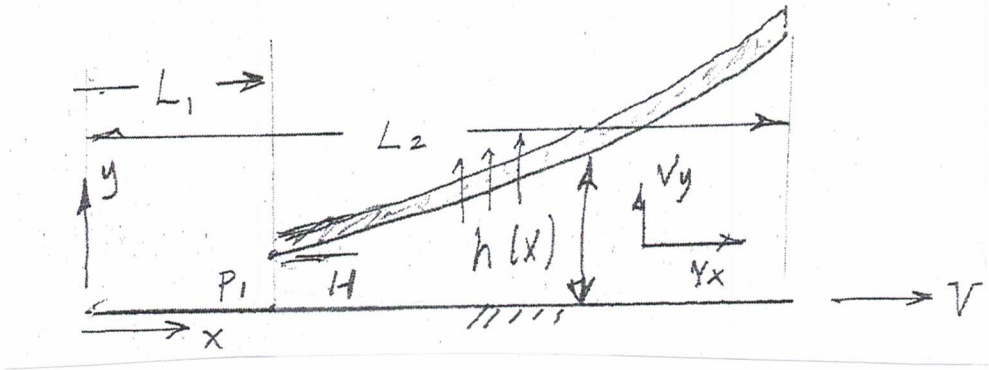
MANE 6520 - Fluid Mechanics, Homework #7 -
Monday 28 November 2022, due Monday 5 December



Consider flow in the gap shown above where $h = H\sqrt{\frac{x}{L_1}}$. The flow is incompressible, Newtonian, steady, 2-D, laminar, thin, and gravity can be neglected. The lower surface slides at velocity V and the gap extends $L_1 \le x \le L_2$. The pressure at the inlet and exit is p_1. The lower surface is solid and the upper surface is porous. We are going to try and find a similarity solution for $\eta = \frac{y}{h}$, $v_x = V\frac{\mathrm{d}f}{\mathrm{d}\eta}(\eta)$, with stream function $\psi = G(x)f(\eta)$. The pressure gradient is zero. Consider the parameters $\rho, \mu, p_1, V, H, L_1$ to be known.

a) Find the stream function variable G in terms of the known parameters and the variable x.
b) Find the cross-film velocity v_y in terms of the known parameters and the variables x and η.
c) Find the similarity equation for $f(\eta)$ with a modified Reynolds number Re^*.
d) What is that Reynolds number Re^* in terms of the known parameters?
e) What are the boundary conditions on $f(\eta)$?