Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NMND512	Ventilation and Environment for the Mining of Critical Minerals	3	0	0	3

Course Objective

This course focuses on mine ventilation principles and environmental management practices specific to the mining of critical and strategic minerals. Emphasis is placed on occupational health, heat and dust control, diesel emissions, deep and mechanized mining challenges, and sustainable ventilation solutions aligned with energy efficiency and net-zero objectives. The course aims to:

- Introduce the importance of ventilation and environmental control in critical mineral mining.
- Develop understanding of airflow mechanics, contaminants, and climatic conditions in mines.
- Address ventilation challenges in deep, mechanized, and automated mines.
- Integrate environmental monitoring, regulation, and sustainability considerations.
- Equip students with practical skills for ventilation planning and mine environmental management.

Learning Outcomes

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

- Explain the significance of mine ventilation and environmental control in critical mineral mining.
- Analyze airflow requirements and contaminant sources in underground and surface mines.
- Design basic ventilation systems considering heat, dust, gases, and diesel emissions.
- Apply environmental monitoring techniques and statutory requirements.
- Evaluate energy-efficient and sustainable ventilation strategies for future-ready mines.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	***Critical Minerals and Mining Environment*:** Definition and classification of critical and strategic minerals, Global and Indian perspective on critical minerals, Mining methods for critical minerals (UG & surface), Environmental sensitivity and occupational challenges	3	• Understand the strategic importance of critical minerals • Identify unique environmental challenges in their mining
2	***Fundamentals of Mine Ventilation:*** Objectives and functions of mine ventilation, Properties of air and mine atmosphere, Laws governing airflow in mine workings, Pressure losses and resistance in mine airways, Natural and mechanical ventilation	7	• Apply basic ventilation laws to mine airflow problems • Estimate airflow and pressure requirements
3	***Air Contaminants and Control Measures*:** Dust generation and control (silica, metal dusts, REEs), Toxic and noxious gases, Diesel particulate matter (DPM) in mechanized mines, Ventilation standards and exposure limits	6	• Assess contaminant sources and health impacts • Recommend appropriate ventilation-based control measures
4	***Mine Climate, Heat and Humidity Control:*** Sources of heat in mines, Heat stress indices and comfort limits, Cooling and refrigeration systems, Climatic challenges in deep critical mineral mines	8	• Analyze mine climatic conditions • Suggest heat mitigation and cooling solutions
5	***Ventilation Systems and Network Analysis*:** Auxiliary ventilation systems, Ventilation planning for development and stoping, Basics of ventilation network analysis, Introduction to ventilation simulation tools	8	• Design auxiliary ventilation layouts • Interpret ventilation network performance
6	***Environmental Monitoring and Control:*** Mine environmental monitoring (air, noise, heat), Statutory provisions and safety regulations, Environmental impact and compliance in critical mineral mining, Role of ventilation in sustainable mining, Advanced underground mine environmental monitoring systems, automation, and control.	8	• Interpret monitoring data for mine environments • Apply regulatory requirements in mine ventilation planning • Evaluate modern ventilation technologies

7	**Case Studies and Applications:** Ventilation challenges in critical mineral mines, Indian and international case studies	2	• Identify key ventilation challenges specific to critical mineral mines (e.g., lithium, cobalt, nickel, rare earths) in both Indian and international contexts.
Total		**42**	

Text Books:

1. Mine Ventilation and Air Conditioning – Hartman et al.
2. Subsurface Ventilation Engineering – McPherson

Reference Books:

1. Mine Environment and Ventilation by G.B. Misra
2. Mine Ventilation by S.P. Banerjee
3. Mine Environmental Engineering, Vol. 1 & Vol. 2 : Mritunjoy Sengupta
4. Environmental Engineering in Mines : V. S. Vutkuri and R. D. Lama
5. Advanced mine ventilation: Pramod Thakur
6. Recent journal articles on critical mineral mining and sustainable ventilation