THE UNIVERSITY OF TEXAS AT AUSTIN
Department of Aerospace Engineering and Engineering Mechanics

ASE 367K FLIGHT DYNAMICS
Fall 2024

HOMEWORK 5
Due: 2024-10-18 at 11:59pm via Canvas

Problem 1

If someone gave you the values C_{D_0} and κ for the drag polar $C_D = C_{D_0} + \kappa C_L^2$, the value T_A for the thrust available, the value W for the weight, and the value S for wing area of a jet powered aircraft flying straight and level at an altitude with air density ρ, explain how you would compute the minimum and maximum speeds at that altitude.

Problem 2

If $\dot{h}_0$ is the minimum sink rate of an aircraft in steady straight gliding flight, what would be the minimum sink rate of the same aircraft in a steady gliding turn, $\dot{h}(\phi)$, be in terms of $\dot{h}_0$ and the bank angle, ϕ?

Problem 3

Compute the range assuming:

i. The aircraft cruises at Mach 0.8 and maintains a constant altitude.
ii. The aircraft cruises at Mach 0.8 and maintains a cruise climb.

for a jet aircraft at an initial cruise altitude of 35,000 ft. (i.e., the altitude at the beginning of the cruise phase) with an initial cruise mass of 78,000 kg (i.e., the mass at the beginning of the cruise phase), **20,000 kg of useable fuel,** and the following characteristics:

$C_{L_0} = 0.2$

$\frac{dC_L}{d\alpha} = 5.7296$ $[rad^{-1}]$

$C_{D_0} = 0.016$

$\kappa = 0.048$

$S = 125$ $[\mathrm{m}^2]$

$c_T = 3.552\text{x}10^{-5}$ $\left[\frac{kg}{N \cdot s}\right]$

$T = 216{,}000 * (P/P_0)$ [N]

where P is the pressure at the altitude in question, and P_0 is the pressure at sea-level.

Problem 4

Consider an aircraft that is symmetric about its xz-plane. Suppose that the total angular momentum of the aircraft in its body frame is given by:

$$\boldsymbol{h}_B = \mathbb{I}_B \boldsymbol{\omega}_B + \boldsymbol{h}'_B$$

where $\boldsymbol{h}'_B = \left(h'_x, h'_y, h'_z\right)^T$ accounts for the angular momentum of the aircraft's rotors in the body frame and is assumed to be constant. In terms of the components of $\boldsymbol{\omega}_B = (p, q, r)^T$, the components of $\dot{\boldsymbol{\omega}}_B = (\dot{p}, \dot{q}, \dot{r})^T$, the non-zero components of $\mathbb{I}_B$ (i.e., I_{xx}, I_{yy}, I_{zz}, etc.) and the components of $\boldsymbol{h}'_B$, derive equations for the body-frame components of the moment acting on the aircraft, L, M and N.