## 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

- $\bullet$   $C_T =$

- $X_{WH_R} =$
- $\bullet Z_{WH} =$
- $b_H =$  /
- $c_{T_H} =$

- $\bullet \ S = \frac{b}{2}c_R(1+\lambda) =$
- $AR = \frac{b^2}{S} =$
- $\bar{c} = MAC = \frac{2}{3}c_R \frac{1+\lambda+\lambda^2}{1+\lambda} =$
- $x_{MAC} = \frac{b}{6} \frac{(1+2\lambda)}{(1+\lambda)} \tan(\Lambda_{LE}) =$
- $\tan(\Lambda_x) = \tan(\Lambda_{LE}) \frac{4x(1-\lambda)}{AR(1+\lambda)}$ 
  - $-\tan(\Lambda_{0.5}) =$  $-\tan(\Lambda_{0.25}) =$

#### Modeling Downwash Coefficients

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

#### **Horizontal Tail Parameters**

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

#### Wing Tail Geometric Parameters

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

- Wing Lift-Slope Coefficients

    $K = 1 + \frac{(8!2 2.3\Lambda_{LE}) AR(0.22 0.153\Lambda_{LE})}{100}$ 
  - $\bullet \ c_{L_{\alpha_{W|_{Mach}}}} =$

#### Horizontal Tail Lift-Slope Coefficients

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



• 
$$CL_{\alpha W|Mach=0} = \frac{2\pi AR}{2 + \sqrt{\left[\frac{AR^2}{k^2}\left(1 + tan^2(\Lambda_{0.5})\right)\right] + 4}}$$

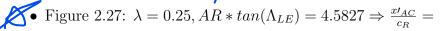
$$\bullet \left(\frac{d\epsilon}{d\alpha}\right)|_{Mach} = \left(\frac{d\epsilon}{d\alpha}\right)|_{Mach=0} \frac{c_{L_{\alpha_{W|Mach=0}}}}{c_{L_{\alpha_{W|Mach}}}}$$

#### Wing Aerodynamic Center

• 
$$\bar{x}_{AC_W} = K_1 \left( \frac{x'_{AC_W}}{c_R} - K_2 \right) = /$$

$$- \frac{\tan(\Lambda_{LE})}{\sqrt{1 - M^2}} = /$$

$$- AR * \tan(\Lambda_{LE}) = /$$



• Figure 2.28: 
$$\lambda = 0.25 \Rightarrow K_1 = /$$

• Figure 2.29: 
$$\Lambda_{LE}=28^{\circ}, \lambda=0.25, AR=8.612 \Rightarrow K_2=$$

• 
$$\bar{x}_{AC_W} = K_1 \left( \frac{x t_{AC}}{c_R} - K_2 \right) =$$

• 
$$\Delta \bar{x}_{AC_B} = -\frac{1}{2.92S\bar{c}} \sum_{i=1}^{N} w_{B_i}^2 \left(\frac{d\bar{\epsilon}}{d\alpha_i}\right) \Delta x_i =$$

$$\bullet \ \bar{x}_{AC_{WB}} = \bar{x}_{AC_W} + \Delta \bar{x}_{AC_B} = /$$

# Aerodynamic Parameters $\bullet \ C_{L_{\alpha}} =$

• 
$$C_{L_{\alpha}} =$$

• 
$$C_{L_{\delta_E}} =$$

• 
$$C_{L_{i_H}} =$$

$$C_{L_{i_H}} =$$

$$C_{m_{\alpha}} =$$

$$C_{m_{\delta_E}} =$$

$$C_{m_{i_H}} =$$

$$\bullet \ C_{m_{i_H}} =$$

• 
$$C_{L_{\dot{\alpha}}} =$$
•  $C_{L_q} =$ 
•  $C_{m_{\dot{\alpha}}} =$ 

• 
$$C_{L_q} =$$

$$\bullet$$
  $C_{m_q} =$