

Aerodynamics Model

Spring 16.82

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Assumptions

1. The wing is a box shape.
2. The non-wing drag is a constant
3. The stall factor is based off standard airfoil polar.
4. Reference length for Reynolds number is teh chord.
5. The skin friction is based off of Blasius flat plate.
6. The form factor for the wing is constant.

Variables

$$\begin{aligned}C_{L-max} &\leftarrow 1.5 \\C_{d0} &\leftarrow 0.02 \\K_{wing} &\leftarrow 1.3 \\S &\leftarrow 190 \text{ ft}^2 \\ \mu &\leftarrow 1.5 \times 10^{-5} \frac{\text{N}\cdot\text{s}}{\text{m}^2} \\cl_{16} &\leftarrow 0.0001 \\e &\leftarrow 0.9\end{aligned}$$

Constraints

$$\begin{aligned} &\begin{bmatrix} C_{D(0)} \geq 0.3183 \frac{C_{L(0)}^2}{ARe} + 2K_{wing}C_{f(0)} + C_{d0} + cl_{16}C_{L(0)}^{16} \\ C_{D(1)} \geq 0.3183 \frac{C_{L(1)}^2}{ARe} + 2K_{wing}C_{f(1)} + C_{d0} + cl_{16}C_{L(1)}^{16} \\ C_{D(2)} \geq 0.3183 \frac{C_{L(2)}^2}{ARe} + 2K_{wing}C_{f(2)} + C_{d0} + cl_{16}C_{L(2)}^{16} \end{bmatrix} \\ &b^2 = ARS \\ &\begin{bmatrix} C_{L-max} \geq C_{L(0)} \\ C_{L-max} \geq C_{L(1)} \\ C_{L-max} \geq C_{L(2)} \end{bmatrix} \\ &\begin{bmatrix} Re_{(0)} = 0.3048 \frac{S^{0.5}V_{(0)}\rho_{(0)}}{AR^{0.5}\mu} \\ Re_{(1)} = 0.3048 \frac{S^{0.5}V_{(1)}\rho_{(1)}}{AR^{0.5}\mu} \\ Re_{(2)} = 0.3048 \frac{S^{0.5}V_{(2)}\rho_{(2)}}{AR^{0.5}\mu} \end{bmatrix} \\ &\begin{bmatrix} C_{f(0)} \geq \frac{0.074}{Re_{(0)}^{0.2}} \\ C_{f(1)} \geq \frac{0.074}{Re_{(1)}^{0.2}} \\ C_{f(2)} \geq \frac{0.074}{Re_{(2)}^{0.2}} \end{bmatrix}\end{aligned}$$