NAME

Fluids-ID

Quiz 15. SAE 30 oil at 20°C flows at U = 10 ft/s over the upper side of a flat plate of which width b = 2 ft and length L = 5 ft and area $A = bL$ = 10 ft². (a) What is the boundary layer thickness at the middle of the plate and (b) what is the friction drag D_f acting on the plate? Transition to turbulent flow may occur at Re = 5×10⁵. (ρ = 1.73 slug/ft³; μ = 0.00607 slug/ft·s)

Note: Attendance (+2 points), format (+1 point)

Reynolds number:

$$Re_L = \frac{UL}{\nu}, \qquad Re_x = \frac{Ux}{\nu}$$

Boundary layer thickness:

$$\frac{\delta}{x} = \begin{cases} \dfrac{5}{\sqrt{Re_x}} & \text{(laminar)} \\[2mm] \dfrac{0.16}{Re_x^{\frac{1}{7}}} & \text{(turbulent)} \end{cases}$$

Friction drag coefficient:

$$C_f = \frac{D_f}{\frac{1}{2}\rho U^2 A} = \begin{cases} \dfrac{1.328}{\sqrt{Re_L}} & \text{(laminar)} \\[2mm] \dfrac{0.031}{Re_L^{\frac{1}{7}}} & \text{(turbulent)} \end{cases}$$