

## Midterm 2

## (155) 1. Laminar, Segregated Two-Phase Flow in a Rectangular Duct

Water and air are pumped through a long rectangular duct under the influence of an imposed pressure drop, as shown in Figure 1. The duct extends a width  $W$  ( $W \gg (h_a + h_b)$ ) into the paper. Write all answers in terms of chosen coordinates,  $W$ , and the parameters given in Figure 1.

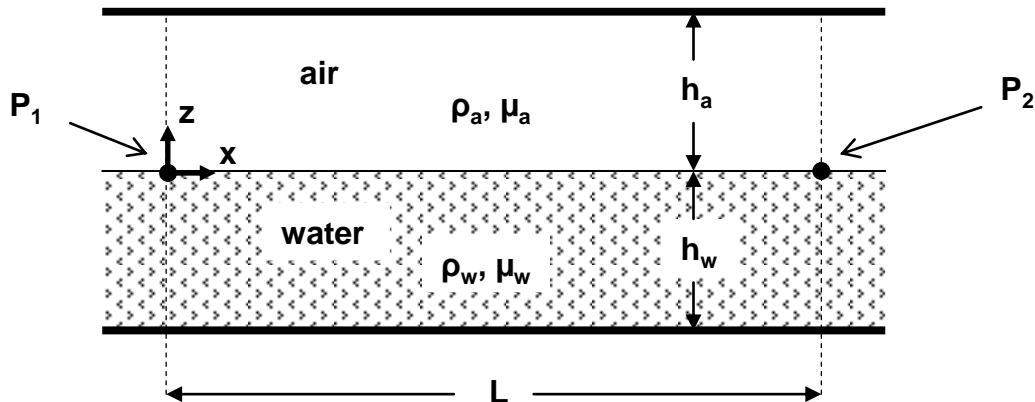


Figure 1: Two-phase flow in a rectangular duct

- (45) a. Solve for the velocity profile in the water phase. You are to use a stress-free boundary condition for water at the air/water interface.
- (45) b. Solve for the velocity profile in the air phase.
- (15) c. Provide a sketch of the velocity profiles in both the air and the water phases.
- (20) d. Solve for the pressure distribution (in both the air and the water phases) including any effect of gravity.
- (30) e. The stress-free boundary condition is an approximation. Why? Explain how the velocity profiles can be obtained rigorously. Indicate specifically which equations must be changed and how.