Final Exam

1. Substitute the stress tensor (2-27) into the Conservation of Momentum equation (2-19) and verify the form of the Navier-Stokes equation (2-29a).

2. For the suggested non-dimensionalizations (2-83), verify the non-dimensional form of the Conservation of Energy equation (2-85).

3. Determine the steady-state velocity and pressure distributions for Coutte flow between two concentric spheres. The outer sphere is fixed, the inner sphere spins about the z axis with a constant angular velocity.

4. For unsteady duct flow in a circular pipe, employ Szymanski's solution (3-96) to determine and plot u/u_{max} at $t^*=0.2$ using the first five terms in the Bessesl series.

5. For Stokes First Problem of steady fluid oscillation above an infinite plate with boundary conditions of
$$u(0,t) = U_o \cos(wt) \qquad u(\infty,t) = 0$$
and an assumed steady solution of
$$u(y,t) = f(y)e^{iwt}$$
verify that
$$u(y,t) = U_o e^{-h} \cos(wt - h) \qquad h = y\sqrt{w/2u}$$

6. For Heimenz's similarity solution for a jet impinging on a flat plate, employ his definition of the viscous streamfunction $y_{viscous} = Bxf(y)$ in conjunction with continuity and momentum to obtain the dimensional ODE
$$f''' + \frac{B}{u}\left(ff'' - f'^2\right) = -\frac{B}{u}$$