

Department of Energy Science and Engineering  
IIT Bombay  
EN 222: Fluid Mechanics and Heat Transfer  
Graded tutorial sheet

1. Water flows from A to D and E through the series pipeline. Given the pipe diameters, velocities and flow rates below, calculate the values of the unknowns.

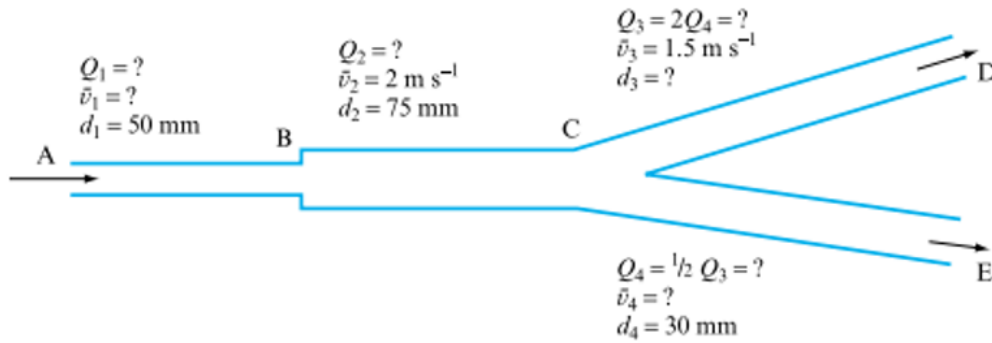


Figure 1: Problem 1

2. In a 0.6 m diameter duct carrying air the velocity profile is given by the following equation.  $u$  (m/s) is the velocity at radius  $r$ . Calculate the volume flow rate of air and the mean velocity.

$$u(r) = 5r^2 - 0.45 \quad (1)$$

3. According to indoor air quality norms, at least 8.0 lps of fresh air needs to be supplied per person (student and instructor) in a classroom. Consider 6 classroom, each with capacity of 40 students. You are asked to design an air supply unit. Air enters through a central duct and leaves through short branches leading into individual rooms.

Branch registers are 200 mm high and 500 mm wide. Calculate the volume flow rate and the velocity through the branches.

Noise increases as the velocity increases. Determine the height of the supply duct if the width is 500 mm and the velocity needs to be restricted at 1.75 m/s.

4. Oil (sp gr. 0.8) flows through the reducer at a rate of  $0.1 \text{ m}^3/\text{s}$ . Assume that the velocity is uniform across the entry and exit cross-section of the reducer. Determine the force needed to hold the reducer in place.

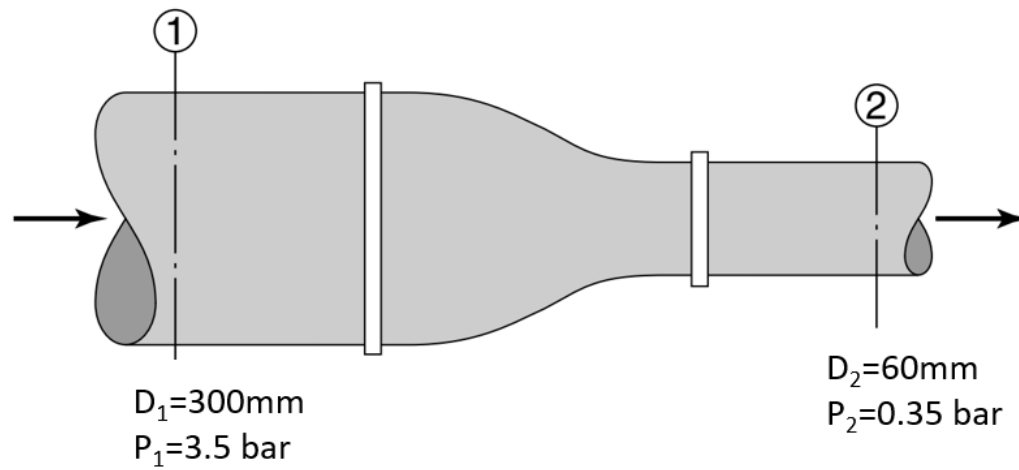


Figure 2: Problem 4

5. In a laboratory experiment, the water flow rate is to be measured catching the water as it vertically exits a pipe into an empty open tank that is on a zeroed balance. The tank is 10 m directly below the pipe exit, and the pipe diameter is 50 mm. One student obtains a flow rate by noting that after 60 s the volume of water (density  $1000\text{ kg/m}^3$ ) in the tank was  $2\text{ m}^3$ . Another student obtains a flow rate by reading the instantaneous weight accumulated of 3150 kg indicated at the 60 s point. Find the mass flow rate each student computes. Why do they disagree? Which one is more accurate? Show that the magnitude of the discrepancy can be explained by any concept you may have.