

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

Question 1:

1. Are the Navier-Stokes equations, which are written as:

$$\frac{D[\vec{v}]}{Dt} = -\frac{1}{\rho}\nabla P + \nu\nabla^2\vec{v} + \frac{1}{\rho}\vec{F}$$

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

2. Why is the bulk elasticity (λ) ignored from the Navier-Stokes Equations?

Question 2:

Solve Ba24, B1(incompressible flow) and B7(a-f) from the supplemental problems

Question 3:

Derive the differential form of the conservation of mass equation for a general flow in cylindrical coordinates. The following procedure may be helpful:

1. Draw a differential element.
2. Determine the out flux of mass across the positive surfaces.
3. Determine the in flux of mass across the negative surfaces
4. Collect the terms by showing that the rate of decrease of mass inside the box is equal to the net flux (out flux - in flux) of mass across the surface.

A few hints:

1. It might be helpful to see how continuity is derived in rectangular coordinates.
2. The arc length(L) can be calculated from the radius(r) and internal angle(θ) by $L = r\theta$
3. You will need to use Taylor series to determine the value of the fluxes at the faces.