Odd-Semester Examinations – 2011-12

V SEMESTER B.E. (MINING ENGINEERING)

Subject: MN501 Mine Ventilation Engineering

Full Marks: 70 Time Allowed: 3 hours

Attempt Question no. 1 and any four from the rest

1. The schematic ventilation network diagram shown in Figure-1 depicts a mine with a downcast and an up-cast shaft having six branches and a fixed-head fan generating a pressure of 1500 Pa. The resistance values of the branches are as below:

Branch	Resistance (Ns^2/m^8)
1-2	0.5
1-3	1.0
2-3	1.0
2-4	4.0
3-4	3.0
4-1	0.3

Formulate a solution scheme to find the volume of air flow (in m^3/s) in each branch by applying Hardy Cross method of network analysis.

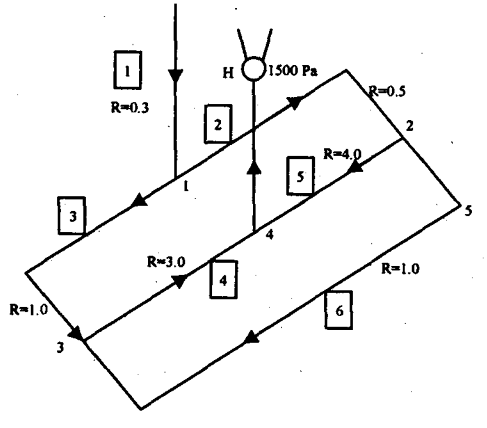

Figure-1: Mine Ventilation Schematic for Question No. 1

State clearly the steps to be followed for solving the network. Draw a simplified network showing the minimal spanning tree. Perform one iteration using the following initial values:

Branch	Assigned Flow (m^3/s)
3-4	17.94
2-5-3	3.79
2-4	15.59

Comment on the corrected values of flow in the network after the first iteration. (18)

2. a) State Poiseuille's equation for pressure loss in steady laminar flow through ducts.
   b) State Chezy-Darcy pressure law applicable to turbulent fluid-flow in ducts. Elucidating the concept of equivalent hydraulic diameter show how Atkinson's equation for flow through mine airways can be derived from the Chezy-Darcy

pressure law.

c) State the square law for airflow through mine openings. Is the square law for airflow through mine openings applicable for airflow calculation in low volume leakage paths in underground mines? Justify your answer. (2+7+4=13)

3. a) Elucidate the phenomenon of pressure loss due to obstructions immersed in the flow path of a fluid having turbulent flow and give an equation for determining static pressure loss (ΔP) due to an immersed body placed in an airway of cross section A when the airflow is turbulent in nature. How the equation can be changed to account for obstructions placed at regular intervals in a mine airway?

b) A mine shaft, 6m in diameter and 300m deep, is fitted with buntons at interval of 3m. The buntons are of I section, 200mm X 150mm in size, and are installed in middle of the shaft with web parallel to the axis. If air velocity in the shaft is $6ms^{-1}$, calculate air loss across a bunton and the total pressure loss in the shaft due to the buntons.

Explain any relationship equation you use. Assume drag co-efficient, $C_D = 2.75$. State clearly any other assumption made. (7+6=13)

4. a) Draw an outlet vector diagram of a backward bladed centrifugal fan depicting, amongst other things, the following:
   (i) peripheral speed (U) of blade tip;
   (ii) peripheral component of fluid velocity (C_u);
   (iii) Radial component of fluid velocity (C_m); and,
   (iv) Vane angle (β)

b) Using the vector diagram drawn, derive a relationship equation to express β in terms of U, C_u and C_m.

c) Using the Euler's equation for centrifugal impellers find expressions for theoretical pressure volume relationships and using those relationships draw theoretical pressure volume characteristics curves for (i) forward bladed (ii) radial bladed and (iii) backward bladed centrifugal curves.

d) Also draw corresponding power-volume theoretical characteristics.

e) Draw an actual pressure-volume characteristic curve for a backward bladed centrifugal fan and discuss the reasons why the actual characteristic curve differs from the theoretical one. (2+1+3+2+5=13)

5. a) The fan-drift air pressures at two speeds of a mine fan were found to be 500 Pa and 550 Pa respectively. If the air quantities in the fan-drift at these two speeds were measured as 70 m^3/s and 73 m^3/s respectively, calculate the NVP of the mine.

b) A pressure of 490 Pa is absorbed by an airflow of $40m^3/s$ passing through a 4m diameter shaft. Calculate the flow of air in the shaft if its diameter is enlarged to 6m, assuming that the pressure drop across the shafts remains unchanged. Also calculate the pressure drop in the enlarged shaft if the flow is maintained at $40m^3/s$. (6+7=13)

6. a) What is a booster fan? What rrestrictions on installation of booster fans are imposed in the Coal Mines Regulations, 1957? What, in your opinion, are the reasons for imposing such restrictions?

b) Two ventilation districts 'A' and 'B' of a mine are connected in parallel. The resistances of 'A' and 'B' are 1.47 Ns^2/m^8 and 2.45 Ns^2/m^8 respectively. Combined

resistance of the shafts and trunk airways is 0.78 Ns^2/m^8. Exhausting pressure generated by the main mechanical ventilator is 736 Pa. Calculate the critical pressure of a booster fan to be installed in district 'B'.
Assume that the main fan pressure remains constant. (6+7=13)
[Hint: at critical pressure there will be complete stoppage of flow in district 'A'.]

7. a) Write a brief note on the standards of ventilation stipulated in the Coal Mines Regulations, 1957.

   b) Define the following terms in relation to the Coal Mines Regulations, 1957:
      i. Auxiliary fan;
      ii. Gassy seams of the third degree;
      iii. General body of air. (7+6=13)

8. a) State the criteria for selection of ventilation survey station. What is preferably the timing of ventilation survey and why?

   b) Discuss the moving traverse and fixed point methods of ventilation survey for measuring air quantity. (5+8=13)

9. a) A fan operating at 740 Pa and 375 rpm circulates 19 m^3/s of air. At what speed should this be run to circulate 22 m^3/s of air? Calculate the fan pressure and air h.p. at the new speed of the fan.

   b) A mine is ventilated by a fan producing 70 m^3/sec at 490 Pa. The fan is driven by a belt drive at a speed of 300 rpm. Electrical input to the motor under these conditions is 60 kW. The motor driving the fan is rated at 75 kW on motor shaft, motor efficiency being 90%. It is desired to increase the quantity of air flow by increasing the speed of the fan by changing the motor pulley. Calculate:
      (i) maximum speed at which the fan can be run without overloading the motor;
      (ii) volume of air that will flow at the new speed (neglect natural ventilating effect);
      (iii) Fan pressure at the new speed. (6+7=13)