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Quiz-2

1. D
2. D
3. C
4. A
5. ~~5~~

5) a) 2π b) $-ve$.

c) $\sin\alpha = \frac{1}{M}$. d) increases.

e) $m = 400{,}000$ kg $V = 240$ m/s. $h = 10$ km.

$\frac{L}{D} = 15$ $P(MW) = ?$

$\Rightarrow \frac{L}{D} = \frac{W}{D} = 15 \Rightarrow D = \frac{W}{15} = \frac{400{,}000 \times 9.806}{15}$

$= 2{,}61{,}493.33333$ N

$P = D.V = 6{,}27{,}58{,}400$ W

$= \cancel{627.584\ MW}$ 62.7584 MW

6) $C_l = a(\alpha - \alpha_{L=0})$

7) $C_d = C_{d_z} + bC_l^2$.

8) $q = \frac{1}{2}\rho_\infty V_\infty^2 = \frac{1}{2}\frac{p_\infty}{RT_\infty}V_\infty^2 = \frac{1}{2}\frac{\gamma p_\infty}{\gamma RT_\infty}V_\infty^2$

$= \frac{\gamma}{2}p_\infty M_\infty^2$

9) $p = 1$ atm $V = 250$ m/s. p_0 at pitot tube

$T = 270$ K

$$V_1^2 = \frac{2a_1^2}{\gamma-1}\left[\left(\frac{p_0}{p_1}\right)^{\gamma-1/\gamma} - 1\right]$$

$$\frac{(\gamma-1)V_1^2}{2a_1^2} = \left(\frac{p_0}{p_1}\right)^{(\gamma-1)/\gamma} - 1$$

$$\left[\frac{(\gamma-1)V_1^2}{2a_1^2} + 1\right]^{\gamma/\gamma-1} \cdot p_1 = p_0$$

$$\left[\frac{(0.4)(250)^2}{2[1.4 \times 287.057 \times 270]} + 1\right]^{(1.4)/0.4} \cdot (101.325)$$

$$p_0 = 148.40563 \text{ kPa.}$$

(10) $M = 2$ @ SSL conditions.

$$\frac{p_0}{p} = \left(1 + \frac{\gamma-1}{2}M^2\right)^{\gamma/\gamma-1}$$

$$p_0 = 101.325\left(1 + (0.2)4\right)^{1.4/0.4}$$

$$= 792.812301 \text{ kPa.}$$ (Total pressure of flow).

a) $$\frac{p_{02}}{p_1} = \left[\frac{(2.4)^2(2)^2}{4(1.4)(4) - 2(0.4)}\right]^{(1.4)/0.4} \frac{1 - \cancel{0}\, 1.4 + 2(1.4)(2)^2}{2.4}$$

$$= 1.253431 \times 4.5$$

$$p_{02} = 571.51753 \text{ kPa.}$$

$$M = \frac{V}{a} = \frac{V}{\sqrt{\gamma RT}}$$

$$2 = \frac{V}{\sqrt{1.4(287.057)(288.15)}}$$

$$V = 680.59287 \text{ m/s}$$

b) $$p_0 = p + \frac{1}{2}\rho V^2 = 101325 + 0.5(1.225)V^2$$

$$= 385.039.076 \text{ kPa.}$$

11. $L_p = 4.85 m$ $V_p = 0.440$ m/s $T = 15°C$

$\mu_W = 8.90 \times 10^{-4}$ Pa.s $= 288.15 K$

p = prototype
m = model

$L_m = \frac{L_p}{5}$ $T = 25°C$ $p = 101.325$ kPa

$= 298.15 K$

$\mu_{air} = 1.789 \times 10^{-5}$ Pa.s.

a) $Re_p = \frac{1000 \times 0.440 \times 4.85}{8.90 \times 10^{-4}} = 239.775280 \times 10^4$

$Re_m = \frac{\cancel{1.225}\ 1.18389 \times V = 4.85}{5 \times 1.789 \times 10^{-5}} = 239.775280 \times 10^4$

$V = 20.879558$ m/s.

Since the velocities are lower than M = 0.3, matching Re is sufficient.

b) $D_m = 5.70$ N. $\cancel{C_{D_m} = \frac{5.70}{\frac{1}{2} 1000 (0}}$

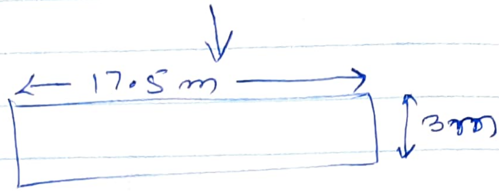
$C_{D_m} = \frac{5.70}{\frac{1}{2}(1.18389)(20.879558)^2 \cdot \left(\frac{4.85}{5}\right)^2} = 0.02346750$

$C_{D_m} = C_{D_p} = \frac{D_p}{\frac{1}{2}(1000)(0.440)^2(4.85)^2}$

$D_p = 53.45205$ N.

12. Rectangular Wing

$V = 200\ m/s.$



$\delta_{lam} = ?$ $\quad C_{f\,lam} = ?$ $\quad D_{f\,lam} = ?$

$\delta_{turb} = ?$ $\quad C_{f\,turb} = ?$ $\quad D_{f\,turb} = ?$

Laminar : $\delta = \dfrac{5.2x}{\sqrt{Re_x}}$ $\quad C_f = \dfrac{1.328}{\sqrt{Re_L}}$

$D_f = \dfrac{1.328}{\sqrt{\rho_\infty V_\infty L / \mu_\infty}}$

Turbulent : $\delta = \dfrac{0.37x}{Re_x^{0.2}}$

$C_f = \dfrac{0.074}{(Re_L)^{0.2}}$ $\quad D_f = C_f \cdot q_\infty S$

L: $\delta = \dfrac{5.2 \times 3}{\sqrt{Re_L}}$ $\quad Re_L = \dfrac{1.225 \times (200)(3)}{1.789 \times 10^{-5}}$

$= 0.0024338\ m.$ $\quad = 410.8440469 \times 10^{5}$

$C_f = 2.07185 \times 10^{-4}$ $\quad D_f = 266.4924\ N.$

T: $\delta = 0.0333109\ m.$

$C_f = 0.00222073$ $\quad D_f = 2856.4176\ N.$

13. $C = 4.7 m$. $V = 84 m/s$. @ SSL

$M_{c/4} = -1452$ N-m $M_{LE} = -4357.5$ N-m.

$L = ?$ $x_{cp} = ?$

$$M_{LE} = -\frac{c}{4} L + M_{c/4} = -x_{cp} L.$$

$$\frac{c}{4} L = M_{c/4} - M_{LE}$$

$$L = 2472.76595 \text{ N}.$$

$$x_{cp} = -\frac{M_{LE}}{L} = 1.762196 \text{ from L.E.}$$