57:020 TEST # 2 Fall 2006

1. Determine the magnitude and direction of the anchoring force needed to hold the horizontal elbow and nozzle combination shown in the Figure in place. The gage pressure at section (1) is 100 kPa. At section (2), the water exits to the atmosphere. Water density is $999 kg/m^3$.

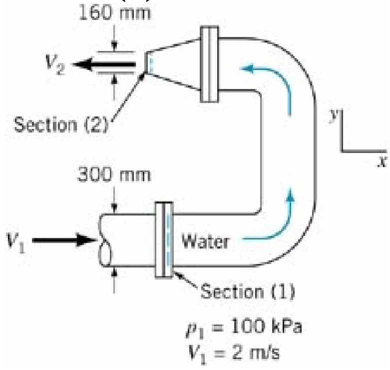

Figure 1 (for Problem 1)

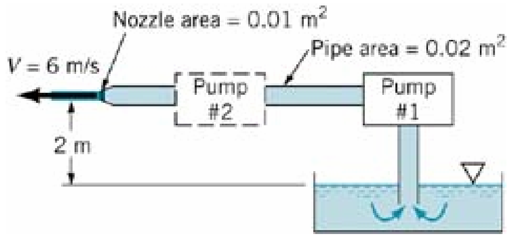

Figure 2 (for Problem 2)

2. Water is to be pumped from the large tank shown in the Figure with an exit velocity of 6 m/s. It was determined that the original pump (pump 1) that supplies 1 kW of power to the water did not produce the desired velocity. Hence, it is proposed that an additional pump (pump 2) be installed as indicated to increase the flowrate to the desired value. How much power must pump 2 add to the water? The head loss for this flow is $h_L = 250Q^2$, where h_L is in m when Q is in m^3/s. Water density is $999 kg/m^3$.

3. Oil (SAE 30) flows between parallel plates spaced b=5 mm apart. The bottom plate is fixed, but the upper plate moves with a velocity of U=0.2 m/s in the positive x direction. The pressure gradient is 60 kPa/m, and it is negative, i.e., $\frac{\partial p}{\partial x} = -60\,kPa/m$. Assume laminar flow. The velocity distribution is given by $u = U\frac{y}{b} + \frac{1}{2\mu}\left(\frac{\partial p}{\partial x}\right)\left(y^2 - by\right)$. The dynamic viscosity of SAE30 oil is $0.38 Ns/m^2$ (a) Calculate the velocity at y=2.5mm. (b) Calculate the shear stress on the bottom plate.

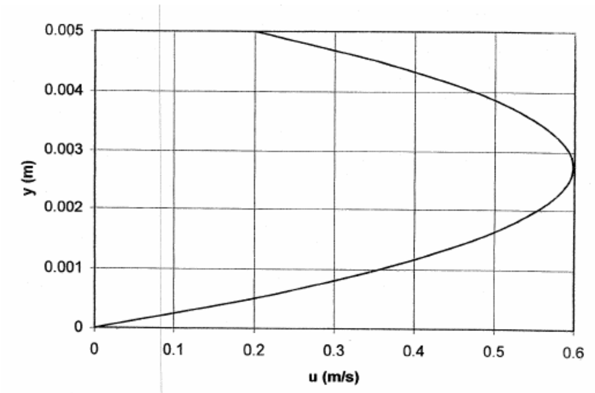

Figure 3 (for Problem 3)

4. River models are used to study many different types of flow situations. A certain small river has an average width and depth of 60 ft and 4 ft, respectively, and carries water at a flowrate of $700\ ft^3/s$. A model is to be designed based on Froude number similarity so that the discharge scale is 1/250. At what depth and flowrate would the model operate?