MEBS7014 Advanced HVAC Applications

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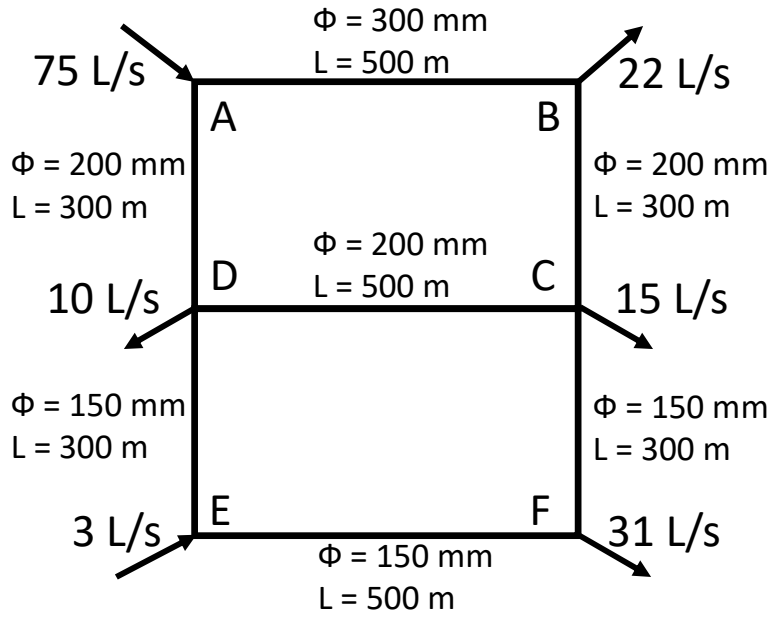
Assignment 01 – Fluid Network Analysis, Fans & Pumps, and Space Air Diffusion (2024-2025)

1. Fluid Network Analysis

1.1 Two water tanks are connected by a pipeline which is 150 mm in diameter for the first 6 m and 225 mm in diameter for the remaining 15 m. The water surface in the upper tank is 6 m above that in the lower. By applying continuity equation and Bernoulli's equation and neglecting any minor losses, calculate the rate of flow in m^3/s. Friction coefficient f is 0.04 for both pipes.

(14 marks)

1.2 For a water distribution network shown below, calculate the head losses and the corrected flows in the various pipes using Hardy-cross method with Hazen-William Equation. The diameters and the lengths of the pipes used are given against each pipe. Compute the corrected flows after two corrections.

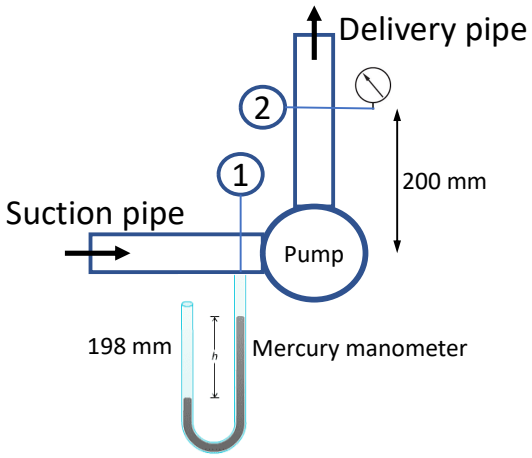


(20 marks)

2. Pumps and Fans

2.1 A centrifugal pump has a 100 mm diameter suction pipe and a 75 mm diameter delivery pipe. When discharging 20 L/s of water, the inlet water mercury manometer with one limb exposed to the atmosphere recorded a vacuum deflection of 198 mm; the mercury level on the suction side was 100 mm below the pipe centerline. The delivery pressure gauge, 200 mm above the pump inlet, recorded a pressure of 0.95 bar. The measured input power was 3.1 kW. Calculate the pump efficiency.

(15 marks)



2.2 A centrifugal supply air fan is being run at a speed of 1800 RPM to deliver the required system air flow of 1600 L/s. The fan total pressure rise at this air flow is 360 Pa. The inlet air to the fan does not encounter the heat emitted from the drive motor. The overall fan efficiency is 60% and this includes the losses in the impeller and the fan casing. Air enters the fan at 20 °C dry bulb. Estimate the temperature of the supply air as it leaves the fan and comment on the result.

(18 marks)

3. Space Air Diffusion

3.1 Suggest suitable airflow patterns and air distribution strategies for the following applications. Explain their characteristics and principles with sketch diagrams.

(a) A large indoor stadium for sports events (such as badminton)
(b) A clean room for pharmaceutical industry

(8 marks)

3.2 Explain the advantages and disadvantages of underfloor air distribution (UFAD). Discuss the major design factors of UFAD in commercial buildings.

(12 marks)

3.3 A room with dimension 12 m by 10 m and height 3.5 m is ventilated by a supply air flow rate of 600 L/s. Calculate the air exchange rate and the time constant of the supply air. If the age of air is found out to be 12 minutes, calculate the air change effectiveness of the system. Comment on the performance of the air distribution system.

(13 marks)