057:20 **TEST # 2** **Fall 2004**

Prob. 1

Information and assumptions

Provided in problem statement

Find

Pressure change between circular and square section

Solution

First write the continuity equation between the duct sections:

$$V_c A_c = V_s A_s$$ (Eqn. = 2)

$$100\left(\pi D^2/4\right) = V_s D^2$$

$$V_s = 100\left(\pi/4\right) = 78.54\ ft/s$$ (Inter. + Ans. = 1)

Bernoulli equation between two sections

$$p_c + \rho V_c^2/2 + z_c = p_s + \rho V_s^2/2 + z_s$$ (Eqn. = 5)

The density is $\rho = \gamma/g = 0.075/32.2 = 0.00233\, slugs/ft^3$

Then

$$p_c - p_s = \left(\rho/2\right)\left(V_s^2 - V_c^2\right)$$

$$= \left(0.00233/2\right)\left(78.54^2 - 100^2\right)$$

$$= -4.46\, lbf/ft^2$$ (Inter. + Ans. = 2)

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Prob. 2

Information and assumptions

Provided in problem statement

Find

x-component of force to hold wye in place

Solution

Velocity and flow rate calculations

$$v_1 = Q_1/A_1 = 20\ ft/s$$ (Inter. + Ans. = 1)

$$v_2 = Q_2/A_2 = 12\ ft/s$$ (Inter. + Ans. = 1)

$$Q_3 = 20 - 12 = 8\ ft^3/s$$

$$v_3 = Q_3/A_3 = 32\ ft/s$$ (Inter. + Ans. = 1)

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x-momentum

$$\sum F_x = \dot{m}_2 v_2 + \dot{m}_3 v_3 \cos 30^o - \dot{m}_1 v_1$$ (Eqn. = 5)

$$F_x + p_1 A_1 - p_2 A_2 = (12\rho)(12) + (8\rho)\left(32\cos 30^o\right) - (20\rho)(20)$$

$$F_x + (1000)(1) - (900)(1) = (144\rho) + (221.7\rho) - (400\rho)$$

$$F_x = -100 + 1.94(-34.4)$$

$$F_x = -166.5 lbf$$ (acting to the left) (Inter. + Ans. = 2)

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Prob. 3

Information and assumptions

Provided in problem statement

Find

Power pump must supply

Solution

Velocity calculation

$$V = Q/A = 0.25/\left(\left(\pi/4\right)\times 0.3^2\right) = 3.54\,m/s$$

$$V^2/2g = 0.638m$$

(Inter. + Ans. = 2)

Write energy equation from reservoir surface to 10m elevation

$$0+0+6+h_p = 100,000/9810 + V^2/2g + 10 + 2.0V^2/2g$$

(Inter. + Ans. = 6)

$$h_p = 10.19 + 10 - 6 + 3.0\times 0.638$$

$$h_p = 16.1m$$

(Inter. + Ans. = 1)

$$P = Q\gamma h_p = 0.25\times 9810\times 16.1 = 39.5kW$$

(Inter. + Ans. = 1)

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Prob. 4

Information and assumptions

Provided in problem statement

Find

Entry velocity of water

Solution

$$\mathrm{Re}_m = \mathrm{Re}_p$$

$$\frac{V_m L_m}{\nu_m} = \frac{V_p L_p}{\nu_p}$$

(Inter. + Ans. = 7)

$$V_m = \left(\frac{L_p}{L_m}\right)\left(\frac{\nu_m}{\nu_p}\right)V_p$$

$$= \left(\frac{10}{1}\right)\times\left(\frac{10^{-6}}{4\times10^{-5}}\right)\times(10)$$

(Inter. = 2)

$$= 2.5\, m/s$$

(Ans. = 1)
