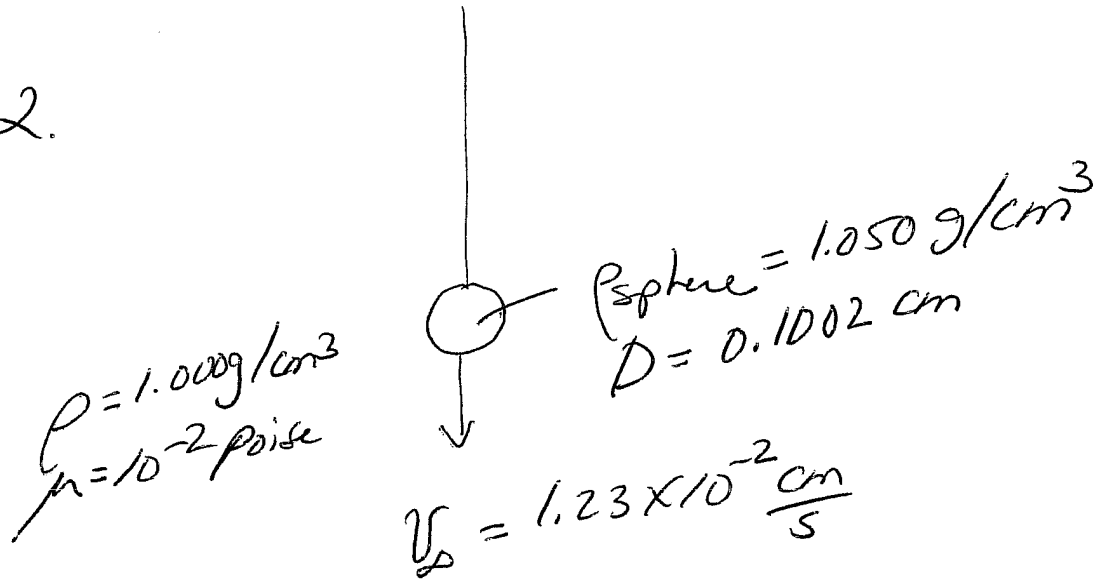
MIDTERM EXAM
CM3110
SOLUTION
21 OCT 2008

1. ERGUN EQN $\frac{150}{Re_p} + 1.75 = f_p$

2.



$C_D = ?$

Calc Re: $Re = \frac{\rho v D}{\mu}$

$$= \frac{\left(\frac{1.000\ g}{cm^3}\right)\left(\frac{1.23 \times 10^{-2}\ cm}{s}\right)(0.1002\ cm)}{10^{-2}\ \frac{g}{cm\ s}}$$

$$\boxed{Re = 0.1232}$$

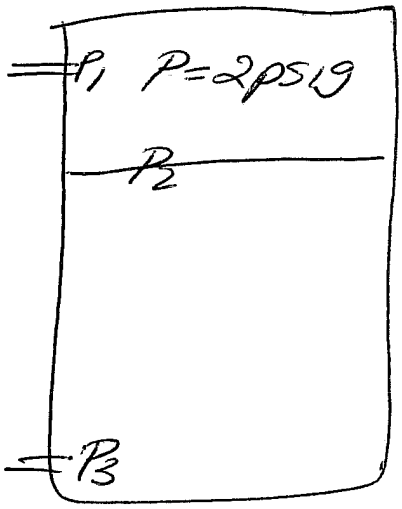
$\Rightarrow$ STOKES FLOW

$\Rightarrow$ $C_D = \frac{24}{Re}$

$$C_D = \frac{24}{0.1232} = 194.805$$

$$\boxed{C_D = 195} \quad \text{3SIG FIGS} \quad //$$

3.



$$\boxed{P_1 = 2.00\ psig}$$

$$\boxed{P_2 = 2.00\ psig}$$

$$P_3 = P_1 + \rho g H$$

$$= 2\ psig + \left(\frac{1.143\ g}{cm^3}\right)\left(\frac{980\ cm}{s^2}\right)(220 \times 10^2\ cm)$$

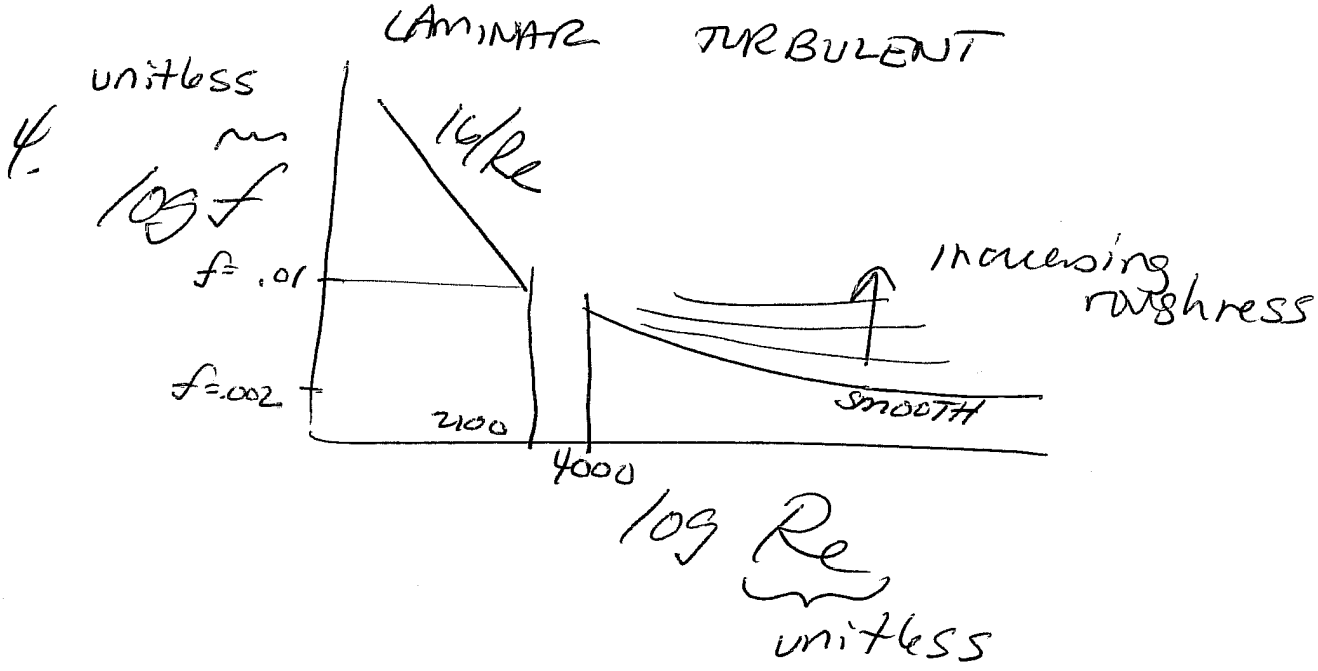
$$\times \frac{1\ dyne\ s^2}{g\ cm} \quad \frac{cm^2\ 14.696\ psi}{1.01325 \times 10^6\ dynes}$$

$P_3 = 2\ psig + 3.574\ psi$

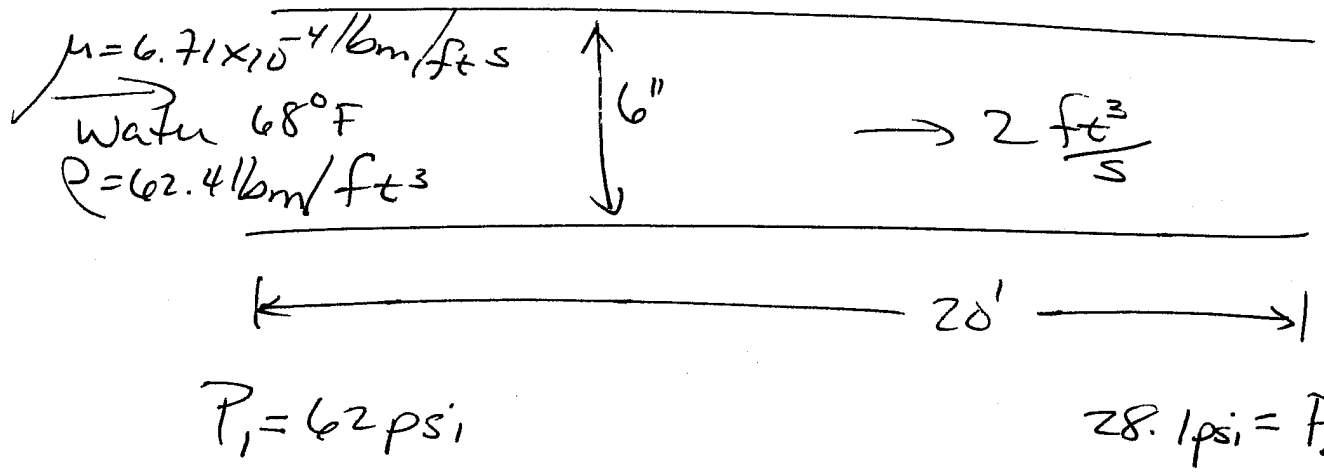
$P_3 = 5.574\ psig$

$\boxed{P_3 = 5.57\ psig}$

4.



5.



(a) Total drag on walls

$$F_{drag} = \Delta P \frac{\pi D^2}{4}$$

$$= \frac{(62 - 28.1)\ \frac{lb_f}{in^2}\ (\pi)\ (6\,in)^2}{4}$$

$$= 958.50\ lb_f$$

$$\boxed{F_{drag} = 958\ lb_f}$$

$$\langle V \rangle = \frac{Q}{A} = \left(\frac{2\ ft^3}{5}\right)\left(\frac{4}{\pi (0.5\ ft)^2}\right) = \boxed{10.1859\ \frac{ft}{s}}$$

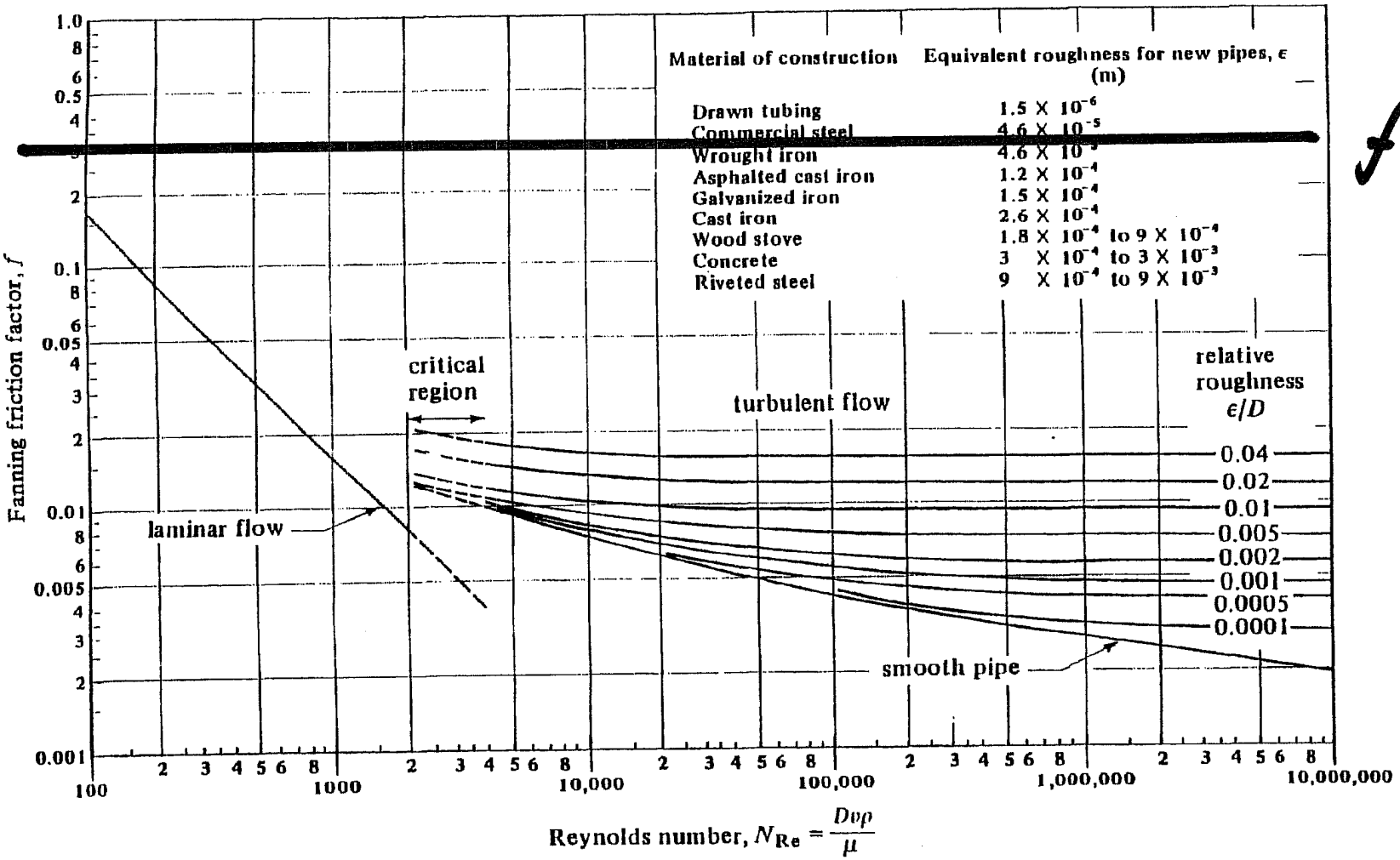
6. What is roughness factor ε?

$$f = \frac{F_{drag}}{\left(\frac{1}{2}\rho V^2\right)(\pi D L)}$$

$$= \frac{\left(958.4999186 \frac{lb_f}{}\right) 32.174 \frac{ft\, lb_m}{lb_f\, s^2}}{\frac{1}{2}\left(62.4 \frac{lb_m}{ft^3}\right)\left(10.1859 \frac{ft}{s}\right)^2 \pi (0.5 ft)(20 ft)}$$

$$f = 0.303$$

$$\Rightarrow \boxed{\varepsilon >> 0.04}$$



f=0.30

FIGURE 2.10-3. *Friction factors for fluids inside pipes. [Based on L. F. Moody, Trans. A.S.M.E., 66, 671 (1944); Mech. Eng. 69, 1005 (1947). With permission.]*