

# MONTANA

## TECHNOLOGICAL UNIVERSITY

### Mine Ventilation

#### COURSE LEVEL OBJECTIVES

- **CO1 - Differentiate** mine ventilation principles and their application in underground mining operations.
- **CO2 - Comprehend & Evaluate** design, operation, and maintenance of ventilation systems and equipment.
- **CO3 - Acquire and Apply** knowledge and skills to monitor and control air quality in underground mines.
- **CO4 – Investigate and Analyze** strategies for managing heat, humidity, dust, and gas hazards in underground mining environments.
- **CO5- Explain** the sensitivity of ventilation circuits and models to address ventilation circuits, networks, and issues related to mine safety.
- **CO6- Demonstrate** critical thinking and problem-solving skills through case studies and practical exercises.

#### COURSE MODULES

1. **M1** – Introduction to Mine Ventilation
2. **M2** – Psychrometrics
3. **M3** – Mine Air-Quality Control
4. **M4** – Airflow through Mine Openings and Ducts
5. **M5** – Ventilation Measurements and Surveys
6. **M6** – Mine Ventilation Circuits and Networks
7. **M7** – Natural Ventilation
8. **M8** – Air-Moving Equipment
9. **M9** – Fan Application to Mines
10. **M10** – Auxiliary Ventilation and Controlled Recirculation
11. **M11** – Mine Ventilation Systems
12. **M12** – Mine Air Conditioning
13. **M13** – Ventilation Legislation, Safety, and Statutory Requirements

### Course Final Project

Design a comprehensive ventilation system for an underground mine.

This project will include:

1. **Assessment of Ventilation Requirements:** Analyzing the mine layout, production rates, and environmental conditions to determine the ventilation needs.
2. **System Design:** Creating a detailed design of the ventilation network, including primary and auxiliary fans, ducting, and airways.
3. **Simulation and Modeling:** Using software to simulate airflow, temperature, and gas concentrations to ensure the system meets safety and efficiency standards.
4. **Energy Efficiency Analysis:** Evaluating the energy consumption of the ventilation system and proposing methods to optimize energy use.
5. **Health and Safety Considerations:** Assessing the impact of the ventilation system on worker health and safety, including dust and gas control.
6. **Cost Analysis:** Estimating the costs associated with the installation and operation of the ventilation system.
7. **Implementation Plan:** Developing a step-by-step plan for the installation and commissioning of the ventilation system.

### MODULE 1: Introduction to Mine Ventilation OBJECTIVES

**M101-** Explain the fundamental principles of mine ventilation. **CO1**

**M102-** Describe the historical development and significance of mine ventilation in underground mining. **CO2**

**M103-** Identify the key components and functions of a mine ventilation system. **CO3**

### MODULE 1 ACTIVITIES and ASSESSMENTS

#### ACTIVITIES (SUGGESTED)

#### ASSESSMENTS

<ul style="list-style-type: none"> <li>• <b>Reading</b></li> <li>• <b>Interactive Lectures:</b> Use diagrams, flowcharts, and animations to illustrate ventilation concepts, pollutant sources, and airflow mechanics. <b>Lightboard- OR Panopto recorded lecture</b></li> <li>• <b>Discussion Forum -Case Studies:</b> Introduce real-world mining incidents to highlight the critical role of ventilation in safety.</li> <li>• Review definitions and concepts- <b>H5P- Flash cards</b></li> <li>• <b>Assignment- Final SCAFFOLD every other module.</b></li> <li>• <b>Alternative assignment</b></li> <li>• <b>Quiz</b></li> </ul>	<ol style="list-style-type: none"> <li>1. Quiz</li> <li>2. Discussion</li> <li>3. H5P flash cards or memorization activity with assessment</li> <li>4. Other</li> </ol>
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MODULE 2: Psychrometry OBJECTIVES	
<b>M201-</b>	Interpret and analyze psychrometric properties of air using dry-bulb temperature, wet-bulb temperature, relative humidity, and dew point, with reference to the psychrometric chart.
<b>M202-</b>	Apply psychrometric principles to assess thermal comfort and evaluate the impact of moisture and temperature conditions in underground mine environments.
<b>M203-</b>	Calculate enthalpy changes and moisture content in ventilation airflows to support decisions on air cooling, heating, and dehumidification in mine ventilation design.

MODULE 2 ACTIVITIES and ASSESSMENTS	
ACTIVITIES	ASSESSMENTS
<ul style="list-style-type: none"> <li>• <b>Reading</b></li> <li>• <b>Interactive Lectures:</b> Use diagrams, flowcharts, and animations to illustrate ventilation concepts, pollutant sources, and airflow</li> </ul>	<ol style="list-style-type: none"> <li>1. Discussion</li> <li>2. Assignment</li> <li>3. Quiz</li> </ol>

mechanics. <b>Lightboard- OR Panopto recorded lecture</b> <ul style="list-style-type: none"> <li>• <b>Discussion Forum -Case Studies:</b> Introduce real-world mining incidents to highlight the critical role of ventilation in safety.</li> <li>• Review definitions and concepts- <b>H5P- Flash cards</b></li> <li>• <b>Quiz</b></li> </ul>	
<b>MODULE 3: Mine Air Quality Control</b> <b>OBJECTIVES</b>	
<b>M301-</b> Assess the factors affecting air quality in underground mines. <b>CO2</b> <b>M302-</b> Evaluate methods for monitoring and controlling dust, gases, and other contaminants. <b>CO4</b> <b>M303-</b> Implement strategies to ensure compliance with air quality standards and regulations. <b>CO5</b>	

<b>MODULE 3 ACTIVITIES and ASSESSMENTS</b>	
<b>ACTIVITIES</b>	<b>ASSESSMENTS</b>
<ul style="list-style-type: none"> <li>• <b>Reading</b></li> <li>• <b>Interactive Lectures:</b> Use diagrams, flowcharts, and animations to illustrate ventilation concepts, pollutant sources, and airflow mechanics. <b>Lightboard- OR Panopto recorded lecture</b></li> <li>• <b>Discussion Forum -Case Studies:</b> Introduce real-world mining incidents to highlight the critical role of ventilation in safety.</li> <li>• Review definitions and concepts- <b>H5P- Flash cards</b></li> <li>• <b>Quiz</b></li> </ul>	1. Discussion 2. Assignment 3.Quiz

<b>MODULE 4: Airflow through Mine Openings and Ducts</b> <b>OBJECTIVES</b>
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**M401**-Analyze the principles of airflow dynamics in mine openings and ducts.  
**M402**-Calculate airflow rates and pressure losses in various mine ventilation scenarios.  
**M403**- Design and optimize duct systems for efficient air distribution in mines.

MODULE 4 ACTIVITIES and ASSESSMENTS	
ACTIVITIES	ASSESSMENTS
<ul style="list-style-type: none"> <li>• <b>Reading</b></li> <li>• <b>Interactive Lectures:</b> Use diagrams, flowcharts, and animations to illustrate ventilation concepts, pollutant sources, and airflow mechanics. <b>Lightboard- OR Panopto recorded lecture</b></li> <li>• <b>Discussion Forum -Case Studies:</b> Introduce real-world mining incidents to highlight the critical role of ventilation in safety.</li> <li>• Review definitions and concepts- <b>H5P- Flash cards</b></li> <li>• <b>Quiz</b></li> </ul>	<ol style="list-style-type: none"> <li>1. Discussion</li> <li>2. Assignment</li> <li>3.Quiz</li> </ol>

14. MODULE 5: Ventilation Measurements and Surveys OBJECTIVES
<p><b>M501</b>-Conduct ventilation surveys to measure airflow, pressure, and gas concentrations.  <b>M502</b>-Interpret ventilation survey data to assess the effectiveness of ventilation systems.  <b>M503</b>-Develop recommendations for improving ventilation based on survey results.</p>

MODULE 5 ACTIVITIES and ASSESSMENTS	
ACTIVITIES	ASSESSMENTS
<ul style="list-style-type: none"> <li>• <b>Reading</b></li> <li>• <b>Interactive Lectures:</b> Use diagrams, flowcharts, and animations to illustrate ventilation concepts, pollutant sources, and airflow mechanics. <b>Lightboard- OR Panopto recorded lecture</b></li> </ul>	<ol style="list-style-type: none"> <li>1. 1. Discussion</li> <li>2. 2. Assignment</li> <li>3. 3.Quiz</li> </ol>

<ul style="list-style-type: none"> <li>• <b>Discussion Forum -Case Studies:</b> Introduce real-world mining incidents to highlight the critical role of ventilation in safety.</li> <li>• Review definitions and concepts- <b>H5P- Flash cards</b></li> <li>• <b>Quiz</b></li> </ul>	
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15. <b>MODULE 6: Mine Ventilation Circuits and Networks</b> <b>OBJECTIVES</b>
<p><b>M6O1</b> – Explain the structure and function of mine ventilation circuits and networks.</p> <p><b>M6O2</b> - Analyze the sensitivity of ventilation circuits to changes in operational conditions.</p> <p><b>M6O3</b> - Design and troubleshoot ventilation circuits to enhance mine safety and efficiency.</p>

<b>MODULE 6 ACTIVITIES and ASSESSMENTS</b>	
	<b>ASSESSMENTS</b>
<ul style="list-style-type: none"> <li>• <b>Reading</b></li> <li>• <b>Interactive Lectures:</b> Use diagrams, flowcharts, and animations to illustrate ventilation concepts, pollutant sources, and airflow mechanics. <b>Lightboard- OR Panopto recorded lecture</b></li> <li>• <b>Discussion Forum -Case Studies:</b> Introduce real-world mining incidents to highlight the critical role of ventilation in safety.</li> <li>• Review definitions and concepts- <b>H5P- Flash cards</b></li> <li>• <b>Quiz</b></li> </ul>	<ol style="list-style-type: none"> <li>1. Discussion</li> <li>2. Assignment</li> <li>3.Quiz</li> </ol>

16. <b>MODULE 7: Natural Ventilation</b> <b>OBJECTIVES</b>
<p><b>M7O1</b> - Describe the principles of natural ventilation in underground mines.</p> <p><b>M7O2</b> - Evaluate the factors influencing natural ventilation effectiveness.</p> <p><b>M7O3</b>- Implement natural ventilation strategies to complement mechanical ventilation systems.</p>

MODULE 6 ACTIVITIES and ASSESSMENTS	
ACTIVITIES	ASSESSMENTS
<ul style="list-style-type: none"> <li>• <b>Reading</b></li> <li>• <b>Interactive Lectures:</b> Use diagrams, flowcharts, and animations to illustrate ventilation concepts, pollutant sources, and airflow mechanics. <b>Lightboard- OR Panopto recorded lecture</b></li> <li>• <b>Discussion Forum -Case Studies:</b> Introduce real-world mining incidents to highlight the critical role of ventilation in safety.</li> <li>• Review definitions and concepts- <b>H5P- Flash cards</b></li> <li>• <b>Quiz</b></li> </ul>	<ol style="list-style-type: none"> <li>1. Discussion</li> <li>2. Assignment</li> <li>3.Quiz</li> </ol>

MODULE 8: Air-Moving Equipment OBJECTIVES
<p><b>M801</b> - Identify different types of air-moving equipment used in mine ventilation.</p> <p><b>M802</b> - Evaluate the performance characteristics of various fans and blowers.</p> <p><b>M803</b> -</p>

MODULE 8 ACTIVITIES and ASSESSMENTS	
ACTIVITIES	ASSESSMENTS
<ul style="list-style-type: none"> <li>• <b>Reading</b></li> <li>• <b>Interactive Lectures:</b> Use diagrams, flowcharts, and animations to illustrate ventilation concepts, pollutant sources, and airflow mechanics. <b>Lightboard- OR Panopto recorded lecture</b></li> <li>• <b>Discussion Forum -Case Studies:</b> Introduce real-world mining incidents to highlight the critical role of ventilation in safety.</li> <li>• Review definitions and concepts- <b>H5P- Flash cards</b></li> <li>• <b>Quiz</b></li> </ul>	<ol style="list-style-type: none"> <li>1. Discussion</li> <li>2. Assignment</li> <li>3.Quiz</li> </ol>

## MODULE 9: Fan Application to Mines

### OBJECTIVES

- M9O1**- Explain the role of fans in mine ventilation systems.
- M9O2** - Analyze the performance curves of different types of fans.
- M9O3**- Design and optimize fan installations for effective mine ventilation.

### MODULE 9 ACTIVITIES and ASSESSMENTS

ACTIVITIES	ASSESSMENTS
<ul style="list-style-type: none"><li>• <b>Reading</b></li><li>• <b>Interactive Lectures:</b> Use diagrams, flowcharts, and animations to illustrate ventilation concepts, pollutant sources, and airflow mechanics. <b>Lightboard- OR Panopto recorded lecture</b></li><li>• <b>Discussion Forum -Case Studies:</b> Introduce real-world mining incidents to highlight the critical role of ventilation in safety.</li><li>• Review definitions and concepts- <b>H5P- Flash cards</b></li><li>• <b>Quiz</b></li></ul>	<ol style="list-style-type: none"><li>1. Discussion</li><li>2. Assignment</li><li>3.Quiz</li></ol>

## MODULE 10: Auxiliary Ventilation and Controlled Recirculation

### OBJECTIVES

- M10-O1** - Describe the need for auxiliary ventilation in underground mines.
- M10-O2** - Evaluate methods for implementing controlled recirculation in mine ventilation
- M10-O3** - Design auxiliary ventilation systems to address specific ventilation challenges.

### MODULE 10 ACTIVITIES and ASSESSMENTS

ACTIVITIES	ASSESSMENTS
<ul style="list-style-type: none"><li>• <b>Reading</b></li><li>• <b>Interactive Lectures:</b> Use diagrams, flowcharts, and animations to illustrate ventilation concepts, pollutant sources, and airflow mechanics. <b>Lightboard- OR Panopto recorded lecture</b></li><li>• <b>Discussion Forum -Case Studies:</b> Introduce real-world mining incidents</li></ul>	<ol style="list-style-type: none"><li>1. Discussion</li><li>2. Assignment</li><li>3.Quiz</li></ol>



<p>to highlight the critical role of ventilation in safety.</p> <ul style="list-style-type: none"> <li>• Review definitions and concepts- <b>H5P- Flash cards</b></li> <li>• <b>Quiz</b></li> </ul>	
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<b>MODULE 11: Mine Ventilation Systems OBJECTIVES</b>
<p><b>M11-O1</b> - Explain the components and operation of integrated mine ventilation systems.</p> <p><b>M11-O2</b> - Evaluate the design and performance of different ventilation system configurations.</p> <p><b>M11-O3</b> - Develop and implement comprehensive ventilation plans for underground mines.</p>

<b>MODULE 11 ACTIVITIES and ASSESSMENTS</b>	
<b>ACTIVITIES</b>	<b>ASSESSMENTS</b>
<ul style="list-style-type: none"> <li>• <b>Reading</b></li> <li>• <b>Interactive Lectures:</b> Use diagrams, flowcharts, and animations to illustrate ventilation concepts, pollutant sources, and airflow mechanics. <b>Lightboard- OR Panopto recorded lecture</b></li> <li>• <b>Discussion Forum -Case Studies:</b> Introduce real-world mining incidents to highlight the critical role of ventilation in safety.</li> <li>• Review definitions and concepts- <b>H5P- Flash cards</b></li> <li>• <b>Quiz</b></li> </ul>	<ol style="list-style-type: none"> <li>1. Discussion</li> <li>2. Assignment</li> <li>3. Quiz</li> </ol>

<b>17. MODULE 12: Mine Air Conditioning OBJECTIVES</b>
<p><b>M12O1</b> - Describe the principles and applications of mine air conditioning.</p> <p><b>M12O2</b> - Evaluate the effectiveness of different air conditioning methods in controlling heat and humidity.</p> <p><b>M12O3</b> - Design and implement air conditioning systems to improve mine working conditions.</p>

<b>MODULE 12 ACTIVITIES and ASSESSMENTS</b>
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ACTIVITIES	ASSESSMENTS
<ul style="list-style-type: none"> <li>• <b>Reading</b></li> <li>• <b>Interactive Lectures:</b> Use diagrams, flowcharts, and animations to illustrate ventilation concepts, pollutant sources, and airflow mechanics. <b>Lightboard- OR Panopto recorded lecture</b></li> <li>• <b>Discussion Forum -Case Studies:</b> Introduce real-world mining incidents to highlight the critical role of ventilation in safety.</li> <li>• Review definitions and concepts- <b>H5P- Flash cards</b></li> <li>• <b>Quiz</b></li> </ul>	<ol style="list-style-type: none"> <li>1. Discussion</li> <li>2. Assignment</li> <li>3.Quiz</li> </ol>

MODULE 13: Ventilation Legislation, Safety, and Statutory Requirements OBJECTIVES
<p><b>M1301</b> – Identify key legislation and regulations governing mine ventilation.</p> <p><b>M1302</b> – Evaluate the impact of safety standards on ventilation system design and operation.</p> <p><b>M1303</b> - Ensure compliance with statutory requirements through effective ventilation management.</p>

MODULE 13 ACTIVITIES and ASSESSMENTS	
ACTIVITIES	ASSESSMENTS
<ul style="list-style-type: none"> <li>• <b>Reading</b></li> <li>• <b>Interactive Lectures:</b> Use diagrams, flowcharts, and animations to illustrate ventilation concepts, pollutant sources, and airflow mechanics. <b>Lightboard- OR Panopto recorded lecture</b></li> <li>• <b>Discussion Forum -Case Studies:</b> Introduce real-world mining incidents to highlight the critical role of ventilation in safety.</li> <li>• Review definitions and concepts- <b>H5P- Flash cards</b></li> <li>• <b>Quiz</b></li> </ul>	<ol style="list-style-type: none"> <li>1. Discussion</li> <li>2. Assignment</li> <li>3.Quiz</li> </ol> <p>Final</p>

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