

HW 32

Ch 17 # 11, 14

17.11) Torque = ?

$$a) V = (.075 \text{ m}) \left(\frac{20 \text{ rev}}{1 \text{ min}} \right) \left(\frac{2\pi \text{ rad}}{1 \text{ rev}} \right) \left(\frac{1 \text{ min}}{60 \text{ s}} \right) = .157 \text{ m/s}$$

$$A = \frac{\pi D^2}{4} = \frac{\pi (.025)^2}{4} = .000491 \text{ m}^2$$

$C_p = 1.35$ (hemisphere from table 17.1)

$$\rho = 1.164 \text{ kg/m}^3 \text{ (at } 30^\circ\text{C)}$$

$$F_{D_m} = C_p (\rho v^2 / 2) A = 1.35 \frac{(1.164)(.157)^2}{2} (.000491)$$

$$F_{D_m} = .000095 \text{ N}$$

$$\text{Torque} = 4 F_{D_m} r = 4 (.000095) (.075) = .0000285 \text{ N}\cdot\text{m}$$

$$b) \rho = 680 \text{ kg/m}^3 \text{ (at 20°C gasoline)}$$

$C_p = 1.35$ (hemisphere from table 17.1)

$$F_{D_m} = C_p (\rho v^2 / 2) A = 1.35 \frac{(680)(.157^2)}{2} (.000491)$$

$$F_{D_m} = .00555 \text{ N}$$

$$\text{torque} = 4 F_{D_m} r = 4 (.00555) (.075)$$

$$\text{Torque} = .00167 \text{ N}\cdot\text{m}$$

$$17.14) F_{DM} = ?$$

$$A = DL \quad A = (.167 ft)(32 \sqrt{\frac{1 ft}{12 in}}) \cdot 2$$

$$A = .889 ft^2$$

$$V = (50 mph) \left(\frac{5280 ft}{1 mile} \right) \left(\frac{1 hr}{3600 sec} \right)$$

$$D = .2 \left(\frac{1}{12} \right)$$

$$D = .167 ft$$

$$V = 220 ft/s$$

$$\nu = 1.17 \times 10^{-4} ft^2/s \quad (\text{at } -20^\circ F)$$

$$\rho = 2.8 \times 10^{-3} slugs/ft^3 \quad (\text{at } -20^\circ F)$$

$$N_r = \frac{VD}{\nu}$$

$$C_D = .8$$

$$N_r = \frac{(220 ft/s)(.167 ft)}{1.17 \times 10^{-4} ft^2/s}$$

$$N_r = 3.14 \times 10^5$$

$$F_{DM} = C_D \left(\frac{\rho V^2}{2} \right) A = .8 \frac{(2.8 \times 10^{-3})(220)^2}{2} (.889)$$

$$F_{DM} = 46.2 lb$$