MIN E 407 Mine Ventilation

Course Outline - Winter 2025

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Lectures: Lectures will be held on Tuesdays and Thursdays from 8:00 to 9:20 AM.

Labs: Dates on the course schedule – All labs in CAT Lab

Grade Distribution:

Assignments	5*4%	20%	
Labs	5*4%	20%	
Midterm Examination		20%	(8:00 – 9:20 AM – Thursday, February 13, 2025)
Final Examination		40%	(1:00 – 3:00 PM – Thursday, April 24, 2025)

Class requirements:

Class attendance is required. Students are expected to arrive at a minimum before class begins. Assignment due dates will be announced. Please ensure that you hand in all required material before the due dates given. Late assignments will automatically incur a 50% penalty. It is expected that assignments will be done neatly and be complete and insightful. Late acceptance must be pre-arranged by email 24 hours before the homework is due. **All exams are closed book, but a formula sheet will be provided. Only non-programmable calculators are allowed.**

Course Resources:

The lecture notes are provided on the course webpage. References will be made to other relevant materials and books. The course notes are mainly compiled from:

Text: Hartman, H.L., Mutmansky, J.M., Ramani, R.V. and Wang, Y.J., 1997, Mine Ventilation & Air Conditioning, 3rd edition, John Wiley & Sons, Wiley Inter-science, 730 pages.

Plagiarism

Plagiarism will not be tolerated in any form and will be dealt with strictly in accordance with university regulations. Please read the code of student behaviour and Don't cheat sheet. The links are posted on the webpage.

Accreditation Units

Accreditation Units – MINE 407 – 3-0-3/2				
Lecture	Seminar	Lab	Credits	Total AU
3	0/1	3/2	3.75	47
Mathematics (M%)	Natural Science (NS%)	Complementary Studies (CS%)	Engineering Science (ES%)	Engineering Design (ED%)
0	0	0	35.3 (75%)	11.7 (25%)

MIN E 407 Mine Ventilation

Course Objectives:

On completion of this course, successful students should be able to demonstrate an understanding of principles and methodologies of mine ventilation. Specifically, students will be able to:

1) Control of the Mine Atmosphere
   - ☑ Functions of ventilation
   - ☑ Properties of air
   - ☑ Gas laws, etc.
2) Mine Gases
   - ☑ Atmospheric air
   - ☑ Poisonous/Explosive gases
   - ☑ Dead Air
   - ☑ Properties of individual mine gases
   - ☑ Gas detection and monitoring techniques
   - ☑ Sources of gases underground
   - ☑ Control of gases underground
3) Basic Fundamentals
   - ☑ Types of pressure (absolute pressure, gage pressure and differential pressure).
   - ☑ Main Properties of Air which affect mine ventilation
   - ☑ Bernoulli's equation
   - ☑ Head losses and Mine heads
   - ☑ Atkinson's equation for friction loss
   - ☑ Air power
4) Instrumentation and Air Measurements
   - ☑ Air Velocity (instruments for measuring air velocity)
   - ☑ Techniques for measuring velocity
   - ☑ Air Quantity
   - ☑ Air Pressure
   - ☑ Temperature and density
6) Basic Mine Ventilation Circuits
   - ☑ Airway resistance
   - ☑ Kirchhoff's Laws
   - ☑ Series and Parallel circuits in ventilation
   - ☑ Controlled splitting
   - ☑ Analysis of simple and complex ventilation networks
   - ☑ Iterative techniques in network analysis (Hardy Cross iteration method)
7) Natural Ventilation
   - ☑ Characteristics of Natural Ventilation
   - ☑ Determination of direction and intensity of natural ventilation
   - ☑ Calculation of Natural Pressure

9) Mechanical Ventilation
   - ☑ Classification of Mechanical Ventilation devices
   - ☑ Types of fans (centrifugal & axial flow fans)
   - ☑ Fan characteristics
   - ☑ Fan Laws
   - ☑ Application of fans to the system
   - ☑ Fan Performance
   - ☑ Multiple fan systems
   - ☑ Fans and natural ventilation
   - ☑ Fan selection

10) Auxiliary Ventilation
   - ☑ Application and importance
   - ☑ Auxiliary system arrangements
   - ☑ Booster ventilation

11) Heat, Humidity, Air Heating and Cooling
   - ☑ Psychrometry
   - ☑ Sources of heat in mines
   - ☑ Sources of moisture
   - ☑ Humidity
   - ☑ Mine air heating and cooling

Recommended Books

1. Hartman, H. L., Mutmansky, J. M., Ramani, R. V & Wang, Y. J. (1997), "Mine Ventilation and Air Conditioning", 3rd edition, *John Wiley & Sons, Inc., New York*.
2. Hartman, H. L., Mutmansky, J. M. & Wang, Y. J. (1982), "Mine Ventilation and Air Conditioning", 2nd edition, *John Wiley & Sons, New York*.
3. Hartman, H. L. (1992), "SME Mining Engineering Handbook", 2nd edition, Vol. 1, *SME, Littleton, USA.*
4. Vutukuri, V. S. & Lama, R. D. (1986), "Environmental Engineering in Mines", *Cambridge University Press*.
5. Rabia, H. (1988), "Mine Environmental Engineering", *Entrac Sotware, Newcastle upon Tyne, UK.*
6. Hartman, H. L. (1961), "Mine Ventilation and Air Conditioning", 1st edition, *The Ronald Press Co.*, *New York.*
7. Cummins, A. B. & Given, I. A. (1973), "SME Mining Engineering Handbook", 1st edition, SME-AIMME, New York.

Graduate Attributes

- Problem Analysis
  - Understand the problem
    - Able to state the essential problem to address – Exam question
  - Assemble knowledge
    - Assembles the relevant models and formulae – Exam question
  - Apply models
    - Applies the appropriate formulae or technique to generate a result – Exam question
  - Evaluate
    - Assesses the result for reasonableness and applicability to models used – Exam question

MINE 407: Mine Ventilation - Winter 2025 Tentative Schedule
Lectures: Tue- Thu, 8:00-9:20AM, Laboratoires : Tue 14:00-16:50, CAT Lab

Week (Dates)	Date	Lec	Lecture Topic	Labs	Assignments
January					
1 (06/01 - 12/01)	7	L01	Introduction, Basics, Gas Laws		1-assigned
	9	L02	Pressures, Bernoulli's Principle		
2 (13/01 - 19/01)	14	L03	Mine Heads - Pressure Gradients	Lab 1	2-assigned
	16	L04	Exhaust-Blower System – State of Flow		
3 (20/01 - 26/1)	21	L05a	Friction loss		
	23	L05b	Shock loss		1-due
4 (27/01 - 02/02)	28	L06	Series and Parallel Circuits	Lab 2	
	30	L07	Complex Network		3-assigned
February					
5 (03/02 - 09/02)	4	L08	Hardy Cross Method		2-due
	6	L09	Hardy Cross Examples		
6 (10/02 – 16/02)	11	L10	Midterm Review	Lab 3	
	13		Midterm EXAM in class time 8:00-9:20AM		3-due
7 (17/02 – 23/02)			**Reading Week**		
8 (24/02 – 02/03)	25	L11	Regulators	Lab 4	
	27	L12	Theory and Design of Fans		4 assigned
March					
9 (3/03 – 09/03)	4	L13	Auxiliary Ventilation		
	6	L13a	Recirculation		5-assigned
10 (10/03 – 16/03)	11	L14	Recirculation - Natural Ventilation	Lab 5	
	13	L15	Mine gases and TLVs – OH&S		
11 (17/03 – 23/03)	18	L16	Fan Laws + Fan Operating Point		4-due
	20	L17	Fan Examples-Ventilation Planning		
12 (24/03 – 30/03)	25	L18	Multiple Fans (Series + Parallel)		
	27	L20	Psychrometry I		
April					
13 (31/03 – 06/04)	1	L21	Psychrometry II		
	3	L22	Final Review		
14 (07/04 – 13/04)	8			5-due	5-due
	10				
Final Exam: Thursday, April 24, 2025 - 1:00PM – 3:00PM					

Note: Labs are due by the next lab session.

Labs

Lab 1 - Roughness and flow

Lab 2 - Basic Mine Ventilation Simulation

- Sessions 1 to 4

Session 1 – Introduction to Ventsim™ • Introduction to Mine Ventilation Simulation • Concepts and theory behind simulation modelling • Benefits and hazards of mine ventilation modelling • The 'Visual' concept of Ventsim™ Key Outcomes • Simulation Algorithm • The importance of resistance in simulation • Data can be visually analyzed and presented	
Session 2 – Ventsim™ Ventilation Basics • Using the mouse • Managing the display • Colors and Numbers • Toolbar buttons, ACTION and VIEW buttons • Using data filters to display certain ranges of data or colors Key Outcomes • Mouse Button functions • Establishing the 'Point of Focus' • Shortcuts to view models	
Session 3 – Building a basic Ventilation Model • Drawing, moving, copying and deleting airways • Surface, connections and dead ends • Applying ventilation pressure – fans and fixes • Specifying airway attributes – sizes, friction factors and resistances • Applying ventilation controls Key Outcomes • Manual construction of models • Importance of surface connection, and blocked ends • Restrictions in 'fixing' airways • Different ways of applying resistance	
Session 4 – Working in 3D • Constructing shafts, ramps and stopes in 3D • Using grouping, levels, layers and saved views • Compressible flows Key Outcomes • Layers to improve display • Easier ways to construct 3D airways • Compressible flow and NVP	

Lab 3 - Working with Mine Data and with true Survey Data - Optimization of Airway Sizes

Session 5 – Working with Mine Data • Import mine design in DXF • Convert to ventilation model • Simplifying and filtering • Advanced and complex DXF centrelines – problems and solutions • Placement ventilation controls Key Outcomes • Good and bad DXF data for making models • Filtering of reference data constructed airways • Fixing poor reference data for model construction	
~~Session 6 – Working with true Survey Data~~ ~~• Methods of manually constructing mine models with actual survey data~~ ~~• Utilising LOCKING and tracing~~ ~~• Other methods of construction~~ ~~• Importing other graphics – topography, stopes, contours etc~~ ~~Key Outcomes~~ ~~• Tracing over reference data~~ ~~• Visualisation of reference data~~ ~~• Using the LOCK function to control cursor movement~~	
Session 7 – Optimisation of Airway Sizes • Calculating the most efficient airway sizes • Ventilation power, fan and mining costs • Selected and Global optimization of models • Life of mine calculations, NPV and changing costs Key Outcomes • Costs settings for accurate optimisation • Limitations in optimising airways • Recovering true savings in cost optimisation	

Lab4 – Fans, Fix Pressures and Fixed Flows - Secondary Ventilation and Ducts – Recirculation

Session 8 – Fans, Fix Pressures and Fixed Flows • When to utilize fans, fixed pressures and fixed flows to produce ventilation. • Entering a fan curve into Ventsim™, FSP versus FTP • Fan efficiencies, power and operating density • Fan configurations, parallel vs series, shock losses, diffusers • Fan problems, stalling and low / no pressure. • Optimizing fan types and configurations Key Outcomes • Construct fan curve models in Ventsim™ • Importance of Static and Total pressure models • Uses of Evases or Diffusers • Fixing poorly performing fans	

Session 9 – Secondary Ventilation and Ducts • Constructing and simulating ventilation ducts and auxiliary ventilation systems. • Multiple duct arrangements and methods. • Leakage factors and techniques. • Solid vs flexible. Using booster fans. Key Outcomes • Auxiliary ventilation design • When to use auxiliary ventilation in models • Limitations in designing auxiliary ventilation systems.	
Session 10 – Recirculation • Detecting recirculation • Recirculation effects on ventilation quality • Controlled versus uncontrolled recirculation • Preventing and fixing recirculation design issues. Key Outcomes • Recognising good and bad recirculation • Methods of fixing recirculation issues	

Lab 5 – Fan performance test: characteristic curves and efficiency

Lab 6 - Mine Contaminants, Gases, and Dust – Steady State & Dynamic

Session 11 – Mine Contaminants and Gases – Steady State • Simulating smoke, fumes and other contaminants in a mine • Concentration and spread of contaminants • Time to spread through a model • Detecting contamination sources • Injecting gases into a mine, linear gas emissions • Emergency response simulation options. Key Outcomes • The many uses of contaminant modelling in Ventsim™ • Limitation of steady state contaminant modelling	
Session 12 – Mine Contaminants and Gases – Dynamic Modelling • Simulating explosive fumes and clearance times. • Modifying ventilation models during simulation – open / closing doors, fans etc. • Graphing contaminant levels over time, reducing clearance times. • Calculating gas and fume building over time in a mine. Key Outcomes • Using contaminant modelling to valid emergency scenarios • Dynamic modelling for improving explosive fume clearance • Gas modelling for gassy mines	

Lab 7 – Heating, Humidity, and Refrigeration in Mines

Session 13 – Heat and Humidity in Mines • Introduction and theory to heat simulation. • Types of heat present in a mine. • Configuring the simulation environment for heat simulation. • Physiological effect of heat on people. • Simulating equipment, diesel machines and electrical motors in models. • Problems and solutions in thermodynamic modelling. Key Outcomes • Understanding of heat types and humidity modelling in mines. • Accurately estimating and modelling all sources of heat in modelling. • Other heat related outcomes such as fog and natural ventilation pressures.	
Session 14 – Heating and Refrigeration in Mines • Application of heating and refrigeration to condition mine atmospheres. • Designing optimal mine temperatures. • Dynamic vs. Static simulation of heat. Key Outcomes • Practical and modelling methods to control heat and cold problems in mines. • Establishment of correct settings to ensure accurate modelling. • Application of heat or refrigeration in mines.	
Session 15 – Diesel Particulate Matter (DPM) simulation • Using diesel heat sources to simulate DPM levels in mines. • Using colours and filter to find area of unacceptable DPM concentration. • Factors affecting levels of DPM in a mine. • Reducing DPM levels through good ventilation design. Key Outcomes • Establishing DPM emission rates for machines • Limitation of DPM modelling • Vent circuit design for reducing DPM exposure.	
Session 16 – Natural Ventilation Pressure and Influences on a mine • Simulating natural ventilation pressure • Common problems and solutions for natural ventilation pressure variation problems. • Reducing and/or enhancing natural ventilation effects. • Introduction to mine fires and effects on ventilation	