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

Homework V.

Due *Friday October 27, 2006*, in fourth hour.

Read: Chapter 9

Problems:

1. Write a paragraph on Bingham fluids. (Use the Internet or the library for information. Be sure to acknowledge your references.)

2. If the speed of shaft is halved in Ex (7.7) from class, what will be the percentage decrease in the heat transferred from the bearing? Assume that the bearing remains at constant temperature.

3. Compute the nine components of the stress for the velocity field $\mathbf{u} = (3x - y^2, 2z + \cos t, -3z + Ax^2)$ and pressure field $p = -3z^2 + 2y + 1$. Does the value of the bulk stress depend on A?

4. A non-Newtonian fluid with $\tau_{rx} = \mu^*(\mathrm{d}v_x/\mathrm{d}r)^3$ flows down a pipe with radius a. If the flow is fully developed, find the velocity profile and the average velocity in terms of the pressure drop $\mathrm{d}P/\mathrm{d}x$.

5. Fluid flows between two parallel plates separated by a distance h: the lower is at rest, the upper has velocity U, and there is a constant background pressure gradient $\mathrm{d}P/\mathrm{d}x$. Find the relation between U and $\mathrm{d}P/\mathrm{d}x$ so that the average velocity is zero.

Comments:

There are a variety of notations for the stress tensor. The book uses σ for normal stresses and τ for shear stresses. In suffix notation I will write the whole stress tensor as $\sigma_{ij} = -p\delta ij + \tau_{ij}$:[1] this gives the stress on face i in direction j. The τ_{ij} term is the viscous stress tensor. The diagonal terms include the pressure and viscous normal stresses.

[1] Remember that $\delta_{ij} = 1$ if $i = j$ and 0 otherwise.