Luke Velangier | AA 311

6.20

given

$S = 47 m^2$ $AR = 6.5$ $e = 0.87$ $W = 103047 N$

$C_{D0} = 0.032$ $T = 40298 N \cdot 2$

$V_\infty = V_{corner} = 250 \frac{mi}{h}$ $C_{L max} = 1.2$

Find: Minimum Turn Radius, maximum turn rate

Properties:

For turns:

$$R = \frac{V_\infty^2}{g\sqrt{n^2-1}} \qquad \omega = \frac{g\sqrt{n^2-1}}{V_\infty}$$

$$q_\infty = \frac{1}{2}\rho_\infty V_\infty^2 \qquad n = \frac{L}{W} \qquad L = q_\infty S C_L$$

Analysis

$\rho_\infty = 0.002378 \frac{slug}{ft^3}$

Because we are given $C_{L,max}$, $\rightarrow L = L_{max}$ for given V_∞, therefore $n = n_{max} \rightarrow R_{min}, \omega_{max}$

$$q = \frac{1}{2}\left(0.002378 \frac{slugs}{ft^3}\right)\left(366.67 \frac{ft}{s}\right)^2 = 159.86 \text{ psf}$$

$$L = (159.86 \text{ psf})(505.645 \text{ ft}^2)(1.2) = 96999.89 \text{ lbs}$$

$W = 23165.99$ lbs $\rightarrow n = \frac{L}{W} = 4.187$

$g = 32.2 \frac{ft}{s^2}$

$$R_{min} = \frac{\left(366.67 \frac{ft}{s}\right)^2}{\left(32.2 \frac{ft}{s^2}\right)\left((4.187)^2 - 1\right)^{\frac{1}{2}}} = \boxed{1026.9 \text{ ft} = 313.09 \text{ m}}$$

$$\omega_{max} = \frac{\left(32.2 \frac{ft}{s^2}\right)\left((4.187)^2 - 1\right)^{\frac{1}{2}}}{366.67 \frac{ft}{s}} = \boxed{0.3571 \frac{rad}{s}}$$

TOPS

Luke Verlangieri | AA 311

given

$V_{max} = 229$ mi/h $h_{alt} = 7500$ ft

$P_{max} = 1200$ hp → each $W = 25000$ lb

$AR = 9.14$ $S = 987$ ft^2 $\eta = 0.8$

$e = 0.7$

Find C_{D0} Assume: Level flight

properties

$P_A = P\eta$ $P_R = DV_\infty$ @ max velo

$C_D = C_{D0} + C_{Di}$ $C_{Di} = \frac{C_L^2}{\pi e AR}$ $P_R = P_A$

$D = C_D \cdot q_\infty \cdot S$ $q_\infty = \frac{1}{2}\rho_\infty V_\infty^2$

Analysis

$\rho_\infty = 1.8975 \cdot 10^{-3} \frac{slugs}{ft^3}$

$P_A = 2 \cdot P_{max} \cdot \eta = 2 \cdot (1200 hp) \cdot 0.8 = 1920 hp = 1.056 \cdot 10^6 \frac{ft \cdot lb}{s}$

$P_R = P_A \rightarrow D = \frac{P_A}{V_\infty} = \frac{(1.056 \cdot 10^6) \frac{ft \cdot lb}{s}}{(335.87 \frac{ft}{s})} = 3144$ lbs

$q_\infty = \frac{1}{2}\rho_\infty \cdot V_\infty^2 = \frac{1}{2}(1.8975 \cdot 10^{-3} \frac{slugs}{ft^3})(335.87 \frac{ft}{s})^2 = 107.02$ psf

for level flight $L = W$

$C_L = \frac{W}{q_\infty(S)} = \frac{25000 lb}{(107.02 psf)(987 ft^2)} = 0.23$

$C_D = \frac{D}{q_\infty(S)} = \frac{3144 lbs}{(107.02 psf)(987 ft^2)} = 0.0297$

$C_{Di} = \frac{C_L^2}{\pi e AR} = \frac{(0.23)^2}{(\pi \cdot 0.7 \cdot 9.14)} = 0.00279$

$C_{D0} = C_D - C_{Di} = 0.0297 - 0.00279 = \boxed{0.02698}$

AA 311 | HW 7

7.1

given: AC lies 0.03 chord length ahead of the cg $\rightarrow (h - h_{ac}) = 0.03$

$C_{M_{cg}} = 0.0050 \quad C_L = 0.50$

Find

C_{MAC}

properties

$$C_L = C_{L,wb}$$

$$C_{m_{cg}} = C_{m,acWB} + C_{LWB}(h - h_{acWB})$$

$h - h_{acWB} \rightarrow$ stable margin

Analysis

$$C_{mac} = C_{m_{cg}} - C_{L_{WB}}(h - h_{acWB})$$

$$= 0.0050 - 0.50(0.03)$$

$$\boxed{C_{mac} = -0.01}$$

7.2

given

$V_\infty = 100\ m/s \quad S = 1.5\ m^2 \quad c = 0.45\ m$

$M_{cg,0} = -12.4\ N\cdot m$, sea level

$L = 3675\ N \quad M_{cg} = 20.67\ N\cdot m$

Find

$C_{m_{ac}}, h_{ac}$

Properties

$$C_{m_{cg}} = \frac{M}{q_\infty \cdot S \cdot c}$$

$$C_{m_{cg_{WB}}} = C_{m_{AC_{WB}}} + C_{L_{WB}}(h - h_{ac})$$

$C_{m,0}$ @ $\alpha_A = 0^\circ \quad a = \frac{dc}{d\alpha}$

Analysis

$\rho_\infty = 1.225 \frac{kg}{m^3} \quad q_\infty = \frac{1}{2}(1.225 \frac{kg}{m^3})(100\ m/s)^2 = 6125.0\ Pa$

$$C_{m_{cg0}} = \frac{-12.4\ N\cdot m}{(1.5\ m^2)(6125\ Pa)\cdot(0.45\ m)} = -0.00299$$

$$C_{m_{cg}} = \frac{20.67}{(1.5\ m^2)(6125\ Pa)(0.45\ m)} = 0.00499$$

@ $L = 0 \quad C_L = 0$

$\rightarrow C_{m_{cg0_{WB}}}$: $\boxed{C_{m_{ac}} = -0.003}$

$$C_L = \frac{L}{q_\infty S} = \frac{3675}{(6125\ Pa)(1.5)} = 0.4$$

$$(h - h_{ac}) = \frac{(C_{m_{cg}} - C_{m_{AC}})}{C_L} = \frac{(0.00499 - 0.0029)}{0.4} = \boxed{0.019}$$

$$\boxed{C_{m_{ac}} = -0.003,\ \text{Stable margin} = 1.9\%}$$