2.20 Marine Hydrodynamics Homework #2(a)
Due: September 29, 2009

Question 1:

In a certain incompressible flow, the velocity field is given by:

$$\begin{cases} u = 4\sin(8x+3y)\,e^{\pi z} \\ v = \alpha\sin(8x+3y)\,e^{\pi z} \\ w = -\cos(8x+3y)\,e^{\pi z} \end{cases}$$

What is the value of the constant α?

Question 2:

1. Are the Euler Equations, which are writen as:

$$\rho\frac{D[v_i]}{Dt} = F_i + \frac{\partial\tau_{ij}}{\partial x_j}$$

   valid for compressible or incompressible flows? Are they valid for Newtonian fluids, Non-Newtonian fluids, both, or neither? Why?

2. The first Kinematic Transport Theorem is valid for:
   (a) All flows
   (b) Incompressible flows only
   (c) Any control volume
   (d) Any material Volume

3. The second Kinematic Transport Theorem is valid for
   - All flows
   - Incompressible flows only
   - Any control volume
   - Any material Volume

4. Solve Ba 20 from the supplemental problems

Question 3: Control Volume Analysis

5.66 from Fund. of Fluid Mech. by Munson, Young, and Okiishi (5^{th} Ed.)

A Pelton wheel vane directs a horizontal, circular cross-sectional jet of water symmetrically as indicated in the figure below. The jet leaves the nozzle with a velocity of 10 m/s. The area of each side of the outlet jet is equal to half that of the inlet area. Determine the x-direction component of anchoring force required to (a) hold the vane stationary, (b) confine the speed of the vane to a value of 2 m/s to the right. The fluid speed magnitude remains constant along the vane surface.