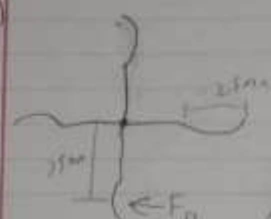
Chapter 17:

17.11

17-11

a)



$C_D = 1.35$

$D = 25mm \cdot \frac{1m}{1000mm} = 0.025m$

$r = 75mm \cdot \frac{1m}{1000mm} = 0.075m$

$\rho = 1.164 \frac{kg}{m^3}$

$\omega = 20 rpm \cdot \frac{2\pi rad}{60s} = 2.094395 \frac{rad}{s}$

$A = 4 \cdot \frac{\pi \cdot (0.025m)^2}{4} = 0.001963495 m^2$

$V = 2.094395 \frac{rad}{s} \cdot 0.075m = 0.15708 \frac{m}{s}$

$F_D = C_D \cdot \frac{\rho \cdot V^2}{2} \cdot A = 1.35 \cdot \frac{1.164 \frac{kg}{m^3} \cdot (0.15708 \frac{m}{s})^2}{2} \cdot 0.001963495 m^2$

$F_D = 3.8065 \cdot 10^{-5} N$

$P_D = F_D \cdot V = 3.8065 \cdot 10^{-5} N \cdot 0.15708 \frac{m}{s}$

$P_D = 5.97929 \cdot 10^{-6} W$

$P_D = \frac{T \cdot \omega}{9.55} \rightarrow \frac{(P_D \cdot 9.55)}{\omega} = T$

$T = \frac{5.97929 \cdot 10^{-6} \cdot 9.55}{20 rpm} = \boxed{2.855094 \cdot 10^{-6} N \cdot m}$

b)

$\rho = 680 \frac{kg}{m^3}$

$C_D = 1.35$

$r = 0.025m$

$D = 0.075m$

$\omega = 20 rpm = 2.094395 \frac{rad}{s}$

$A = 4 \cdot \frac{\pi \cdot (0.025m)^2}{4} = 0.001963495 m^2$

$V = 0.15708 \frac{m}{s}$

$F_D = 1.35 \cdot \frac{680 \frac{kg}{m^3} \cdot (0.15708 \frac{m}{s})^2}{2} \cdot 0.001963495 m^2$

$F_D = 0.022237314 N$

$P_D = F_D \cdot V = 0.022237314 N \cdot 0.15708 \frac{m}{s}$

$P_D = 0.003493029 W$

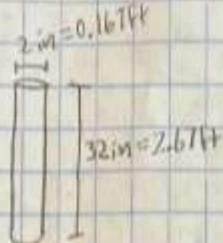
$P_D = \frac{T \cdot \omega}{9.55} \rightarrow \frac{P_D \cdot 9.55}{\omega} = T$

$P_D = \frac{0.003493029 W \cdot 9.55}{20 rpm} = 0.001667921 N \cdot m$

17.14

17.14.)

$F_D = ?$



$V = 150\ \text{mph} = 220\ \frac{ft}{s}$

$\rho_{air @ -20°F} = 2.8\times10^{-3}\ \frac{slugs}{ft^3}$

$\eta_{air @ -20°F} = 3.27\cdot10^{-7}\ \frac{lb\cdot s}{ft^2}$

$C_D = \dfrac{F_D/A}{\frac{1}{2}\rho v^2}$

$A = (\frac{1}{2}\pi d\cdot h) = (\frac{1}{2}\pi\cdot 0.167ft)(2.67ft) = 0.7\ ft^2$

$N_R = \dfrac{\rho v D}{\eta} = \dfrac{(2.8\times10^{-3}\frac{slugs}{ft^3})(220\frac{ft}{s})(0.167ft)}{3.27\cdot10^{-7}\frac{lb\cdot s}{ft^2}} = 3.145\times10^5 \therefore C_D = 1.2$ from fig 17.6 in Ch 17

$A\cdot C_D\cdot\frac{1}{2}\rho v^2 = F_D = (0.7ft^2)(1.2)(\frac{1}{2}(2.8\times10^{-3}\frac{slugs}{ft^3})(220\frac{ft}{s})^2) \Rightarrow F_D = 56.918\ lbs$

Because there are 2 rods: $2\cdot F_D = F_D \Rightarrow 2\cdot 56.918\ lbs = \boxed{113.84\ lbs = F_D}$

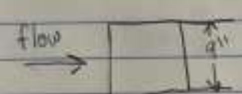
17.16

17.16)

$V = \frac{100\,mi}{h}\,\Big|\,\frac{1\,hr}{3600}\,\Big|\,\frac{5280\,ft}{1\,mi} = \frac{440}{3}\ ft/s$ $\quad F_D = C_D(\frac{\rho v^2}{2})A \quad N_R = \frac{vD}{\nu}$

$T = -20°F \quad \rho = 2.8\times10^{-3}\ slugs/ft^3 \quad L = 5ft$

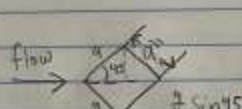
$\dfrac{\frac{440}{3}\cdot\frac{9}{12}}{1.17\times10^{-4}} = \underline{940170.94}$



$F_D = C_D(\frac{\rho v^2}{2})A$

$F_D = (1.16)(\frac{2.8\times10^{-3}\,slugs/ft^3\cdot(\frac{440}{3}ft/s)^2}{2})(\frac{9}{12}\cdot 5ft)$

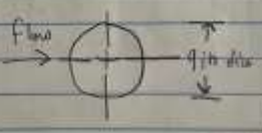
$F_D = 131\ lbs$



$F_D = C_D(\frac{\rho v^2}{2})A$

$F_D = (1.60)(\frac{2.8\times10^{-3}\cdot(\frac{440}{3})^2}{2})(5.303)$

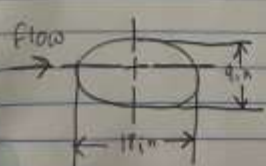
$\frac{9}{12}\sin 45$ $\quad F_D = 255\ lbs$



$F_D = C_D(\frac{\rho v^2}{2})A$

$F_D = (1.12)(\frac{2.8\times10^{-3}\cdot(\frac{440}{3})^2}{2})(\frac{9}{12}\cdot 5ft)$

$F_D = 126.48\ lbs$



$F_D = C_D(\frac{\rho v^2}{2})A$

$F_D = (0.61)(\frac{2.8\times10^{-3}\cdot(\frac{440}{3})^2}{2})(\frac{9}{12}\cdot 5ft)$

$F_D = 68.89\ lbs$

17.26

TW 2.2 08/01

17.26)

$R_{TS} = ?$ $P_E = ?$

$\Delta = 125$ LONG TONS $\left(\frac{2240 \text{ lbs}}{1 \text{ LONG TON}}\right)$

$= 280000$ lbs

R_{ST}/Δ = SPECIFIC RES. RATIO = 0.06

$T = 77°F$

$R_{TS} = R_{ST}(\Delta) = 280000 \text{ lbs}\,(0.06)$

$= \underline{\underline{16{,}800 \text{ lbs}}}$

$P_E = R_{TS} V = 16\,800 \text{ lbs}\,(50 \text{ ft/s})$

$= 840\,000 \text{ lb·ft/s} \left(\frac{1 \text{ hp}}{550 \frac{\text{lb·ft}}{s}}\right)$

$= \underline{\underline{1527.27 \text{ Hp}}}$

17.30

#17.30

→ determine Lift and Drag @ 10°

Cord length 1.4 m, span of 6.8 m

Perform at speed 200 km/h standard atm at 200 m and 10,000 m

A of air foil: 1.4 × 6.8 = 9.52 m²

$V = 200 \text{ km/h} = 55.5 \text{ m/s}$ $\rho = 1.202 \text{ kg/m}^3$

$\alpha = 10°$

At 10° $C_D = 0.05$ $C_L = 0.9$

→ At 200 m:

$$F_D = C_D\left(\frac{\rho V^2}{2}\right)A = 0.05\left[\frac{(1.202 \text{ kg/m}^3)(55.5 \text{ m/s})^2}{2}\right] \times 9.52 \text{ m}^2$$

$\underline{F_D = 882.72 \text{ N}}$

→ At 10,000 m $\rho = 0.4135\ kg/m^3$

$F_D = C_D\left(\frac{\rho v^2}{2}\right)A$

$= 0.05\left(\frac{(0.4135)(55.5)^2}{2}\right)(9.52)$

$\underline{F_D = 303.683\ N}$

Finding lift:

$F_L = C_L\left(\frac{\rho v^2}{2}\right)A$

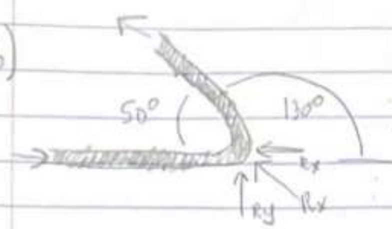
$= 0.9\left(\frac{(0.4135)(55.5)^2}{2}\right)9.52$

$\underline{F_L = 5.466\ kN}$

Chapter 16:

16.6

16.6)



H_2O @ 180°F $V_0 = 22.0\ ft/s$

$A = 2.95\ in^2 = 0.02049\ ft^2$

$\rho_{H_2O@180°F} = 1.88\ \frac{slugs}{ft^3} = 1.88\ \frac{lb \cdot s^2}{ft^4}$

$F = \rho Q \Delta v$

$Q = vA$

$Q = 22.0\ ft/sec \cdot 0.02049\ ft^2$

$Q = 0.451\ ft^3/s$

$F_x = \rho Q(V_{fx} - f_{iy})$

$F_y = \rho Q(V_{fy} - \cancel{V_{ix}})$

$F_x = 1.88\ \frac{s^4}{ft^3} \cdot 0.451\ \frac{ft^3}{s}\left(16.85\ \frac{ft}{s} - 22\ \frac{ft}{s}\right)$

↳ $F_x = -4.376$ lbs

$F_y = 1.88\ \frac{s^4}{ft^3} \cdot 0.451\ \frac{ft^3}{s}\left(14.14\ \frac{ft}{s}\right)$

↳ $\boxed{F_y = 11.99\ lbs \quad F_x = -4.3671\ lbs}$

V_y, V_x, 22

$22 \sin 50 = V_y$

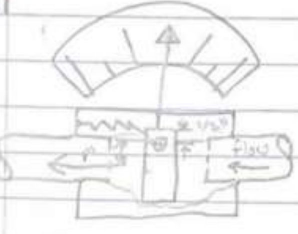
$22 \cos 50 = V_x$

$V_y = 16.85\ ft/s$

$V_x = 14.14\ ft/s$

16.11

16.11



$\rho_{H_2O} @ 4°C = 1.94 \frac{slugs}{ft^3} = 1.94 \frac{lbs \cdot s^2}{ft^4}$ $A = 0.006\ ft^2$

$Q = 100\ gpm = 0.223\ ft^3/s$

$Q = VA \Longrightarrow V = \frac{Q}{A}$

$V = \frac{0.223\ ft^3/s}{0.006\ ft^2} = 37.17\ ft/s$

$F_{flow} = \rho Q \Delta V$

$F_{flow} = 1.94 \frac{lbs \cdot s^2}{ft^4} \cdot 0.223 \frac{ft^3}{s} \cdot 37.17 \frac{ft}{s}$

$d = 1/2"$ $D = 1"$

$F_{flow} = 16.08\ lbs$

$\Sigma F = 0$

$F_{spring} = \frac{F_{flow} \cdot D}{d} = \frac{16.08 \cdot 1}{0.5}$

$M_{spring} = M_{flow}$

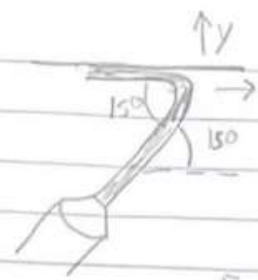
$F_{spring} = 32.16\ lbs$

$F_{spring} \cdot d = F_{flow} \cdot D$

16.20

16.20)

a.)

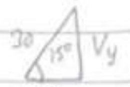


$Q = \frac{V}{A}$ $A = \frac{\pi}{100} = 0.0314\ m^2$ $V_{jet} = 30\ m/s$

$Q = \frac{30\ m/s}{0.0314\ m^2} = 954.93\ m^3/s$ $D_{noz} = 200\ mm = 0.2\ m$

$\rho_{H_2O} = 997\ kg/m^3$

$F = \rho Q \Delta V$



$F_x = \rho Q \Delta V$

$F_y = 997 \frac{kg}{m^3} \cdot 954.93 \frac{m^3}{s} (30 \sin 15°)$ $F_x = 997 \frac{kg}{m^3} \cdot 954.93 \frac{m^3}{s} (30 \cos 15°)$

$F_y = 7392378.26\ N$ $F_x = 27588731.24\ N$

$F_{x\,stationary} = 27588.731\ kN$ $F_{stationary} = 7392.8\ kN$

b.)

$V_c = V_1 - V_0$ $Q_e = AV_e = 0.0314\ m^2 \cdot 18\ m/s = 0.5652\ m^3/s$

$V_c = 30\ m/s - 12\ m/s = 18\ m/s$ $R_x = \rho Q_e V_e (1 + \cos\theta)$

$R_y = \rho Q_e V_e \sin\theta$ $R_x = 997 \frac{kg}{m^3} \cdot 0.5652 \frac{m^3}{s} (1 + \cos 15°) = 1107.8\ N$

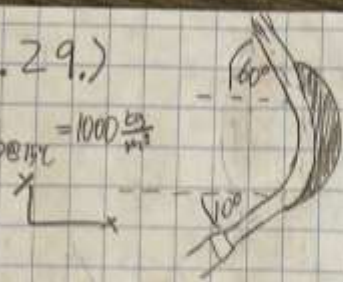
$R_y\ 997 \frac{kg}{m^3} \cdot 0.5652 \frac{m^3}{s} (\sin 15°)$

$R_y = 145.85\ N$ $R_x = 1107.8\ N$

16.29

16.29.)

$\rho_{H_2O @ 15^\circ C} = 1000 \frac{kg}{m^3}$



$d = 7.5\ mm = 0.0075\ m$

$v = 25\ m/s$

$A = \frac{\pi d^2}{4}$

$A = \frac{\pi (0.0075 m)^2}{4}$

$A = 0.0000442\ m^2$

$Q = vA$

$Q = (25 \frac{m}{s})(0.0000442\ m^2)$

$Q = 0.001105 \frac{m^3}{s}$

$F_x = \rho Q(v_{fx} - v_{ix})$ $\quad v_{ix} = 25\cos(10)$ $\quad v_{fx} = 25\cos(60)$

$F_y = \rho Q(v_{fy} - v_{iy})$ $\quad v_{iy} = 25\sin(10)$ $\quad v_{fy} = 25\sin(60)$

$F_x = (1000 \frac{kg}{m^3})(0.001105 \frac{m^3}{s})(25\cos(60) - (-25\cos(10))) \Rightarrow \boxed{F_x = 41.02\ N}$

$F_y = (1000 \frac{kg}{m^3})(0.001105 \frac{m^3}{s})(25\sin(60) - 25\sin(10)) \Rightarrow \boxed{F_y = 19.1\ N}$

Paragraph:

During the problems we looked at in class, we looked at how the drag and lift equations are used. We also learned that when an object is traveling at a low velocity it has a low Reynolds number and when it is traveling at a high velocity it has a high Reynold’s number. This is because at high speeds, the fluid becomes more turbulent and when it is at slow speeds it is laminar. Turbulent fluid has a high Reynold’s number while laminar fluids have low Reynold’s numbers. Additionally, we looked at open channel flow and how the pressure is constant and is always just atmospheric pressure.

We also learned the formula for forces due to fluids in motion. This formula is further broken up into formulas for the forces in the x, y, and z directions by using the velocity in either the x, y, or z direction. This can be found using trigonometry. It is important to know which forces are acting in which directions so that they can be added together properly. The directions of the forces are determined by using a free-body diagram.