MANE 6520 - Fluid Mechanics

Test #1 - In class – Monday, 11 November 2022
Both problems are 2D (the width is W into the paper), incompressible (with density ρ), the fluid is Newtonian (constant viscosity μ), fully developed, and steady. The surrounding pressure is uniform and atmospheric p_{atm}

1. Consider the falling fluid film along a vertical wall under the action of gravitational acceleration g, shown in Fig. 1. The film thickness H is unknown, but the volume flow rate Q (m^3/s) is known.
a) Start with the 2D continuity and incompressible Navier-Stokes equations. Reduce these to a governing ordinary differential equation (ODE), showing briefly your reasoning to eliminate terms.
b) What are the boundary conditions, again briefly giving your reasoning?
c) Find the velocity profile $v_x(y)$ also in terms of the parameters and variables noted above.
d) Find the film thickness H in terms of the parameters noted above.
e) Find the momentum flow rate $\dot{G}_x$.

2. Consider the "scraper" shown in Fig. 2, where fluid is trapped inside. The lower surface sliders horizontally at velocity V. The gap inside is H = constant and the length is $L>>H$. There is no leakage at the contact point and a pressure p can be maintained inside. Neglect gravity.
a) Start with the 2D continuity and incompressible Navier-Stokes equations. Reduce these to a governing ordinary differential equation (ODE), showing briefly your reasoning to eliminate terms.
b) What are the boundary conditions, again briefly giving your reasoning?
c) Find the velocity profile $v_x(y)$ also in terms of the parameters and variables noted above.
d) Find the pressure variation $p(x)$ also in terms of the parameters noted above.
e) Find the force vector on the lower surface due to the fluid **F**.

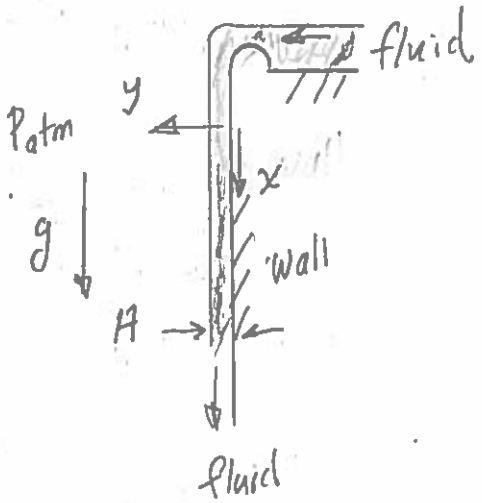

Fig. 1

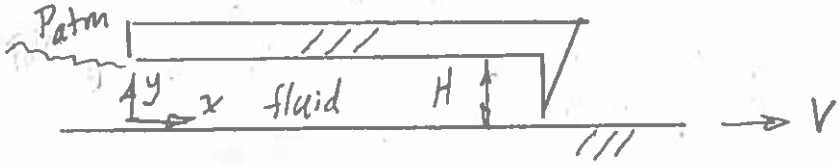

Fig. 2