GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Mining Hazards and Safety
(Course Code:4352204)

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

1. RATIONALE

Due to the nature of work in mines, it may sometimes create hazardous situations which are directly linked with the safety of miners as well as the economy of the industry. Sometimes, the situations become so critical that they will affect the nearby society or livelihoods. Some known hazards that have been reported in many mines in the past are mine fires, inundation, and explosions.

Mining laws also emphasize the provisions regarding safe practices in mines to avoid any circumstances that may create hazardous situations. However, due to varying geological and mining conditions, sometimes a judgmental decision taken by the mining engineer will ensure the safety of the mine as well as society.

A mining diploma holder must acquire a deep knowledge and understanding of the post-effects of any hazard which may arise along with the mitigational safety measures. They must be competent in selecting suitable materials, methods, and technology in varying situations. This course will improve the skill to adopt suitable measures and techniques promptly at any emergency situation that may arise in a mine.

2. COMPETENCY

The course should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- **Identify the risk of hazardous condition in mines.**
- **Adopt suitable mitigational measures against mine hazards.**

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: Identify the main cause and preventive measure of mine fire.
CO2: Illustrate the governing factors for fire damp explosions.
CO3: Manipulate the techniques to reduce the risk due to coal dust explosions.
CO4: Analyze the responsible conditions for mine inundation.
CO5: Apply all statutory norms to deal a critical situation of rescue and recovery.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA*	ESE	CA	ESE	
4	-	-	4	30	70	-	-	100

(*): 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. AFFECTIVE DOMAIN OUTCOMES

a) Act as a team member/ individual in rescue and recovery operation.
b) Displays a professional commitment to ethical practice on a daily basis.
c) Adopt environmentally friendly methods in mines.
d) Verify the mitigational measures taken against hazardous situation.

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.

6. 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	Unit Outcomes (UOs)	Topics and Sub-topics
Unit –I **Mine Fire**	1a. Apply basic principle to find the main cause of fire. 1b. Classify the types of fire. 1c. Select a suitable quenching material to deal with a particular class of fire. 1d. Adopt suitable measures to prevent fire condition in mines. 1e. Design a suitable inspection plan for spontaneous heating of coal. 1f. Analyze the stage of	1.1 Essential conditions required to start a fire (concept of fire triangle). 1.2 Classifications of fires with suitable fire extinguishers (Class A, Class B, Class C, Class D, Class E, Class F) 1.3 Fire prone areas in surface & underground mines 1.4 Causes of surface and underground fire with preventive measures 1.5 Governing factors, detection, prevention and control of spontaneous heating /fire 1.6 Precautions against outbreak of surface fire

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
	spontaneous heating depending upon its symptoms. 1g. Select a suitable quenching method to deal with a particular type of fire.	1.7 Fire quenching materials used in mines for dealing with fire 1.8 Fire-fighting on surface and below ground methods applied for approachable fires (direct attack methods) for not approachable fires (sealing of fire area: preparatory, temporary, permanent stopping, flooding the area with water or inert gas).
Unit – II **Fire Damp Explosion**	2a. Identify the cause of fire damp explosion. 2b. Conclude the findings to get the severity of gas air mixture. 2c. Calculate the inflammability limit of a gas air mixture. 2d. Select suitable measures to reduce the risk due to fire damp explosion	2.1. Causes of fire damp explosion 2.2. Coward's diagram 2.3. Limits of inflammability of fire damp 2.4. Sources affecting limits of inflammability of fire damp 2.5. Detection of inflammability limit of a gas air mixture 2.6. Mechanism of fire damp explosion 2.7. Preventions of fire damp explosions
Unit– III **Coal Dust Explosion**	3a. Identify the cause of coal dust explosion. 3b. Conclude the findings to get the severity of coal dust explosion. 3c. Select suitable measures to reduce the risk due to coal dust explosion 3d. Compare coal dust with firedamp explosion	3.1. Causes of coal dust explosion 3.2. Factors affecting Inflammability of coal dust, explosibility limits with limiting conditions 3.3. Mechanism of coal dust explosion 3.4. Preventions of coal dust explosion: a. Prevention for accumulation of coal dust b. Prevention for removal of coal dust c. Use of stone dust barriers (characteristic of dust, types of barriers, location, maintenance) 3.5. Comparison of coal dust and firedamp explosion

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit– IV **Mine Inundation**	4a. Identify the dangerous sources of water 4b. Choose suitable measures to prevent irruption of water in mine 4c. Select suitable measures to reduce the risk due to inrush of water in mine 4d. Identify suitable place for dam construction	4.1. Causes of inundation in mines a. By surface water b. By overlying strata c. By water logged working 4.2. Measures against inundations a. Surface measures b. Underground measures 4.3. Water logged workings in mines 4.4. Dewatering of water-logged workings a. Exploratory b. Drilling 4.5. Water dams constructional features
Unit – V **Mine Rescue and Recovery**	5a. Prioritize the rescue apparatus to be procured in mine 5b. Persuade the statutory provisions to be followed in mines 5c. Dramatize mine rescue and recovery operation conducted in mine 5d. Select suitable rescue and recovery apparatus	5.1. Human respiratory system 5.2. Mine rescue apparatus a. Self-contained breathing apparatus b. Filtered air respirators, air purifying respirators c. Fresh air hose or tube breathing apparatus 5.3. Resuscitation (artificial respiration) 5.4. Preparatory for resuscitation 5.5. Rescue organization a. Rescue station, rescue room b. Rescue organization at mines c. Rescue and recovery work following mine disaster

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Mine Fire	16	4	8	8	20
II	Fire Damp Explosion	10	0	4	8	12
III	Coal Dust Explosion	8	2	8	0	10
IV	Mine Inundation	10	6	5	2	13
V	Mine Rescue and Recovery	12	8	5	2	15
Total		**56**	**20**	**30**	**20**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's 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 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) Visit nearby firefighting station.
b) Visit a mine and write a report on safety measures planned by them against various hazards.
c) Undertake micro-project.
d) Dramatize rescue and recovery work conducted by rescue team
e) Conduct a group discussion on various issues of mine safety

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES

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) Guide students on how to address issues on environment and sustainability
g) Video lectures showing operational principles of various rescue operators
h) Guide students on how to address issues on mine hazards
i) Animated documentaries on various mine hazards

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:

a) Prepare a poster showing various classes of fire with material involve and suitable fire extinguishers
b) Prepare an illustration banner related to fire safety in mines
c) Presentation on any case study related with mine disaster.
d) Prepare a poster showing human respiratory system
e) Make slides showing artificial respiration technique
f) Design a fresh air base layout for an underground mine
g) Prepare a chart showing schematic diagram of various stopping
h) Prepare a sheet showing constructional features of dams used in underground mine

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Elements of Mining Technology Vol. II	D. J. Deshmukh	Denett & Co., Nagpur Year: 2008 ISBN-13 : 978-8189904333
2	Mine Ventilation	S. Ghatak	Coalfield Publishers, Ukhra Year: 1991
3	Mine Disasters and Mine Rescue	Madisetti Anant Ramlu	The Orient Blackswan, Telangana Year: 2018 ISBN-13 : 978-9386235589
4	Mine Disasters and Mine Rescue	Madisetti Anant Ramlu	Madisetti Anant Ramlu, Telangana Year: 2006 ISBN-13 : 978-8173715730
5	Fires in Coal Mines	L C Kaku	Oriental Publishers, Jaipur Year: 1985
6	Mine Rescue Manual	Robert L. Ferriter, Chris Enright	Society for Mining, Metallurgy & Exploration Year: 2014 ISBN-13: 978-0873354059
7	Prevention and Combating Mine Fires	Sudhish Chandra Banerjee	CRC Press Year: 2000 ISBN-13: 978-1000443769

14. SOFTWARE/LEARNING WEBSITES

a) https://nptel.ac.in MOOC Course
b) federalregister.gov. “Underground Mine Rescue Equipment and Technology” https://www.federalregister.gov/documents/2006/01/25/06-722/underground-mine-rescue-equipment-and-technology.

c) V. S. Vutukuri, and R. N. Singh. “Mine Inundation-Case Histories.” *Mine Inundation-Case Histories* 14, no. 1 (1995): 107–30. https://doi.org/10.1007/BF02914857.
d) CDC. “CDC - Mining Feature - Coal Mine Explosion Prevention - NIOSH.” Centers for Disease Control and Prevention, https://www.cdc.gov/niosh/mining/features/coalmineexplosion.html.
e) Scribd. “Methane Gas Properties & Coward’s Diagram | PDF | Coal | Methane,” n.d. https://www.scribd.com/document/360834216/Methane-Gas-Properties-Coward-s-Diagram.
f) Park, Cherry. “5 Types of Fire Extinguishers: A Guide to Using the Right Class.” IFSEC Global | Security and Fire News and Resources, https://www.ifsecglobal.com/global/choose-right-type-fire-extinguisher/.
g) The Fire Triangle. “The Fire Triangle,” n.d. https://www.sc.edu/ehs/training/Fire/01_triangle.htm.
h) “Backstory: The Chasnala Mining Tragedy of 1975.” cnbctv18.com, June 23, 2021. https://www.cnbctv18.com/views/backstory-the-chasnala-mining-tragedy-of-1975-9754561.htm.
i) Mining Accidents in India. “Mining Accidents in India,” http://ismenvis.nic.in/Database/Mining_Accidents_in_India_24483.aspx.

15. PO-COMPETENCY-CO MAPPING

Semester V	**Mining Hazards & Safety (Course Code:4352204)**									
	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**	**PSO 2**	**PSO 3** (If needed)
Competency	• Identify the risk of hazardous condition in mines. • Adopt suitable mitigational measures against mine hazards.									
Course Outcomes CO1 Identify the main cause and preventive measure of mine fire.	3	2	3	-	2	1	1	-	-	-
CO2 Illustrate the governing factors for fire damp explosions.	-	3	-	-	2	1	2	-	-	-
CO3 Manipulate the techniques to reduce the risk due to coal dust explosions.	-	3	3	3	3	2	2	-	-	-
CO4 Analyze the responsible conditions for mine inundation.	-	3	-	-	-	-	2	-	-	-
CO5 Apply all statutory norms to deal a critical situation of rescue and recovery.	3	2	3	3	3	3	2			

Legend: ‘**3’** for high, ‘**2**’ for medium, **‘1’** for low or **‘-’** for the relevant correlation of each competency, CO, with PO/ PSO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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