

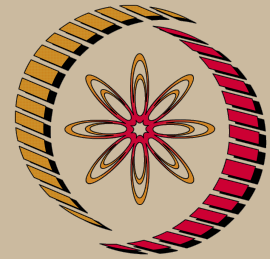
An Introduction to Underground Mine Environment and Ventilation - Web course

COURSE OUTLINE

This course will provide knowledge on supply and control of air for underground mines and the removal of contaminants. After the completion of the course, the student is expected to know about ventilation planning for an underground mine, details of different types of mechanical ventilators and ventilation system. Apart from this, it is expected that the student can design a ventilation system for a given set of conditions.

COURSE DETAIL

Module	Contents	Number of Lectures(Hours)
1. MINE GASES	General composition: Composition of dry air, Requirement of sufficient quantity of air in mines. Impurities in mine air. Threshold limit values: Threshold limit values of gas mixtures. Relative density and specific gravity of gases. Oxygen: General properties, Physiological effects, Detection of oxygen. Nitrogen: General properties. Carbon dioxide: General properties, Physiological effects, Permissible concentration, Detection of co ₂ . Carbon monoxide: General properties, Permissible concentration, Physiological effects, Detection of carbon monoxide. Hydrogen sulphide: General	10



NP-TEL

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Mining Engineering

Pre-requisites:

- No Pre-requisites for a BE/B.Tech student.

Coordinators:

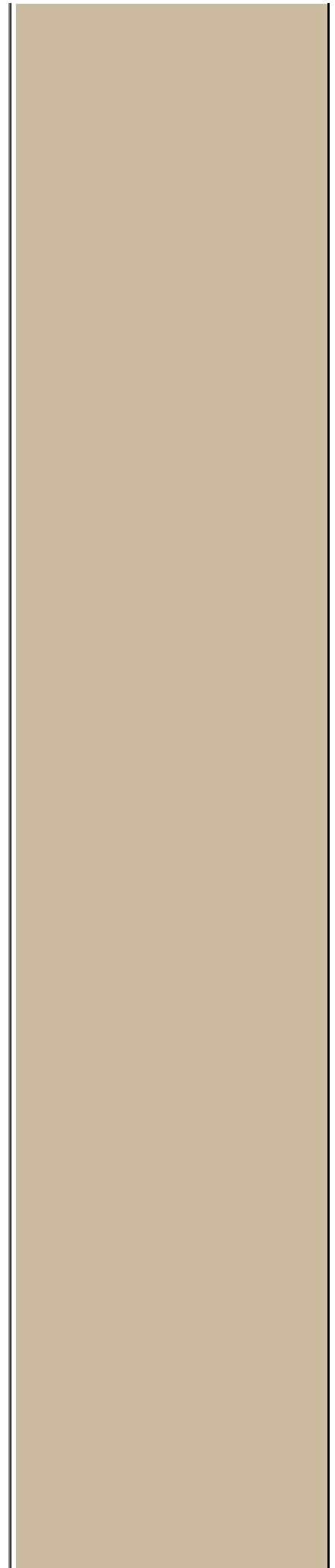
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properties, Physiological effects, Detection of H₂S. Nitrous fumes: General properties, Physiological effects, Detection of NO₂. Sulphur dioxide: General properties, Physiological effects, Detection of SO₂. Hydrogen: Physical properties, Sources of hydrogen in underground mines. Methane: Physical properties, Explosibility curve of methane, Lag on ignition, Classification of coal mines based on methane emission, Occurrence of methane, Desorption of methane and its emission to underground openings. Methane outbursts:

In-seam outbursts, Roof and floor outbursts. Control of methane emission in mines. Methane drainage: Cross-measure methane drainage. Inseam gas drainage: Method of dewatering, Typical life cycle of a gas drainage borehole. Hirschbach method or superjacent heading method. Surface borehole technique. Components of methane drainage system: Pipe ranges, Monitors, Control and safety devices, Extractor pumps. Mine air sampling. Methods of sampling: Grab sampling, New advancement in technology of grab sampling, Integrated sampling. Analysis of mine air samples: Chemical analysis, Physical analysis. Testing of methane or firedamp. Indian regulations pertaining to methane concentration. Methods of detecting methane: Flame

	<p>safety lamp, Working principle of flame safety lamp, Manufacturers of flame safety lamp in India, Approval by DGMS. Testing procedure of methane: Accumulation test, Percentage test. Working of flame safety lamp: Precautions to be taken if firedamp (methane) starts burning within the gauze wire, Limitations of the normal flame safety lamp. Methanometers: Test procedure.</p>		
2. MINE ILLUMINATION	<p>Introduction. Technical terms in lighting and photometry: Intensity, Mean spherical candle power, Mean horizontal candle power, Illumination, Lumen, Luminous efficiency, Reflection. General lighting arrangements, Standards for mine lighting, Important guidelines with respect to luminance, Introduction to glare, Types of glare, Glare reduction. Mine lighting and its effects on accidents, production and health</p>	2	
3. HEAT AND HUMIDITY	<p>Introduction. Various terminology used in psychrometry: Vapour pressure, Saturation vapour pressure, Gas constant of unsaturated air, Specific heat of moist air, Latent heat, Sensible heat, Sigma heat and total heat, Density of humid air. Humidity, Different ways of expressing humidity: Relative humidity, Specific humidity, Absolute humidity. Dew point. Degree of saturation.</p>	10	

Measurement of water vapour in air.
Thermodynamic method of measuring humidity: Dry-bulb temperature, Wet-bulb temperature.
Concept of wet bulb temperature and barometric pressure: Concept of wet-bulb temperature, Concept of barometric pressure.
Types of hygrometers: Wall mounted type hygrometer: Construction, Working, Precautions, Whirling hygrometer or sling psychrometer: Construction, Working, Precautions, Limitations.
Assmann psychrometer: Construction, Working, Advantages, Precautions.
Calculating water vapour content in the unsaturated air. Steps for calculating water vapour content of moist air.
Sources of heat in mines. Strata heat: Geothermal step and geothermal gradient, Thermal conductivity of rocks, Heat flux, Virgin rock temperature, Fourier's law, Factors determining strata heat flow in mines.
Some of the theoretical concepts involved in heat flow: Sensible heat flow, Latent heat flow, Humidity, Thermostat condition in the return. Other sources of heat addition to underground mine environment: Auto-compression, Machinery and lights: Electrical machinery, Diesel equipments, Compressed air run engines.
Underground water, Human metabolism, Rock movement, Oxidation, Blasting and fragmented rocks/minerals, Pipelines,

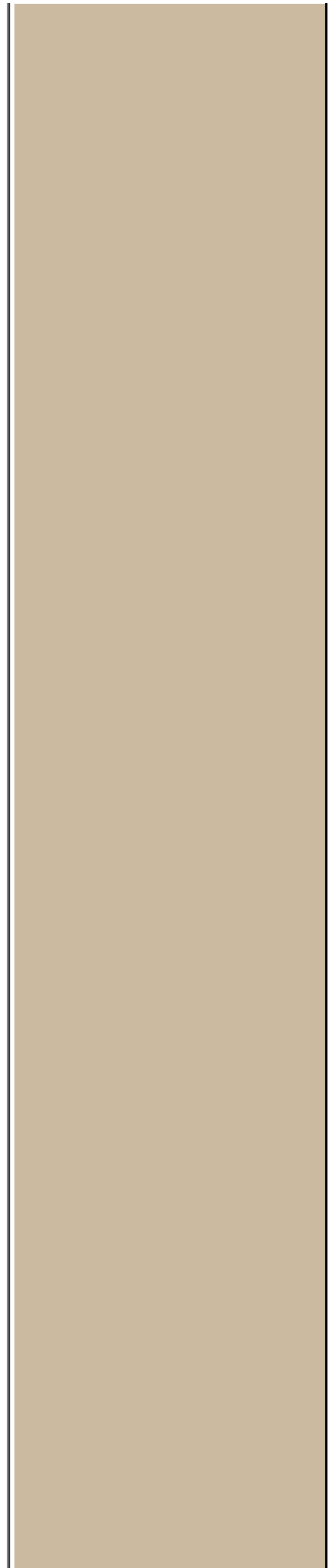


	<p>Energy losses in airways, Sources of cooling in mines. Metabolic heat balance in human body. Some terminologies: Mean skin temperature and core body temperature, Hypothermia, Hyperthermia. Effects of heat and humidity: Heat loss greater than heat generated, Heat loss lower than heat generated, Effect of high wet bulb temperature, Heat hazards: heat cramps, heat exhaustion, heat stroke, Effect of air velocity, Fall of miners working efficiency. Heat indices in underground mines: Direct indices, Empirical indices, Rationally derived heat indices. Need of controlling mine environment. Refrigeration: Methods of refrigeration, Different types of refrigeration plants based on location. Heat exchangers, Classification of heat exchangers, Examples of heat exchangers, Some other indirect ways of controlling mine climate.</p>		
<p>4. APPLICATION OF FLUID MECHANICS IN MINE VENTILATION</p>	<p>Introduction to Fluid and Basic Equations. Reynolds Number and Critical Velocity. Approach Towards Reynolds Number. Laminar Flow. Friction Factor. Turbulent Flow. Expression for Pressure Loss due to Turbulent Flow in Pipes. Work Done Against Friction. Which Type of Flow is Favorable in Mines. Eddy Formation.</p>	<p>3</p>	
<p>5. AIRWAY RESISTANCE</p>	<p>Atkinsons Equation, Determination of Coefficient of Friction</p>	<p>3</p>	

	Factor (): By Analogy with Similar Airways, From Design Tables, From Geometric Data. Shock Loss, Shock Pressure Loss, Equivalent Length. Shock Factor, Types of Bends, Shock Loss Factor for Bends, Shock Loss Factor for Area Changes, Drag Coefficient.		
6. UNDERGROUND VENTILATION SYSTEM	<p>How Air Flows in Mines, Categorization of Ventilation System in Mines, Elements of Primary Ventilation System: Downcast and Upcast, Intakes and Returns, Fans, Choice Between Forcing and Exhausting Fan System, Stoppings and Seals, Doors, Airlocks, Regulators, Passive Regulator, Active Regulator, Air Crossings.</p> <p>District System: U-Tube Ventilation System, Through-Flow Ventilation System. Application of U-Tube Type Ventilation System: Application of U-Tube Type Ventilation System in Bord and Pillar Method of Mining, Application of U-Tube Type Ventilation System in Longwall Mining: Advancing Longwall Panel, Retreating Longwall Panel, W-System.</p>	2	
7. NATURAL VENTILATION	Natural Ventilation, Production of Natural Ventilation, Density Difference Between the Air of two Shafts, Definition of Natural Ventilating Pressure, Motive Column,	2	

	<p>Computation of NVP from Air Density, Practical Methods Of Determining NVP: From Measurement of Pressure and Quantity of Air in the Fan Drift, From Measurement of Pressure and Quantities in the Fan-Drift at two Different Speeds of Fan, From Measurement of Air Pressure at Pit-Bottom with Fan Running and Fan Stopped.</p> <p>Determination of Natural Ventilation Pressure from Thermodynamic Principle, Natural Ventilation along with Mechanical Ventilation, NVP Determination From PV-Diagram.</p>		
<p>8. MECHANICAL VENTILATION</p>	<p>Basic Types of Fans Used for Ventilating Underground Mines. Centrifugal Fan; Eye in a Centrifugal Fan, Single Inlet and Double Inlet Centrifugal Fans, Types of Blades, Evasee and Scroll/Volute, Classification of Centrifugal Fans: Based on Intake and Discharge, Based on Location of Drive/Motor. Axial Flow Fan. Classification Based on Attachment of the Blade. Types of Blades. Derivation of Theoretical Head Developed by Centrifugal Fans. Theoretical Head Characteristics of a Centrifugal Fan. Theoretical Power Characteristics of Centrifugal Fan. Actual Head Characteristics of Centrifugal Fan. Efficiencies Associated with a Fan. Fan Laws. Characteristic Curves of Fan: Comparison of the</p>	<p>8</p>	

Characteristics of a Runner and a Mountaineer, What Does a Fan Characteristic Curve Give. Pressure Quantity Curve: What is Stall Zone in PQ – Curve, What Happens if a Fan is Operated in the Stall Zone. Input Power Curve. Efficiency Curve: Air Power, If No Work is Done What Happens to the Input Power Supplied to the Fan. Selection Process of Mine Fans: Fan Selection, Fans in Series, Fans in Parallel. Series Connection: Case – I, Case – II, Case – III. Parallel Connection: Case – I, Case – II. Fan Selection. General Expression for Series and Parallel Connection: Series Connection, Parallel Connection. Auxiliary Ventilation. Types of Auxiliary Ventilation. Forcing System of Auxiliary Ventilation: General, Advantages of Forcing System of Auxiliary Ventilation, Disadvantages of Forcing System of Auxiliary Ventilation. Exhaust System of Auxiliary Ventilation: General, Advantages of Exhaust System of Auxiliary Ventilation, Disadvantages of Exhaust System of Auxiliary Ventilation. Overlap System of Auxiliary Ventilation: General, Advantages of Overlap System of Auxiliary Ventilation, Disadvantages of Overlap System of Auxiliary Ventilation. Reversible System of Auxiliary Ventilation:



	<p>General, Advantages of Reversible System of Auxiliary Ventilation, Disadvantages of Reversible System of Auxiliary Ventilation. Line Brattices System of Auxiliary Ventilation: Advantages of Line Brattice System of Auxiliary Ventilation, Disadvantages of Line Brattice System of Auxiliary Ventilation. Booster Fans, Purpose of Booster Fans, Disadvantage of Booster Fans, Critical Pressure of Booster Fan, Pressure Required to be Developed by Booster Fan, Installation of Booster Fans.</p>	
9. VENTILATION NETWORK ANALYSIS	<p>Airways Connected in Series and Parallel: Airways Connected in Series, Airways Connected in Parallel, Ratio of Resistances of Series and Parallel Airways. Splitting of Airways: Merits, Demerits. Merits and Demerits of Series Airways. Introduction, Basic Concepts in Ventilation Network Analysis: Junctions, Branch, Mesh, Kirchhoff's Laws: Kirchhoff's First Law, Kirchhoff's Second Law. Methods of Solving Ventilation Networks: Network Reduction Using Series and Parallel Circuits, Using Kirchhoff's Laws, Numerical Methods. Hardy Cross Method of Successive Approximation</p>	2
10.	Ventilation Surveys. Air	3

VENTILATION SURVEYS

Quantity Survey: Vane Anemometer, Pitot Static Tube, Smoke Tube, Kata-Thermometer, Hot Wire Anemometer, Tracer Gas Method. Air Quantity Measurement using Orifice Plates and Venturimeters: Orifice Plates, Venturi Meters. Selection of Measurement Stations for Pressure Quantity Survey. Measurement of Cross-Sectional Area: Taping, Offset Method, Profilometer Method, Craven Sunflower Method, Photographic Method. Pressure Surveys: Aneroid Barometer. Equipments Required for Pressure Quantity Survey. Organization of Pressure Quantity Surveys. Air Quality Surveys.

References:

1. Banerjee S.P. (2003); "Mine Ventilation"; Lovely Prakashan, Dhanbad, India.
2. Deshmukh, D. J. (2008); "Elements of Mining Technology, Vol. , II"; Denett & Co., Nagpur, India.
3. Hartman, H. L., Mutmanský, J. M. & Wang, Y. J. (1982); "Mine Ventilation and Air Conditioning"; John Wiley & Sons, New York.
4. Karmakar, N. C. (2001); "Handbook of gas testing"; Lovely Prakashan, Dhanbad, India.
5. Le Roux, W. L. (1972); "Mine Ventilation Notes for Beginners"; The Mine Ventilation Society of South Africa.
6. McPherson, M. J. (1993); "Subsurface Ventilation and Environmental Engineering"; Chapman & Hall, London.
7. Misra G.B. (1986); "Mine Environment and Ventilation"; Oxford University Press, Calcutta, India.
8. Ramlu, M. A. (1991); "Mine fires, Explosions, Rescue, Recovery and Inundations"; Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
9. Vutukuri, V. S. & Lama, R. D. (1986); "Environmental Engineering in Mines"; Cambridge University Press, Cambridge.

