9.37

GIVEN: WATER FLOW OVER A THIN PLATE ($T = 60°F$)

6 FEET LONG
3 FEET WIDE

FIND: B.L. THICKNESS, X LOCATION, AND SHEAR STRESS AT $Re_x = 500,000$.

SOLUTION:

$$Re_x = \frac{U_o X}{\nu} \qquad X = \frac{\nu Re_x}{U_o} \qquad \nu = 1.22 \times 10^{-5} \frac{FT^2}{S}$$

$$X = \frac{(1.22 \times 10^{-5})(500,000)}{5} = 1.22 \text{ FT} \qquad \boxed{X = 1.22 \text{ FT}}$$

$$\delta = \frac{5X}{Re_X^{\frac{1}{2}}} = \frac{5(1.22)}{(500,000)^{\frac{1}{2}}} \qquad \delta = 0.00863 \text{ FT.}$$

$$\boxed{\delta = 0.103 \text{ IN.}}$$

$$\tau_o = 0.332 \mu \frac{U_o}{X} Re_x^{\frac{1}{2}} = 0.332 (2.36 \times 10^{-5}) \left(\frac{5}{1.22}\right) (500,000)^{\frac{1}{2}}$$

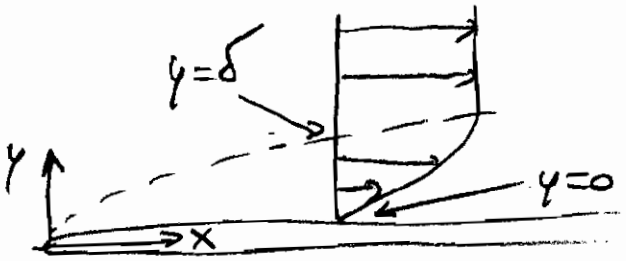
$$\tau_o = 0.0227 \text{ PSF}$$

GIVEN:

9.40 Oil ($\mu = 10^{-2}$ N · s/m^2; $\rho = 900$ kg/m^3) flows past a plate in a tangential direction so that a boundary layer develops. If the velocity of approach is 4 m/s, then at a section 30 cm downstream of the leading edge the ratio of τ_δ (shear stress at the edge of the boundary layer) to τ_0 (shear stress at the plate surface) is approximately (a) 0, (b) 0.24, (c) 2.4, (d) 24.

FIND: $\dfrac{\tau|_{y=\delta}}{\tau|_{y=0}}$

SOLUTION:



$$\tau = \mu \frac{du}{dy}$$

AT $y = \delta$, $\dfrac{du}{dy} = 0 \Rightarrow \tau|_{y=\delta} = 0$

$$\frac{0}{\tau_0} = 0 \qquad (a)$$