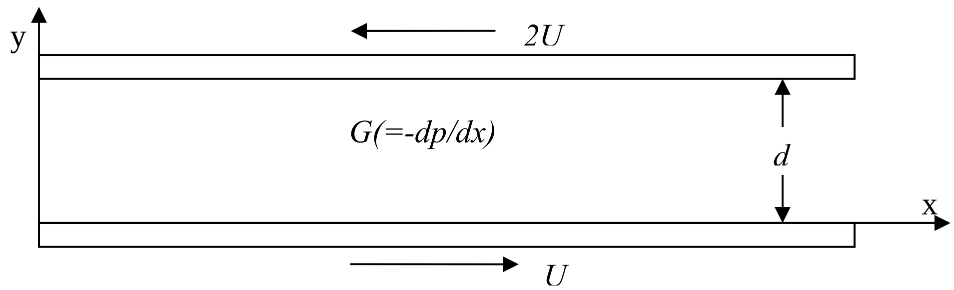
<u>Exam 3 Review problems</u>

1.

There is a gap between two plates separated at distance d. The top plate is pulled by $2U$ for negative x-direction, and bottom plate is pulled by U for positive x-direction. Assume that there is a constant pressure gradient G. Use μ: dynamic viscosity of the fluid, ρ: density of the fluid. (a) Obtain the velocity profile between two plates and shear stress as a function of y. (b) Obtain the flow rate per unit width between the plates.

v

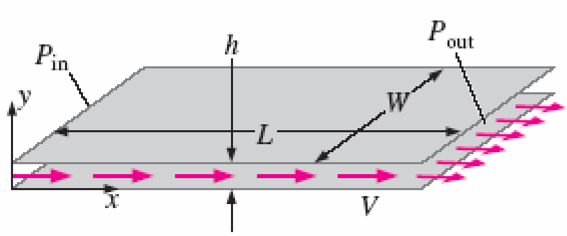


2.

Consider the following steady, three-dimensional velocity field in Cartesian coordinates: $\vec{V} = (u, v, w) = (axy^2 - b)\vec{i} + cy^3\vec{j} + dxy\vec{k}$, where a, b, c, and d are constants. Under what conditions is this flow field incompressible?

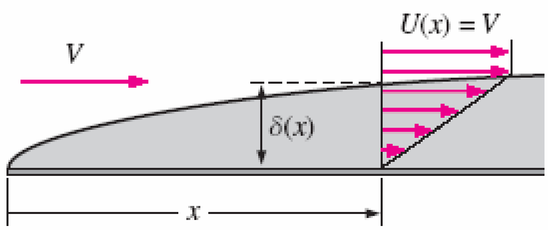
3.

Engine oil at T = 60°C is forced between two very large, stationary, parallel flat plates separated by a thin gap height h = 2.5 mm (Fig. P9–82). The plate dimensions are L = 1.5 m and W = 0.75 m. The outlet pressure is atmospheric, and the inlet pressure is 1 atm gage pressure. Estimate the volume flow rate of oil. Also calculate the Reynolds number of the oil flow, based on gap height h and average velocity V. Is the flow laminar or turbulent?



4.

The streamwise velocity component of a steady, incompressible, laminar, flat plate boundary layer of boundary layer thickness δ is approximated by the simple linear expression, $u = Uy/\delta$ for $y < \delta$, and $u = U$ for $y > \delta$ (Fig. P10–92). Generate expressions for displacement thickness and momentum thickness as functions of δ, based on this linear approximation. Compare the approximate values of δ^*/δ and θ/δ to the values of δ^*/δ and θ/δ obtained from the Blasius solution.



5.

Consider a turbulent boundary layer on a flat plate. Suppose only two things are known: $C_{f,x} \cong 0.059 \cdot (\mathrm{Re}_x)^{-1/5}$ and $\theta \cong 0.097\delta$. Use the Kármán integral equation to generate an expression for δ/x

6.

The drag coefficient of a vehicle increases when its windows are rolled down or its sunroof is opened. A sports car has a frontal area of 18 ft^2 and a drag coefficient of 0.32 when the windows and sunroof are closed. The drag coefficient increases to 0.41 when the sunroof is open. Determine the additional power consumption of the car when the sunroof is opened at (*a*) 35 mi/h and (*b*) 70 mi/h. Take the density of air to be 0.075 lbm/ft^3.