Robust Servo LQR

1. Using the aircraft pitch-axis plant data from Example 5.2 (Eq. 5.58 page 119) without an actuator, DESIGN a RSLQR to command Az using a state feedback controller.

Turn in LQR design charts: Figures 3.4 – 3.8.

In analyzing your design use a 11 Hz actuator model. Eq 5.58 has a actuator model included – you need to use an 11 Hz model. Assume that the elevon fin is rate limited to 100 deg/s for 1 g (32 fps2) commanded.

Using the LQR design charts, show how you evaluated your design in the frequency domain and in the time domain. Describe how you selected the FINAL DESIGN (bandwidth) of your design.
For the final design,

> Break the loop at the plant input and evaluate the design from in the frequency domain.
> i) Plot a Nyquist plot and Bode plot for L_u. Identify the LGCF, Phase crossover frequency
> ii) Plot $\underline{\sigma}(I+L_u)$ and $\underline{\sigma}\left(I+L_u^{-1}\right)$.
> iii) Compute classical stability margins and singular value stability margins at the plant input.
> iv) Plot the sensitivity S and comp sensitivity T for the commanded variable.

List out all matrices used in the final design and analysis, closed loop eigenvalues and eigenvectors.

Using the small gain theorem, (robustness theory from Chapter 5), show your design is robust to the actuator dynamics (use a 11 Hz actuator with 0.707 damping).

2. List the controller matrices $\left(A_c, B_{c_1}, B_{c_2}, C_c, D_{c_1}, D_{c_2}\right)$ implementing the RSLQR .

$$\dot{x}_c = A_c x_c + B_{c_1} y + B_{c_2} r$$
$$u = C_c x_c + D_{c_1} y + D_{c_2} r$$

where $y = x_p$