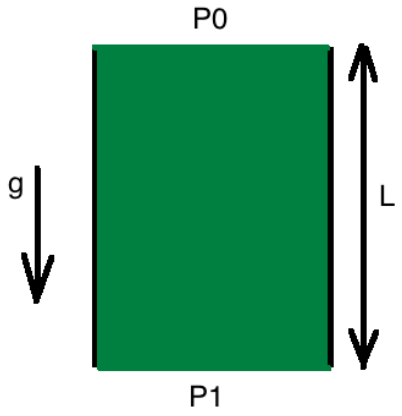
ABE 307
Homework 3
Fall 2017
Assigned: 09/16/17
Due: 09/25/17

1. An oil has a kinematic viscosity of 2 x 10^{-4} m^2/s and a density of 0.8 x 10^3 kg/m3. If we want to have a falling film of thickness of 3 mm on a vertical wall, what should the mass rate of flow of the liquid be? Show all your steps for calculation along with how you arrive at equation for calculating the flow rate of mass. (Hint: In class, we derived the average velocity for a falling film on inclined plane. This problem is based on similar derivation). (15)

2. Consider a liquid of density ρ and viscosity μ flowing downwards between two walls as shown. Consider a section of length L. If the pressure in the liquid varies linearly from P0 at the top, to P1 at the bottom, derive the velocity profile inside the channel assuming the flow to be fully developed. Gravity acts along the downward direction and can be assumed to be g. (15)



3. Consider two immiscible oils of densities ρ_1 and ρ_2 and viscosities μ_1 and μ_2 , respectively. Find the velocity profile in a compound film formed by both oils flowing near a vertical wall as shown below: (20)
   a) Write down the momentum balance for both oils.
   b) What is the boundary condition for velocity at the interface of the two oils?
   c) What is the boundary condition for the shear stress at the interface?
   d) Solve for the velocity profile. Assume gravity to be g acting along the downward direction