Odd-Semester Examinations – 2013-14

V SEMESTER B.E. (MINING ENGINEERING)

Subject: MN503 Mine Ventilation Engineering

Full Marks: 70 Time Allowed: 3 hours

Attempt question no. 1 and any four from the rest. Figures in the parentheses indicate marks. All parts of a question must be answered at the same place. Use of graph paper is permissible.

1. For the purpose of designing a circular ventilation shaft, the following data were used:

Shaft sinking:

- Equipment set up and decommissioning costs = Rs40,950,000
- Excavation cost = Rs18270/m
- Fittings and lining cost = Rs28980/m

Physical data:

- Depth of shaft, L = 700 m
- Effective coefficient of friction, f = 0.01
  (friction factor $k = 0.6f = 0.006$ kg/m^3)
- Mean air density, ρ = 1.12 kg/m^3
- Airflow, Q = 285 m^3/s
- Fan efficiency(overall), η = 0.65
- Life of shaft, n = 15 years

Additional financial data:

- Annual rate of interest, i = 10 per cent
- Average cost of electrical power e = Rs 6.33 per kWh

a) Establish the capital cost function (P_c) for sinking the shaft and determine the equivalent annual cost (EAC) of shaft sinking

b) Establish the operating cost (energy cost) function and determine the annual operating cost S_0 to be incurred for causing the airflow through the shaft

c) Establish the total annual cost and then determine, by analytical method, the optimum diameter D_o of the ventilation shaft

[5+4+5=14]

2. Keeping the statutory provisions in view, write brief notes on any two of the following in relation to sub-surface ventilation in underground coal mines:

   a. Standard of ventilation

   b. Minimum velocity of air current to be maintained at various places while working a gassy seam of the third degree. Comment on the practicality of the provision in relation to a mechanized longwall face producing 1500 tonnes of coal per day.

   c. Air quantity required in blind headings driven by drilling and blasting.

[7x2=14]

3. Figure 1 is the schematic of a complex network and gives the resistance of each branch. A fan produces a constant total pressure of 2000 Pa and the airflow in branch 3 is to be regulated to a fixed airflow of 10m^3/s.

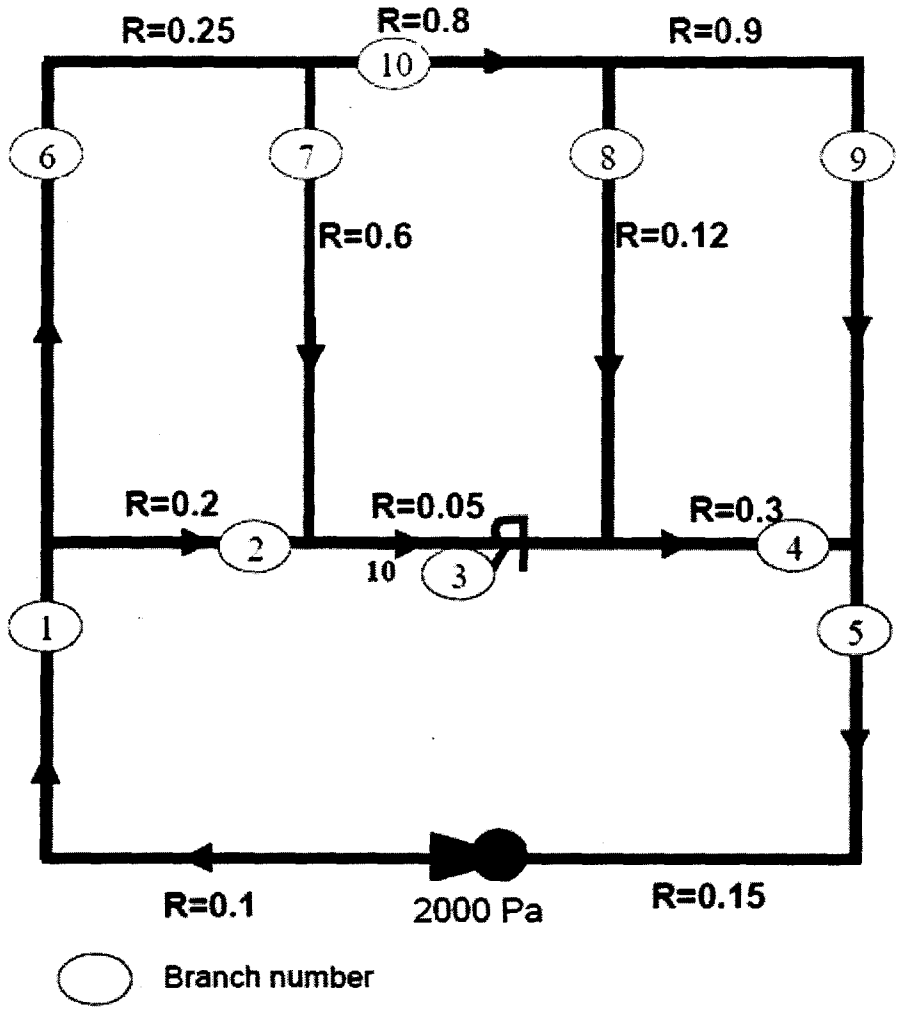

Figure 1. Network showing branch numbers, airway resistances and booster fan pressure

Clearly stating the logic and arguments, describe the steps you will follow to determine, by Hardy-Cross method, the distributions of airflows, frictional pressure drops, and the resistance of the regulator required in branch 3. Proceed upto formation of the initial Hardy Cross tableau and state the procedure for solving it but you need not actually solve the network. [14]

4. a) A pressure of 500 Pa is absorbed by an airflow of $50m^3$/ sec passing through a 5m diameter shaft. Calculate the flow of air in the shaft if its diameter is enlarged to 7m. 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 $50m^3$/ sec.

   b) Two sets of ventilation ducts carry air at the same velocity. One duct has a diameter of 1000mm. What is the diameter of the other duct if the quantity passing is 36% less than that in the 1000mm duct? [8+6=14]

5. An axial flow fan is fitted with inlet guide vanes to give a counter swirl to the air at inlet to the rotor. In order to ensure that the air at exit from the rotor is axial, the amount of counter swirl is made equal to the drag velocity. Using suitable sketches and vector

diagrams derive an expression to calculate the total theoretical pressure developed by the fan. [14]

6. A centrifugal fan under test, running at constant speed, gives the following results –

Volume (m^3/min)	1000	2000	3000	4000	5000	6000
Pressure (mm w-g)	104	116	114	104	88	55

Find the volume of air delivered by the fan and the w-g produced by it when the mine resistance changes from 0.02 to 0.03 weisbach. [14]

7. a) Two connected shafts are 1200 m deep. The downcast shaft average temperature is 12.8°C, the upcast shaft air temperature is 26.7°C. Calculate the NVP in Nm^{-2} as well as in metres of motive column of air. Barometer reading at the shaft collar is 94.817 kPa. Neglect vapour pressure in the shafts.

   b) A mine is ventilated by a fan producing 70 m^3/sec at 5 cm w-g. 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 100 hp 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) w-g at the new speed. [7x2=14]

8. a) What is the best way to increase air-flow in a mine? Justify your answer with mathematical reasoning.

   b) Three equal air splits are put first in series and then in parallel. Calculate the savings in energy (in percentage terms) when the splits are in parallel compared to when they are in series if pressure across the splits remains unchanged. [6+8=14]

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

   b) Discuss what the moving traverse and fixed point methods of measuring air quantity are. [5+9=14]