CHEN.3030 Fluid Mechanics
Short Quiz: Viscous Internal Flows

Part a: In class we showed that the velocity distribution in a circular pipe under laminar flow conditions is given by

$$u(r) = -\frac{\left(R^2 - r^2\right)}{4\mu}\frac{d}{dx}\left(P + \gamma h\right)$$

If the pipe inside radius is R, for a given pressure plus elevation gradient, determine expressions for the volumetric flow rate, Q, and the average fluid velocity, v, within the pipe. Be formal!!!

Part b: For the specific case shown in the sketch with oil as the working fluid, determine Q if the mercury manometer reads h = 4 cm, ρ_{oil} = 880 kg/m^3, μ_{oil} = 0.068 N-s/m^2, and ρ_{Hg} = 13550 kg/m^3. Note also that, at the end, you should always validate the original laminar flow assumption. Use the back side of the page, as needed, for you work…

Note: If you are unsuccessful with Part a, use $Q = -\frac{d}{dx}\left(P + \gamma h\right)\frac{\pi R^4}{16\mu}$ to do the Part b calculations.