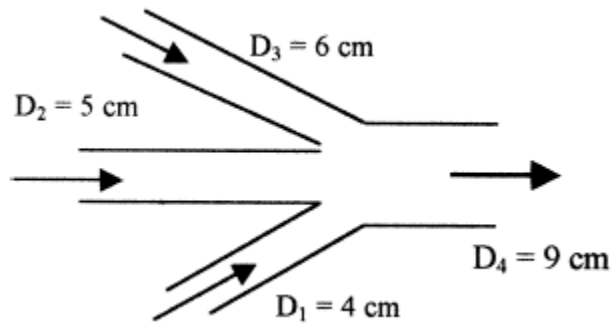NAME

Fluids-ID

Quiz 6. Three pipes steadily deliver water to a large exit pipe in Figure. The velocity V_2=5 m/s, and the exit flow rate Q_4=0.0333 m³/s. Find V_1, and V_3 if it is know that increasing Q_3 by 20% would increase Q_4 by 10%.

Note: Attendance (+2 points), format (+1 point)

Solution:
Continuity eq. for fixed CV with 1D flow and discrete CS's,
$$0 = \sum \dot{m}_{out} - \sum \dot{m}_{in}$$ (+4 points)

Where $\dot{m} = \rho Q = \rho V A$, thus
$$0 = (\rho Q_4) - (\rho V_1 A_1 + \rho V_2 A_2 + \rho V_3 A_3)$$

Or
$$0 = Q_4 - (V_1 A_1 + V_2 A_2 + V_3 A_3)$$ (+1 point)

Since 0.2Q_3=0.1Q_4
$$V_3 = \frac{Q_4}{2A_3} = \frac{0.0333}{\frac{\pi}{2}0.06^2} = 5.89 \frac{m}{s}$$ (+1 point)

Substituting V_3
$$0 = 0.0333 - \left(V_1 \frac{\pi}{4}0.04^2 + 5\frac{\pi}{4}0.05^2 + 5.98\frac{\pi}{4}0.06^2\right)$$

Solving for V_1
$$V_1 = 5.43 \frac{m}{s}$$ (+1 point)