EXAM #1 October 6, 2008

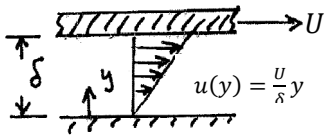
1. A 25-mm-diameter (D) shaft is pulled through a cylindrical bearing (L = 0.5 m) as shown in Fig. 1. The lubricant that fills the 0.3-mm gap (δ) between the shaft and bearing is an oil having a kinematic viscosity of 8.0 $\times$ 10^{-4} m^2/s and a specific gravity of 0.91. Determine the force P required to pull the shaft at a velocity U of 3 m/s. Assume the velocity distribution in the gap is linear (See sketch below).

   Hint) $P = \tau \cdot A$

   τ : Shear stress

   $A = \pi DL$: contact area

   $\rho_{H_2O@4°C}$ = 1000 Kg/m^3



2. A homogeneous, 4-ft-wide, 8-ft-long rectangular gate weighing 800 lb is held in place by a horizontal flexible cable as shown in Fig. 2. Water acts against the gate which is hinged at point A. Friction in the hinge is negligible. Determine the tension, T, in the cable.
   (Hint: γ = 62.4 lb/ft^3 for water; $I_{xc} = ab^3/12$ for a rectangle with base a and height b)

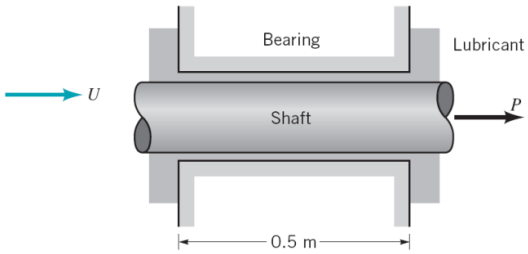


Figure 1

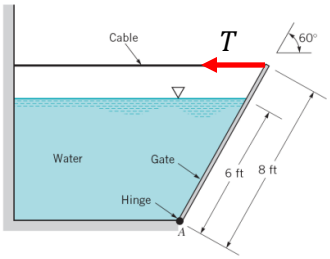


Figure 2

3. The specific gravity of the manometer fluid shown in Fig. 3 is 1.07. Determine the volume flow rate, Q, if the flow is inviscid and incompressible and the flowing fluid is gasoline.
   (Hint: γ_{water} = 9.80 kN/m^3; $\gamma_{gasoline}$ = 6.67 kN/m^3)

4. Consider a sphere of radius R = 1m immersed in a uniform stream U_0 = 1 m/s, as shown in Fig. 4. According to a theory, the fluid velocity along streamline AB is given by

$$\underline{V} = u\hat{\imath} = U_0(1 + R^3/x^3)\hat{\imath}$$

   Find the fluid acceleration at $x = -2R$.

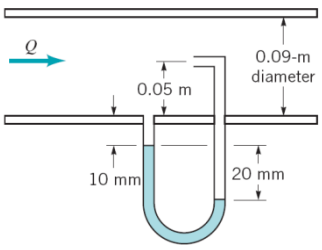


Figure 3

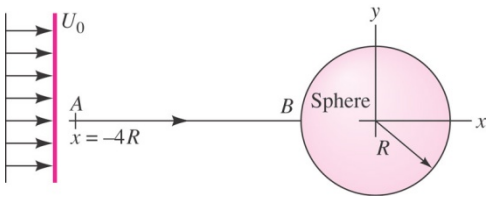


Figure 4