Homework 3

Due Nov 1, 2006.

1 Repeat the class unsteady emptying tank problem but this time including the change in depth of the water in the tank. Take the area of the tank to be A, the area of the outflow pipe to be a and the initial depth of fluid to be h_0. Identify the nondimensional groups and discuss the nature of the solution (e.g. plot some curves, look at limits).

2 Derive the equation for the surface of an ideal fluid rotating with constant angular velocity Ω under gravity g. Can you use Bernoulli? [The free surface is at constant pressure.]

3 Derive the governing equation for the velocity potential in inviscid isothermal compressible flow. If $\phi = \Gamma\theta/2\pi$ can you find solutions for p and ρ that tend to uniform values at infinity? [Use Bernoulli.]

4 Derive the vorticity equation for inviscid compressible viscous flow. Derive also the governing equation for ω/ρ. Discuss the physical nature of the $\nabla p \times \nabla \rho$ term. What happens if the fluid is barotropic?