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

ASE 367K FLIGHT DYNAMICS
Fall 2024

HOMEWORK 3
Due: 2024-09-20 at 11:59pm via Canvas

Problem 1

The vertical tail volume of an aircraft is defined by

$$V_F = \frac{S_f(x_{ac_f} - x_{cg})}{Sb},$$

where S_f and S are the fin and wing planform area, respectively, b is the wing span, and $x_{ac_f} - x_{cg}$ is the distance between the aerodynamic center of the fin and the CG of the aircraft. For an airplane with $C_{L_{\alpha_f}} = 5.5$, assuming negligible sidewash effects, what tail volume is required to achieve a weathercock stability derivative of $C_{n_\beta} = 0.16$?

Problem 2

For the airplane below, assume the right engine fails when the aircraft is in level flight at 130 knots, creating a yawing moment of 100000 [ft-lb]. Neglect the fuselage effect, determine:

a. The resulting sideslip angle in degrees if no rudder deflection is input.
b. The rudder input δ_r required to maintain the direction of flight prior to the engine failure.

Assume sea level, standard conditions: $\rho = 0.002378$ [slugs/ft^3]. Also,
1 [knot] $= 1.6878$ [ft/s].

Wing		Horizontal Tail		Vertical Fin	
b	$=$ 80 [ft]				
S	$=$ 1200 [ft^2]	S	$=$ 250 [ft^2]	S	$=$ 125 [ft^2]
$\bar{c}$	$=$ 10 [ft]	$\bar{c}$	$=$ 5 [ft]	$\bar{c}$	$=$ 5 [ft]
i	$=$ 0 [deg]	i	$=$ -1.6 [deg]		
C_{L_α}	$=$ 5.2 [rad^{-1}]	C_{L_α}	$=$ 4.5 [rad^{-1}]	C_{L_α}	$=$ 5.5 [rad^{-1}]
C_{L_0}	$=$ 0.1	C_{L_0}	$=$ 0.0	C_{L_0}	$=$ 0.0
$C_{M_{ac}}$	$=$ -0.1	$C_{M_{ac}}$	$=$ 0.0	$C_{M_{ac}}$	$=$ 0.0
		$C_{L_{\delta_e}}$	$=$ 1.5 [rad^{-1}]	$C_{L_{\delta_r}}$	$=$ 1.5 [rad^{-1}]
x_{ac}	$=$ 13 [ft]	x_{ac}	$=$ 40 [ft]	x_{ac}	$=$ 40 [ft]
		ϵ_0	$=$ 1.0 [deg]	σ_0	$=$ 0.0 [deg]
		ϵ_α	$=$ 0.3	σ_β	$=$ 0.0
		η	$=$ 0.95	η	$=$ 1.0

The cg of the aircraft is at $x_{cg} = 14$ [ft], the weight of the aircraft is $20,000$ [lb], and

$$C_{M_{0_p}} = 0.0\,, \quad C_{M_{0_f}} = 0.0\,, \quad C_{M_{\alpha_p}} = 0.0\ [\text{rad}^{-1}]\,, \quad \text{and} \quad C_{M_{\alpha_f}} = 0.0\ [\text{rad}^{-1}]\,.$$