AML 160
Major-2008

Time 2 Hours. Attempt all questions. Each carries 10 marks. State all assumptions clearly.

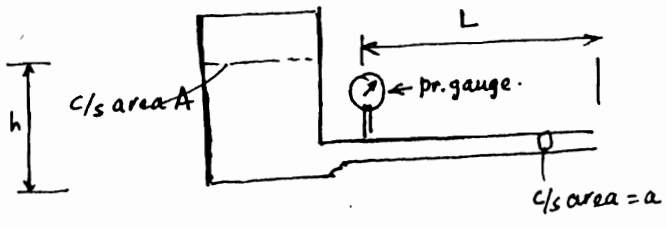
1. The pressure gauge on the pipe shows that the pressure decreases linearly from p_1 to p_2 over time T. At $t=0$, the flowrate is q_0. Determine the amount of water that has flown out of the tank in this time. Assume inviscid, incompressible flow, and that the tank has a large cross sectional area, compared to the cross sectional area of pipe, a.

2. Consider a very small spherical object of radius a moving through a fluid of viscosity μ and density ρ. The Reynolds number $\frac{\rho V a}{\mu} \approx 0$, where V is the velocity of the sphere. We expect that the parameters for this problem are F, V, a, μ and ρ, where F is the drag force on the sphere.
   i. Do you think inertia is important in this problem?
   ii. Based on (i), is $\rho V^2 a^2$ the correct scaling for F? If not, what is the appropriate scaling for the drag force? (hint: pressure drag is zero for this flow)
   iii. Based on (ii), is μ a repeating parameter? Which are the other repeating parameters?
   iv. Determine the two non dimensional parameters (Π groups). The dependent parameter involves F. What is the independent Π group?
   v. Can you determine what is the functional relation between the two Π groups (hint: Since the Reynolds number is nearly zero, it cannot influence the functional form).

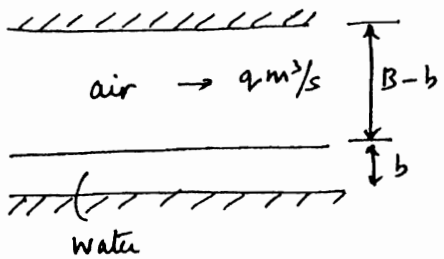
3. Air is being pumped through a long, wide channel at qm^3/s. The height of the channel is Bm. Water is present at the bottom of the channel to a height b. Calculate the flow rate of water, assuming fully developed flow in both air and water.

4. Estimate the power required to drive a raft with floor area of 4m by 4m in still water at 18kmph. The following is known. ρ_{water}=1000kg/m^3.

Boundary Layer	$\frac{\delta}{x}$	C_f
Laminar	$\frac{5.48}{\sqrt{Re_x}}$	$\frac{0.73}{\sqrt{Re_x}}$
Turbulent	$\frac{0.382}{Re_x^{1/5}}$	$\frac{0.0594}{Re_x^{1/5}}$



Problem 1.



Problem 3.