Advanced Mechanics of Flight - Coursework 2019

Consider a glider at 1000 m ($\rho = 1.112$ kg/m^3) on a descent trajectory with glide angle $\Theta_0 = -2$ deg and velocity $V_\infty = 28$ m/s. The vehicle has a rectangular wing and a rectangular tail with a flap with a maximum deflection angle of ± 25 deg. Following definitions and assumptions in the notes, the relevant geometrical, mass and aerodynamic parameters are:

m =318 kg	S=6.11 m^2	l_t=4.63 m
I_{yy} =432 kgm^2	S_t=1.14 m^2	l_w=0.30 m
$C^w_{L\alpha}$=5.55	b=15 m	
$C^t_{L\alpha}$=4.30	$C^t_{L\delta}$=0.45	

1. Construct the system matrix for the longitudinal dynamics and use it to investigate the stability of the glider at the nominal descent conditions. **(20%)**

2. Compare the period of the phugoid mode obtained from the eigenvalue analysis with that measured in the time-domain response to a step input on the elevator. **(20%)**

3. Show the sensitivity of the system eigenvalues to 20% relative changes in each of the following parameters: $C^w_{L\alpha}$, $C^t_{L\alpha}$, I_{yy} and V_∞. Show your results in stability plots and discuss your findings. **(20%)**

4. A torsional spring k_β at the mid point between wing and tail aerodynamic centres now introduces the effect of a flexible fuselage. Investigate its effect on the longitudinal modes in terms of the nondimensional parameter $\sigma = \frac{k_\beta}{\frac{1}{2}\rho_\infty V_\infty^2 S_t l_t}$ for $5 \leq \sigma \leq 50$. Discuss your results. **(20%)**

5. LQR control is finally used for stability augmentation of the rigid glider. Investigate the effect of the selection of the LQR weights in the closed-loop stability of the aircraft. Restrict your search to diagonal matrices and investigate

   (a) the effect of penalizing actuator by increasing R for Q a unit matrix, **(10%)**

   (b) combinations of weights that increase the damping in the closed-loop phugoid mode for $R = 1$. **(10%)**

Your report should include only results and discussion up to a maximum of 6 pages. Attached your code in an appendix. You can refer to any equations in the class notes by citing their number.