Problem 2B.1

**Different choice of coordinates for the falling film problem.** Rederive the velocity profile and the average velocity in §2.2, by replacing $x$ by a coordinate $\bar{x}$ measured away from the wall; that is, $\bar{x} = 0$ is the wall surface, and $\bar{x} = \delta$ is the liquid–gas interface. Show that the velocity distribution is then given by

$$v_z = \left(\frac{\rho g \delta^2}{\mu}\right) \left[\left(\frac{\bar{x}}{\delta}\right) - \frac{1}{2} \left(\frac{\bar{x}}{\delta}\right)^2\right] \cos \beta$$

and then use this to get the average velocity. Show how one can get Eq. 2B.1-1 from Eq. 2.2-18 by making a change of variable.