ECE 486 **Assignment # 9 (Extra Credit)**

Issued: April 28 Due: May 5, 2022

Reading Assignment:

FPE, Sections 7.1–7.5, 7.7–7.8.

Problems: (all computations using Matlab)

Modeling & full-state feedback:

1. Consider the SISO model,

$$Y(s) = \frac{s+1}{s^2+2s+2} U(s)$$

   Obtain a second-order state-space model (without Matlab).
   Obtain a state-feedback compensator $u = -Kx + r$, placing the closed loop poles at -4 and -25.

2. Consider the satellite position model with delay,

$$G_p(s) = \frac{1 - s/2}{1 + s/2} \frac{1}{s^2}.$$

   Obtain a third-order state-space model (without Matlab).
   Obtain a state-feedback compensator $u = -Kx + r$, placing the closed loop poles at -4, -13 and -25.

Observers & sensitivity

3. Return to the feedback system considered in Problem 1:
   (a) Construct a stable observer to estimate x based on measurements of (u, y).
   (b) Obtain a state-feedback compensator $u = -K\hat{x} + K_r r$, where K was obtained in your prior work, and K_r is chosen so that the DC gain Y/R is equal to unity.
   (c) Obtain a step response using Matlab.

4. Return to the feedback system considered in Problem 2:
   (a) Construct a stable observer, and using this obtain a compensator of the form $U = -G_c Y + G_r R$.
   (b) Obtain a Nyquist plot for $G_c G_p$ using Matlab, and estimate the gain and phase margins.