GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-V

Course Title: Mine Ventilation

(Course Code: 4352202)

Diploma Programme in which this course is offered	Semester in which offered
Mining Engineering	5th Semester

1.RATIONALE

The diploma holders in mining engineering will be responsible to keep underground mines in comfortable & safe working conditions by ensuring brisk ventilation with proper lighting arrangements. They should be able to select the suitable fans & the proper airways to ventilate whole mine &/or it's various sections. This subject provides them basic knowledge of mine atmosphere with required ventilation & lighting arrangements with its associated problems & remedies.

2. COMPETENCY

The course content should be taught and with the aim to develop required skills in the students so that students are able to acquire following competency:

- **Examine quality of mine atmosphere.**
- **Operate effectively various instruments related to mine ventilation.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

CO1: Examine quality of mine air to keep working environment safe.
CO2: Select a suitable mine fan to procure adequate ventilation in underground mines.
CO3: Adopt suitable technique for controlling the distribution of air in mine network.
CO4: Select suitable places for lighting to maintain safe mining conditions.

4.TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/0)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA*	ESE	CA	ESE	
4	0	2	5	30	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to

facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *- Practical;* ***C*** *– Credit,* ***CA*** *- Continuous Assessment;* ***ESE*** *- End Semester Examination.*

5.SUGGESTED LIST OF EXERCISES/PRACTICAL

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the* ***PrOs*** *marked* ***'*'*** *are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Appox. Hrs. Required
1	Determine gas percentage by flame safety lamp in varying condition of Gas Testing Chamber.	I	4*
2	Determine relative humidity of air by whirling Hygrometer.	I	4*
3	Determine cooling power of air by Kata thermometer.	I	4*
4	Determine Velocity, Quantity, and Pressure drop of air in a duct by Pitot Tube and inclined tube manometer.	II	4*
5	Determine the neutral point in Return way for locating Booster Fan.	II	4*
6	Calculate regulator's size in an airway in varying conditions.	III	4*
7	Calculate the quantity of mine air passing through each split in given conditions.	III	4*
	Total		**28**

Note

i. *More* ***Practical Exercises*** *can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. *The following are some* ***sample*** *'Process' and 'Product' related skills (more may be added/deleted depending on the course)that occur in the above listed* ***Practical Exercises*** *of this course required which are embedded in the COs and ultimately the competency.*

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Calculation of quantities	30
2	Followed formula and methods sequentially	20
3	Operating of instruments	10
4	Follow safe practices	10
5	Answer the questions related to exercises	10
6	Neatness in work	10
7	Submission in time	10
Total		**100**

6.MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practical in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO.No.
1	**Flame Safety Lamp (GL 50/GL7):** Upper section: - A bonnet, two steel wire gauzes, handle / hook (of 20 or 28 mesh size) Middle section: - Two sets of rings interconnected by five steel rods, glass (may be one or two set-inner and outer) around the flame, chimney, two asbestos washers. Lower section: - Fuel vessel, burner, wick assembly, a screw locking arrangement, and re-lighting device (if available)	1
2	**Whirling Hygrometer:** Dimensions: 230 x 80 x 28mm, Range: -5°C to 50°C, Weight: 300g (0.6lb)	2
3	**Kata thermometer:** Alcohol thermometer, large bulb of 4 cm length and 2cm width, total width 20 cm, measuring temperature 38°C and 35°C	3
4	**Pitot Tube:** Made up of Stainless steel, contains two concentric tubes, size range - 0.30 to 2.00 m, 10mm thickness, measuring velocity - 0 to 25m/sec. **Inclined tube manometer:** Two PVC tubing of 10m length, bottle of manometer fluid with labelled density, swiveled in 4 positions – 1 in 5, 1 in 10, 1 in 20 & vertical (approx.), pressure measurement – 250 mm wg, velocity range – 0 to 28 m/sec.	4
5	**Anemometer:** Mild steel body, wind speed measurement – 1.016 to 50.8 m/sec, accumulated air reading up to 3048m, fan blades set an angle of 40º to 45º, two dials - smaller dials marked into 10 divisions and larger dial into 100 divisions.	4 and 7
6	**Electronic Velometer:** Dimension – 168 * 80 * 35 mm, Display - 18 mm (0.7”) LCD, operating temperature - 0º C to 50º C, Operating humidity – 90% RH (relative humidity), weight – 325 gm	4 and 7

7.AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfil the development of this competency.

1. Valuing: Recognize the importance of examining mine air quality to ensure a safe working environment.
2. Appreciation: Understand the significance of adequate ventilation in underground mines for the overall safety and health of workers.
3. Concern: Develop genuine concern for controlling the distribution of air in mine networks to maintain a safe and healthy environment.
4. Responsibility: Take responsibility for selecting suitable places for lighting to uphold safe mining conditions.

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8.UNDERPINNING THEORY

Only the major Underpinning Theory is formulated as higher level UOs of Revised Bloom's Taxonomy in order development of the COs and competency is not missed out by the students and teachers. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I **Mine Air**	1a: Compare mine air with atmospheric air. 1b: Identify the cause of impurity in mines air. 1c: Identify the main cause of discomfort conditions by observation of physiological effects. 1d: Check quality of mine air by suitable technique and instrument.	1.1 Composition of Atmospheric air and its suitability for human respiratory system. 1.2 Composition of Mine air, sources of impurities due to other gases in it like Carbon dioxide, nitrous fumes, SO_2, etc physiological effects of oxygen deficiency in mines air. 1.3 Damps in mines: their types with its composition, mode of occurrence, method of detection, noxious & poisonous physiological effects and precautionary measures. 1.4 Sources affecting quality of Mine Air: Effects of Temperature and humidity on human body. 1.4.1 Sources of heat and humidity in mine air 1.4.2 Instruments and process used for measuring Mine Air (temperature, humidity and cooling power)

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – II **Fan Ventilation**	2a. Measure the pressure difference available for Natural Ventilation. 2b. Explain objectives & standards of ventilation. 2c. Describe suitability and installation of mine fans for various purpose in underground mines. 2d. Calculate pressure requirement of mine air to overcome airway resistance. 2e. Measure the air pressure produced by Mine fans. 2f. Solve problems related with mine air velocity and quantity.	2.1 Natural ventilation- Causes & its establishment. Calculation based on Natural Ventilation Pressure (N.V.P) and motive column. 2.2 Need and Objectives of Mine Ventilation, standards of mine ventilation as per regulation. 2.3 Mechanical/Fan Ventilation- (a) Fan types- on the basis of location (main fan, auxiliary fan and booster fan), air flow direction (forcing & exhaust), & working principle (centrifugal Fan and Axial Flow Fan); Comparison among these fan types. (i) Centrifugal fan: Working principle & its installation as main fan. (ii) Axial flow fan: Working principle; its installation as main fan, auxiliary fan, & booster fan with its purpose. (b) Air quantity control technics and air reversal system by both fans. 2.4 Laws of mine air friction and its calculation of pressure requirement to overcome the airway resistance. 2.5 Measurement of Fan Pressure by using pitot tube with inclined tube manometer 2.6 Determination of mine air velocity & quantity by using fan pressure.

Unit – III **Mine Air Distribution and its Control**	3a. Describe the suitability of devices used for controlling the distribution of mine air. 3b. Explain patterns of ventilation. 3c. Calculate quantity of air passing through splits. 3d. Explain various ventilation survey procedures.	3.1 Devices used for distribution & control of mine air: • Ventilation stopping, • Air crossing, • Doors, • Brattice partition, & • Regulator with calculation of opening size. 3.2 Ventilation Pattern: Ascensional & descensional ventilation; Homotropal & Antitropal ventilation. 3.3 Splitting: purpose, its advantages, calculation of air passing through each split. 3.4 Ventilation surveys in mines**:** (i) Quantity survey. (ii) Pressure survey
Unit – IV **Mine Lighting**	3a. Define terminologies of Mine lighting. 3b. Enlist the places required to be lighted in mines. 3c. Explain standards of mine lighting. 3d. Explain function of cap lamp.	4.1 Terminology: Intensity of light, Mean Spherical Candle Power, and Lumen. 4.2 General lighting places in mines 4.3 Standards of lighting as per CMR. 4.4 Salient features of Cap lamp.

9.SUGGESTED SPECIFICATIONTABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Mine Air	18	13	6	4	23
II	Fan Ventilation	20	10	5	10	25
III	Mine Air Distribution & its Control	12	6	3	6	15
IV	Mine Lighting	06	7	0	0	7
	Total	**56**	**36**	**14**	**20**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's Revised Taxonomy)

Note: *This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from above table.*

10. SUGGESTED LIST OF STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Organize visits to operational mines or ventilation facilities to observe real-world ventilation systems in action.
b) Arrange workshops and seminars where industry experts and professionals can share their experiences and insights on mine ventilation. Undertake micro-project.
c) Encourage students to join professional societies or associations related to mining engineering or ventilation.
d) Organize design competitions where students can develop ventilation system designs for hypothetical mining scenarios.

11. SPECIAL INSTRUCTIOAL STRATERGIES (If any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (MOOCs) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) 'L' in section No. 4 means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About 20% of the topics/sub-topics which are relatively simpler or descriptive in nature is to be given to the students for self-learning, but to be assessed using different assessment methods.
e) With respect to section No.10, teachers need to ensure to create opportunities and provisions for co-curricular activities.
f) Video lectures showing operational principles of various mine fans.
g) Guide students on how to address issues on mine hazards.
h) Animated documentaries on various mine ventilation system.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

1. Design a poster that highlights the importance of examining mine air quality and its impact on the working environment.
2. Prepare a chart that visually presents the criteria and considerations for selecting a suitable mine fan for adequate ventilation in underground mines.
3. Prepare a presentation showcasing various techniques for controlling the distribution of air in a mine network.
4. Prepare a poster that provides guidelines for selecting suitable places for lighting in mines to maintain safe working conditions.
5. Design a series of posters that provide essential safety guidelines for miners, focusing on topics such as air quality testing, fan operation and maintenance and air distribution control.

13.SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Elements of Mining Technology – II Part A & B	D. J. Deshmukh	Denett & Co. ISBN 978-81-89904-34-0
2	The Universal Mining School (UMS) Vol.1	Cardiff (GT. Britain)	Cardiff Priory Press Limited
3	Mine Environment and Ventilation	G. B. Mishra	Oxford University Press ISBN : 0-19-562232-4
4	Mine Ventilation	S. P. Banerjee	Lovely Prakashan Dhanbad ISBN : 978-8179560174
5	Numerical problems on Mine Ventilation	L. C. Kaku	Lovely Prakashan Dhanbad ISBN : 978-8179561393

14.SOFTWARE/LEARNING WEBSITES

1) A web course on National Programme on Technology Enhanced Learning (NPTEL) by Dr. Harsha Vardhan named "An Introduction to Underground Mine Environment and Ventilation": https://archive.nptel.ac.in/courses/123/106/123106002
2) Topic: - Mine Hazards and Environment Source: - www.mineportal.in https://drive.google.com/file/d/14f5fXh4M_6EyzOS1-L5vHkCTLY9i-QTl/view
3) Various pdf documents related to mine ventilation topics, link: - https://miningquiz.com/pdf/ventilation.htm
4) Ventsim 3D Mine Ventilation Simulation software for understanding ventilation system, weblink:- https://ventsim.com/download/currentdownloads/
5) Tutorial video you tube links for ventsim 3D Mine Ventilation Simulation software - https://www.youtube.com/@HowdenVentsim, https://www.youtube.com/watch?v=xIjx4CG6Qz0&list=PL0ZXhuwzmNB5ifTHBySj4ZczMMit7E-Bw

15.PO-COMPETENCY-CO MAPPING

Semester V	Mine Ventilation (Course Code:4352202)								
	POs and PSOs								
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ development of solutions**	**PO 4 Engineering Tools, Experimentation &Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Management**	**PO 7 Life-long learning**	**PSO 1 Student will be able to operate flame safety lamp effectively.**	**PSO 2 Student will be able to test percentage of inflammable gas.**
Competency	• Examine quality of mine atmosphere. • Operate effectively various instruments related to mine ventilation.								
Course Outcomes CO1 Examine quality of mine air to keep working environment safe.	3	-	2	2	2	-	2	3	3
CO2 Select a suitable mine fan to procure adequate ventilation in underground mines.	2	3	3	2	2	2	2	-	-
CO3 Adopt suitable technique for controlling the distribution of air in mine network.	2	3	3	-	3	-	2	-	-
CO4 Select suitable places for lighting to maintain safe mining conditions.	-	-	-	-	2	-	2	-	-

16.COURSE CURRICULUM DEVELOPMENT COMMITTEE

SR. No.	Name and Designation	Institute	Contact No.	Email
1	Mr. S. G. Srivastav I/c Head of Dept. Mining Engineering.	Government Polytechnic, Bhuj	9428546433	shivkumarsrivastav11@gmail.com
2	Mr. P. Y. Trivedi Lecturer In Mining Engineering.	Government Polytechnic, Bhuj	9909219747	pranavytrivedi@gmail.com
3	Mr. S. C. Dabhekar Lecturer In Mining Engineering.	Government Polytechnic, Bhuj	8732983906	shrijaldabhekar@gmail.com