EXAM #2 November 12, 2007

1. A 10-cm fire hose with a 3-cm nozzle in Fig. 1 discharges 1.5 m^3/min to the atmosphere. Assuming frictionless flow, find the force F_B exerted by the flange bolts to hold the nozzle on the hose. (ρ_{water} = 998 kg/m^3)

2. Water is to be moved from one large reservoir to another at a higher elevation as indicated in Fig. 2. The loss of available energy associated with 2.5 ft^3/s being pumped from sections (1) to (2) is $61\bar{V}^2/2$ ft^2/s^2, where $\bar{V}$ is the average velocity of water in the 8-in. inside piping involved. Determine the amount of shaft power required $\dot{W} = \dot{m}w_s$.
(ρ = 1.94 slugs/ft^3, g = 32.2 ft/s^2, 1 lbf = 1 slug·ft/s^2, 1 hp = 550 lbf·ft/s = 550 slug·ft^2/s^3)

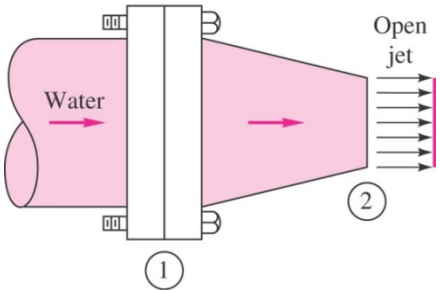

Figure 1

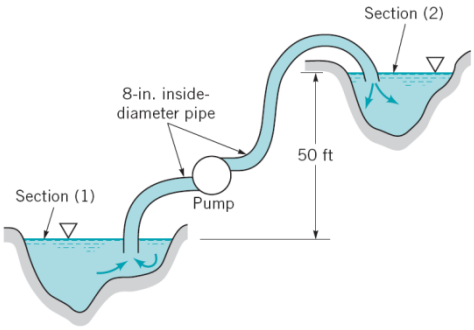

Figure 2

3. A viscous, incompressible fluid flows steadily between the two fixed, infinite, horizontal, and parallel plates as shown in Fig. 3. The flow is fully developed and laminar. (a) Determine an expression for the velocity distribution between the plates by use of the Navier-Stokes equations. (b) What is the maximum velocity u_{max} if the fluid is Oil (SAE 30) at 15.6°C, the pressure drop per unit length along the channel is 20 kPa/m, and the distance between the plates h is 4 mm. (μ_{oil} = 0.38 N·s/m^2)

4. Assume that the drag force D on a small sphere of diameter d placed in a rapidly moving stream of fluid as shown in Fig. 4 depends on the fluid density ρ but not the fluid viscosity. Use dimensional analysis to determine how the drag is affected if the velocity U of the fluid is doubled.

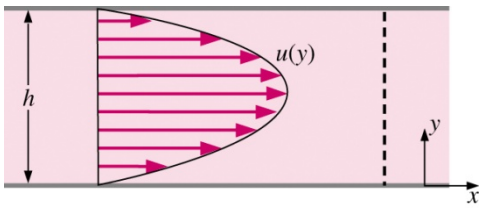

Figure 3

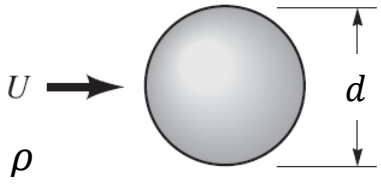

Figure 4