University of Dayton

Department of Mechanical and Aerospace Engineering

MEE 440/AEE 521 – Flight Vehicle Performance/Dynamics
Homework-

1. For the aircraft assigned to you and use the corresponding aircraft data, provided drawings. Extract the relevant geometric parameters and provide estimates for all the longitudinal coefficients.

Wing Geometric Parameters

- $C_T =$
- $\Lambda_{LE} =$
- $C_R =$
- $b =$
- $X_{WH_R} =$
- $Z_{WH} =$
- $b_H =$
- $c_{T_H} =$
- $c_{R_H} =$
- $\Lambda_{LE_H} =$
- $\lambda = \frac{c_T}{c_R} =$
- $S = \frac{b}{2} c_R (1 + \lambda) =$
- $AR = \frac{b^2}{S} =$
- $\bar{c} = MAC = \frac{2}{3} c_R \frac{1+\lambda+\lambda^2}{1+\lambda} =$
- $x_{MAC} = \frac{b}{6} \frac{(1+2\lambda)}{(1+\lambda)} \tan(\Lambda_{LE}) =$
- $\tan(\Lambda_x) = \tan(\Lambda_{LE}) - \frac{4x(1-\lambda)}{AR(1+\lambda)}$
  - $\tan(\Lambda_{0.5}) =$
  - $\tan(\Lambda_{0.25}) =$

Modeling Downwash Coefficients

- $K_{AR} = \frac{1}{AR} - \frac{1}{1+(AR)^{1.7}}$
- $K_\lambda = \frac{10-3\lambda}{7}$
- $K_{mr} = \frac{1-\frac{m}{2}}{(r)^{0.33}}$
- $\left(\frac{d\epsilon}{d\alpha}\right)|_{Mach=0} = 4.44\left(K_{AR} K_\lambda K_{mr} \sqrt{cos(\Lambda_{0.25})}\right)^{1.19}$

Horizontal Tail Parameters

- $\lambda_H = \frac{c_T}{c_R} =$
- $S_H = \frac{b_H}{2} c_R (1 + \lambda_H) =$
- $AR_H = \frac{b_H^2}{S_H} =$
- $\bar{c}_H = \frac{2}{3} c_{R_H} \frac{1+\lambda_H+\lambda_H^2}{1+\lambda_H} =$
- $x_{MAC_H} = \frac{b_H}{6} \frac{(1+2\lambda_H)}{(1+\lambda_H)} \tan(\Lambda_{LE_H}) =$
- $\tan(\Lambda_{0.5_H}) =$

Wing Tail Geometric Parameters

- $X_{WH} = X_{WH_R} + \frac{c_{R_H}}{4} - \frac{c_R}{4}$
- $r = \frac{2X_{WH}}{b} =$
- $m = \frac{2Z_{WH}}{b} =$
- $x_{AC_H} = X_{WH_R} + x_{MAC_H} + \frac{\bar{c}_H}{4} - x_{MAC}$
- $\bar{x}_{AC_H} =$

Wing Lift-Slope Coefficients

Lil K

- $K = 1 + \frac{(8.2-2.3\Lambda_{LE})-AR(0.22-0.153\Lambda_{LE})}{100}$
- $c_{L_{\alpha_{W|_{Mach}}}} =$

Horizontal Tail Lift-Slope Coefficients

- $k_H = \frac{(8.2-2.3\Lambda_{LE_H})-AR_H(0.22-0.153\Lambda_{LE_H})}{100} + 1 =$
- $c_{L_{\alpha_{H|_{Mach}}}} =$

- $c_{L\alpha_{W|Mach=0}} = \frac{2\pi AR}{2+\sqrt{\left[\frac{AR^2}{k^2}\left(1+tan^2(\Lambda_{0.5})\right)\right]+4}}$
- $\left(\frac{d\epsilon}{d\alpha}\right)|_{Mach} = \left(\frac{d\epsilon}{d\alpha}\right)|_{Mach=0}\frac{c_{L\alpha_{W|Mach=0}}}{c_{L\alpha_{W|Mach}}}$

Wing Aerodynamic Center

- $\bar{x}_{AC_W} = K_1\left(\frac{x\prime_{AC_W}}{c_R} - K_2\right) =$
  - $\frac{\tan(\Lambda_{LE})}{\sqrt{1-M^2}} =$
  - $AR * \tan(\Lambda_{LE}) =$
- Figure 2.27: $\lambda = 0.25, AR * tan(\Lambda_{LE}) = 4.5827 \Rightarrow \frac{x\prime_{AC}}{c_R} =$
- Figure 2.28: $\lambda = 0.25 \Rightarrow K_1 =$
- Figure 2.29: $\Lambda_{LE} = 28°, \lambda = 0.25, AR = 8.612 \Rightarrow K_2 =$
- $\bar{x}_{AC_W} = K_1\left(\frac{x\prime_{AC}}{c_R} - K_2\right) =$
- $\Delta\bar{x}_{AC_B} == -\frac{1}{2.92S\bar{c}}\sum_{i=1}^{N} w_{B_i}^2 (\frac{d\bar{\epsilon}}{d\alpha}_i)\Delta x_i =$
- $\bar{x}_{AC_{WB}} = \bar{x}_{AC_W} + \Delta\bar{x}_{AC_B} =$

Aerodynamic Parameters

- $C_{L_\alpha} =$
- $C_{L_{\delta_E}} =$
- $C_{L_{i_H}} =$
- $C_{m_\alpha} =$
- $C_{m_{\delta_E}} =$
- $C_{m_{i_H}} =$
- $C_{L_{\dot{\alpha}}} =$
- $C_{L_q} =$
- $C_{m_{\dot{\alpha}}} =$
- $C_{m_q} =$