8. To create a simplified mine ventilation network model, simulate airflow, calculate fan requirements, identify potential bottlenecks, and optimize the ventilation system for air quantity and quality, Software Focus: Ventsim, VentSIM, SINET.
9. To develop a short-range production schedule for an open-pit mine, allocating ore and waste movement, and to calculate the required number of shovels and dumpers for a given production target, Software Focus: Specific scheduling modules within main mine planning software (e.g., Surpac Scheduler, Datamine MineSched), Excel for fleet sizing calculations.
10. To perform a basic 2D or 3D slope stability analysis of an open pit or underground excavation using a numerical modeling tool, identifying potential failure surfaces and calculating factors of safety, Software Focus: GALENA, Slide (Rocscience), Phase2 (Rocscience), FLAC (Itasca).

Course outcomes: Upon successful completion of this course, students will be able to:

1. Apply Modern Mining Software: Effectively utilize industry-standard computer-aided mine planning software (e.g., Surpac, Datamine, Micromine, Whittle, Ventsim) for various mine planning and design tasks.
2. Perform Geological Data Management and Modeling: Process, validate, and manage geological data (drillholes, surveys) to create accurate 3D geological wireframe and block models of mineral deposits.
3. Conduct Geostatistical Analysis and Grade Estimation: Apply geostatistical techniques, particularly variography, to characterize spatial variability of ore grades and perform reliable grade estimation using methods like Kriging for resource modeling.
4. Design and Optimize Open Pit Mines: Design and optimize open-pit mine layouts, including pit limits, pushbacks, benches, and haul roads, considering economic and geotechnical parameters.
5. Design Underground Mine Workings: Develop basic underground mine designs, including main access drives, ventilation networks, and stope layouts for various mining methods.
6. Develop Mine Production Schedules: Create realistic short-term and long-term mine production schedules, considering operational constraints, equipment availability, and blending requirements.
7. Analyze and Optimize Mine Systems: Apply simulation and analytical tools to assess the performance of mining systems, optimize equipment fleet size, and improve overall operational efficiency.
8. Conduct Basic Geotechnical and Ventilation Analysis: Perform fundamental analyses related to slope stability, pillar design, and mine ventilation, using appropriate software tools.
9. Interpret and Present Mine Planning Results: Generate and interpret various outputs from mining software (e.g., maps, sections, reports, visualizations) and effectively communicate mine planning concepts and results in a professional manner.
10. Understand the Limitations of Software and Data: Recognize the assumptions and limitations inherent in computer-aided mine planning software and the importance of data quality and validation in generating reliable mine plans.