Université d'Évry-Val-d'Essonne, UFR Sciences et Technologies,
Master2 E3A: Smart Aerospace & Autonomous Systems

Aerial Vehicles Lab

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Exercise(1)

Consider an airplane patterned after the twin-engine Beechcraft Queen Air executive transport flying at an altitude of $10Km$. The airplane weight is $38,220N$, wing area is $27.3m^2$, aspect ratio is 7.5, Oswald efficiency factor is 0.9, and parasite drag coefficient $C_{d_o} = 0.03$ calculate the following:

1. the thrust required to fly at a velocity of $350km/h$.
2. the minimum thrust required and its corresponding velocity graphically and analytically.
3. the minimum thrust required and its corresponding velocity if the aircraft is to fly at an altitude of $7Km$
4. the minimum velocity of the aircraft knowing that $C_{l_{max}} = 1.2$ and its corresponding required thrust.
5. the maximum range if the aircraft is gliding from $10Km$ altitude

Exercise(2)

Consider the steady state rate of climb of a jet airplane, $\dot{h} = V \sin(\gamma)$, at standard sea level, $\rho = 1.225Kg/m^3$, subject to the following constraints

$$\sin(\gamma) = \frac{f_t - D}{mg}, \quad D = .5\rho S V^2 (C_{Do} + K{C_l}^2), \quad C_l = \frac{2mg\cos(\gamma)}{\rho S V^2}$$

Using the following data

$$\frac{f_t}{mg} = .8, \quad \frac{mg}{S} = 3000N/m^2, \quad V_{max} = 255m/s, \quad C_{Do} = .015, \quad K = .04, \quad C_{lmax} = 1.2$$

Calculate the maximal angle of climb γ at standard sea level, subject to the given constraints? Also, determine the airspeed V corresponding to the maximal angle of climb.

Exercise(3)

Consider a remotely piloted aircraft with the following longitudinal dynamics plant:

$$A = \begin{bmatrix} -0.025 & -40 & -20 & -32 \\ .0001 & -2 & 1 & -.0007 \\ .01 & 12 & -2.5 & .0009 \\ 0 & 0 & 1 & 0 \end{bmatrix}, \quad B = \begin{bmatrix} 3.25 & -.8 \\ -.2 & -.005 \\ -32 & 22 \\ 0 & 0 \end{bmatrix}$$

$$C = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \quad D = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

Here both the outputs as well as the two control inputs are in radians. It is desired to design an LQR compensator, such that the closed-loop response to initial condition $x(0) = (0, .1, 0, 0)^T$, settles down in about $10s$, without requiring control input magnitude greater than $5°$.

1. Using "damp.m", check the controlability of this aircraft.
2. an LQR regulator can be designed with suitable cost parameters, such as $Q = .01 \times I$, $R = I$, what do you obtain as a step response?