CENG101A: Introductory Fluid Mechanics Fall Quarter 2006
http://maecourses.ucsd.edu/mae210a

Homework IV.

Due *Friday October 20, 2006*, in fourth hour.

Read: Chapters 7 and 8

Problems:

1. Water is heated through a horizontal pipe with constant diameter D. The pressure gradient along the pipe $\mathrm{d}P/\mathrm{d}z$ is constant and the (average) velocity is $-(\mathrm{d}P/\mathrm{d}z)R^2/8\mu$. If the water does not change temperature, what is the head added or removed from the water over a length L of pipe? If the pipe is insulated, what is the temperature change over a length L of pipe?

2. Hoover Dam is 726 feet high and has a power generating capacity of 2.8 million kW. Assuming that the efficiency of conversion from potential energy to electrical energy is 80%, what is the flow rate?

3. The Fountains of Bellagio[1] have 1,200 water jets that can project water 240 feet in the air. What is the velocity of a jet at its base?

4. A water clock is axisymmetric with profile $r = h(z)$. Determine the function $h(z)$ so that the downward velocity of the water surface is constant in time. [This is a desirable property for a water clock.]

5. A block is dragged along a layer of fluid. Derive the force needed in terms of the area of the bottom of the block A, the viscosity of the fluid μ and the thickness of the layer d. [Assume a linear velocity distribution in the fluid.]

Quiz II: The second quiz will be on Friday October 20. The exam will be closed book and will cover the material from chapters 3–6.

Comments:

Chapter 7 introduces viscosity. Viscosity enters the constitutive equation for fluids. The fluids that we study will obey equation (7-4) (in appropriate generalized form). This equation is a mathematical description of the definition of a fluid – **a substance that deforms continuously when acted on by a shear stress** – for Newtonian fluids. Shear stress is a force per unit area, like pressure, but it acts parallel to the surface in the direction of fluid motion.

Chapter 8 looks at simple one-dimensional fluid flows including viscosity. The full equations of motion will be derived in Chapter 9.

[1] `http://www.wetdesign.com/client/bellagio`