END-SEMESTER EXAMINATION

Course: 7th Sem B.Tech. (Mining Engineering)

Session: 2022-2023

Semester: Summer

Subject: Mine Environmental Engineering (MND – 406)

Time: 3 hrs

Max. Mark: 100

Instruction: ***Answer any FIVE questions.***

Q.No.	*Question*	*Marks*
1	How does analysis of air sample help in early detection of heating? Given below the analysis result of a sample taken from inside a sealed off fire area: $N_2 = 79.79\%$, $CO_2 = 8.44\%$, $CH_4 = 3.86\%$, $O_2 = 4.97\%$, $CO = 2\%$, and $H_2 = 0.94\%$. What does it indicate regarding (a) the condition of fire, and (b) air-tightness of the stoppings?	5+10+5
2	a) Explain with the help of suitable sketches the details of a stone barrier for a bord and development district with six level headings. The galleries are 4.5 m width × 2 m height and pillars are 18 m centre to centre.	12
	b) Describe the procedure after an explosion in a mine to ascertain whether it is a coal dust or firedamp explosion.	8
3	a) What preventive action you would recommend to avoid the mine dust becoming air-borne. What action you would propose to take for the dilution and suppression of airborne dust.	5+5
	b) How can the concentration of air-borne dust in the mine atmosphere be determined? Describe the impact of dust on the human system in coal mines. What do you consider to be the safe limit?	10
4	a) What are the principal causes of inundation in coal mines? What precautions would you take to guard against of inundation from surface water?	5+5
	b) In an underground mine, water is flowing in a gallery 4 m width and 3 m height at a rate of 2000 GPM with 120 m head. With the help of diagrams, describe how you would construct the brick dam with special reference to (a) Selection of site, and (b) Thickness of dam. Assume the safe crushing strength of the brick is assumed to be 17.5 kg/cm^2.	10
5	State the circumstances under which the following apparatus are used indicating the limitations, if any, of their use: (i) Filter type self-rescuer, (ii) Chemical type self-rescuer, (iii) Self-contained breathing apparatus, and (iv) Reviving apparatus	4 × 5
6	a) Describe with the aid of a sketch, a modern layout for a 2000 cap lamp self-service installation.	10
	b) A mechanised underground mine produces 1500 tonnes of coal per day. Specify the number of electric cap lamps required for a self-service lamp room in the mine. Output Per Man Shift (OMS) of the mine is assumed to be 0.9.	10
7	a) Determine the lower limit of the following gaseous mixture: 97% methane, 2% ethane and 1% hydrogen. What is the danger associated with gas concentration outside the limits of inflammability of methane?	5+5
	b) With the help of diagrams, describe how you would do the dust sampling in (i) a Bord and Pillar working and (ii) a Longwall working.	5+5

End of the Question Paper

MID-SEMESTER EXAMINATION

Course: 7th Sem B.Tech. (MNE, MME, EE, ECE, CSE, M&C, MLMTE, & PE) & JRF

Session: 2024-2025 **Semester**: Monsoon

Subject: Mine Environmental Engineering (MND – 406)

Time: 2 hrs **Max. Mark**: 32

Instructions: ***Answer ALL questions.***

Q.No	Question	Marks
1	a) Air is flowing with a flow rate of 24 m^3/s in a roadway of 4 m width × 3 m height × 100 m length in an underground coal mine. Is there any danger of methane layering if the percentage of methane in the mine atmosphere is 3.5%? **Solution:** $$S_{\text{index}} = \sqrt[3]{\frac{23V^2}{C\sqrt{F}}}$$ V = Mean air velocity (24/12 = 2 m/s) C – Mean methane content (3.5 % CH4) F – Cross-sectional area of airway at the measuring station, (12 m^2) $S_{index} = 1.85 < 2$, hence there is probable danger of methane layering	*3*
	b) A long heading 5 m wide and 4 m high is ventilated by a forcing tube circulating 4 m^3/s of air at the face. Calculate the distance from the face at which all the +10 μm dust particles would have settled down from the airstream. The dust particles have a density of 2650 kg/m3. Assume your own data, if required. **Solution:** $Vt = 3.03 \times 10^4 \times 2650 \times 10^{-10} = 0.008$ m/s $Re = (4*4*20)/(20*18*0.16*10^{-4}) > 4000$ $Vt_{actual} = 0.008*0.5 = 0.004$ m/s Time required a 10 μm dust particle to settle from the roof of the drive to the floor = 4/0.004 = 1000 s The horizontal distance traversed by the particle in this time = (4/20)*1000 =200 m	5
2	How can the concentration of air-borne dust be determined? What impact the types of dust found in coal mine have on human system? What preventive actions would you recommend to avoid the mine dust becoming airborne? What do you consider to be the safe limit in Indian underground coal mines? **Airborne dust concentration is determined by** • Only approved type of instruments are to be used for sampling. • Sampling is of two types: Static sampling, personal sampling • Static sampling is done by gravimetric sampler – Static sampling gives mainly an assessment of workplace environment. • Personal sampling gives airborne dust concentration of breathing zone of the worker. • Dust sampler should be properly maintained and systematically calibrated.	*2+2+2+ 2*

Impact of dust on human system

- Dust of any kind when inhaled in large quantities lead to the development of respiratory diseases such as chronic bronchitis and pneumoconiosis.
- Pneumoconiosis is a generic term used for occupational lung disease due to dust.
- Overexposure to coal dust in coal mines may cause coal workers' pneumoconiosis (CWP) or "Black Lung," and increases the risk of death from lung cancer and cardiopulmonary diseases.
- Radiographic examination reveals the coal plaques as block spot in the chest X-rays.

a) Prevention of production of dust:

Operation	Preventive Measures
1. Drilling	(a) Using sharp bits (b) maintaining high thrust at a low rotational speed.
2. Coal Cutting	(a) Using sharp picks, complete set of picks, (b) Cutting speed should be compatible with advance of the machine, (c) Provision and use of gummer.
3. Blasting	(a) Controlling the pattern of holes, quantity and strength of explosives (b) No. of blastings to be kept down to the minimum (c) Confining shot firing to relatively idle periods
4. Coal transport/handling	During transport and at transfer points, keeping coal bunkers full, minimizing spillage
5. Roof control	Reducing crushing of pillars, thereby reducing production of dust.

Sl. No.	Type of Dust	Permissible concentration mg/m³	Country
1.	Dust containing more than 70% free silica	1.0	Russia
2.	Dust containing 10 to 70% free silica	2.0	
3.	Coal dust containing less than 10% free silica	4.0	Russia
4.	Coal dust containing no free silica	10.0	
5.	Stone drivages which have more than 50% stone in cross sectional area of the face.	3	U.K
6.	Production faces, coal drivages and transfer points	8	
7.	Average concentration of respirable dust with free silica content less than 5%	~~3~~ 2 (10/%.f.s) >5%.f.s	India circular No.16 1975

3 How is the functioning of stone dust barriers different from that of stone dusting in underground mine workings? What steps would you take to make them effective? 4+4

Solution:

Stone dust barriers

- Stone dust barrier is a device which uses the dynamic pressure of explosion to release and disperse a mass of stone dust in the form of thick cloud into the path of an on-coming explosion flame thereby smothering the flame.
- The shelf barrier consists of a no. of dust-laden shelves.
- Independently supported transverse to and along the roadway in which it is installed.

Failure of stone-dust barrier

- When the barrier itself lies in a flammable firedamp-air mixture or firedamp occurs as a layer at the roof
- When flame velocities are high (more than 500 m/s) as when an explosion is initiated by a powerful firedamp explosion.
- When the barrier is located less than 40-60 m or far from a face or other potential point of ignition so that the dynamic pressure is less than the min. required and normally lies between 3-5 Kn/m^2.
- When an explosion is initiated by a weak ignition source and sufficient dynamic pressure is not built up.

Stone dust application

- It consists of applying stone dust on the sides, roof, and floor of all mine workings except those within 10 m or less of all working faces so that it overlays the deposited coal dust and thus prevents the latter from being ignited or taking part in an explosion.
- Stone dust can be applied by hand or mechanical means using stone dusting machines.
- Intimate mixing of SD and CD is very important. SD is expected to prevent initiation and propagation of explosion, though in practice SD is found to be more effective in preventing an explosion rather than preventing propagation.
- Stone dusting can be applied onto mine surfaces through tubing or hose of up to 200 m long.

Characteristics of suitable stone dust:

- Absorption of heat
- Screening of inflammable particles from radiant heat
- Fineness
- It should not be hygroscopic so that it does not cake.
- Dispersibility: Should be readily dispersible into the air when blown by mouth or by suitable appliance.
- Combustible matter present
- It should be soluble in the fluids of the lungs.
- It should be as light in colour as possible and preferably white.

Steps to be taken to make SDing effective

- SD and CD must be in intimate admixture
- Top layer of SD should be dry.
- Inert dust stored in the mine has to be changed if it is not dispersible or when coated with CD.
- When the make of CD is heavy, removal of mine dust is necessary before applying SD.
- The incombustible dust present should satisfy the statute (75% to 85%)

Steps to be taken to make SDB effective

- The efficiency of a stone dust barrier depends on the time interval between dust discharge and flame arrival which depend upon
  - The design and location of the barrier.
  - Presence of firedamp-air mixture and

		➢ Intensity of explosion • A time interval of 0.1 to 0.2 s is sufficient enough to create a flame-quenching cloud.	
	4	The following gives the working history of a miner at a copper mine:	2+2+2+2

Nature of work	Number of months worked	Average dust production in the respirable size range (mg/m^3)	Percentage of free silica in the respirable dust
Drilling	39	1.8	5.6
Mucking	48	2.4	8.2
Drill shop	85	0.9	4.8
Surface	72	0.4	0.5

Calculate cumulative dust dosage as well as his average dust exposure of the miner. Assume 150 working hours in a month. Estimate the exposure to dust hazard of the miner. Also find the factor of safety in dust exposure of miner according to the norm.

Solution:

cumulative dust dosage = (39*1.8+48*2.4+85*0.9+72*0.4)*150 = 43605 mg h m^{-3}

Average dust exposure =
43605/[(39 +48+85+72)*150] = 1.19 mg/m^3

Average free silica percentage
=
(39*1.8*5.6+48*2.4*8.2+85*0.9*4.8+72*0.4*0.5)/(39*1.8+48*2.4+85*0.9+72*0.4) = 5.91%

TLV = 10/5.91 = 1.69

The factor of safety = 1.69/1.19 = 1.42

End of the Question Paper