Control Systems

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First Name:
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Exercise 1 Consider the transfer function $G(s) = \frac{1}{s(s+2)(s-2)}$.

a. [7 points] Use the root locus to design a feedback control scheme and a controller $G_c(s)$ such that the closed loop system is asymptotically stable, and use the Routh Criterium to compute the range of values of the gain of $G_c(s)$ such that asymptotic stability is satisfied.

b. [3 points] Discuss the procedure to solve the above problem, when it is also required that the real part of each eigenvalue of the closed loop system is less than -1.

Exercise 2 Consider a control scheme as depicted in Figure 1,

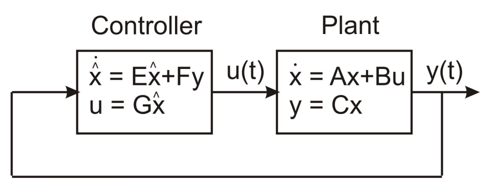

Fig. 1. Control scheme.

where $A = \begin{bmatrix} 2 & 1 \\ 5 & 1 \end{bmatrix}$, $B = \begin{bmatrix} b \\ 1 \end{bmatrix}$ and $C = \begin{bmatrix} 0 & c \end{bmatrix}$, with $b, c \in \mathbb{R}$ real parameters.

a. [5 points] Design the matrices E, F, G as functions of the parameters b, c, such that the closed loop system is asymptotically stable, and such that the transient is negligible after 3s.

b. [5 points] Discuss stabilizability with state feedback, detectability and stabilizability with output feedback of the system.

Exercise 3 [10 points] Illustrate the observer of linear time invariant systems with scalar input and scalar output. Provide conditions for the existence of an observer of the state, and conditions such that it is possible to arbitrarily assign the eigenvalues of the estimation error dynamics. Provide significant examples of observable and detectable systems.