P7.20 Air at 20°C and 1 atm flows at 20 m/s past the flat plate in Fig. P7.20. A pitot stagnation tube, placed 2 mm from the wall, develops a manometer head $h = 16$ mm of Meriam red oil, SG = 0.827. Use this information to estimate the downstream position x of the pitot tube. Assume laminar flow.

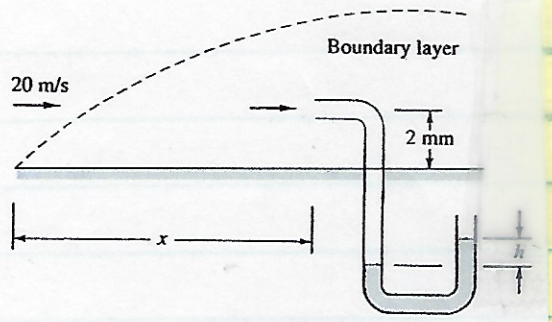

Fig. P7.20

Manometer $p_s - \gamma_m h = 0$

$p_s = \gamma_m h = .827 \times \rho_w \times 9.81 \times .016$

$\rho_w = 998$ kg/m³

Bernoulli $p + \frac{1}{2}\rho V^2 = p_s + \frac{1}{2}\rho V_s^2 = 129$ Pa

$V = \sqrt{\frac{2p_s}{\rho_a}} = \sqrt{\frac{2 \times 129}{1.2}}$ $\rho_a = 1.2$ kg/m³

$= 14.7$ m/s

$V/U = \frac{14.7}{20} = .734$

Table 7.1 The Blasius Velocity Profile [1 to 3]

$y[U/(\nu x)]^{1/2}$	u/U	$y[U/(\nu x)]^{1/2}$	u/U
0.0	0.0	2.8	0.81152
0.2	0.06641	3.0	0.84605
0.4	0.13277	3.2	0.87609
0.6	0.19894	3.4	0.90177
0.8	0.26471	3.6	0.92333
1.0	0.32979	3.8	0.94112
1.2	0.39378	4.0	0.95552
1.4	0.45627	4.2	0.96696
1.6	0.51676	4.4	0.97587
1.8	0.57477	4.6	0.98269
2.0	0.62977	4.8	0.98779
2.2	0.68132	5.0	0.99155
2.4	0.72899	∞	1.00000
2.6	0.77246		

Table 7.1 $y = y\,(U/\nu x)^{1/2}$

$= 2.42$

$x = (U/\nu)(y/y)^2$

$= (20/1.5E\text{-}5)(.002/2.42)^2$

$= .908$ m

$Re_x = \frac{Ux}{\nu} = 1.21 \times 10^6$

$Re_{x\,trans} \sim 5 \times 10^5 - 3 \times 10^6$