Control Systems : Set 11 : Statespace (2)

Prob 1 | Consider a system with state matrices

$$A = \begin{bmatrix} -2 & 1 \\ 0 & -3 \end{bmatrix} \qquad B = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \qquad C = \begin{bmatrix} 1 & 3 \end{bmatrix}$$

a) Use feedback of the form $u(t) = -Kx(t) + \bar{N}r(t)$, where $\bar{N}$ is a nonzero scalar, to move the poles to $-3 \pm 3j$

b) Choose $\bar{N}$ so that if r is a constant, the system has zero steady-state error, that is $y(\infty) = r$

c) The system steady-state error performance can be made robust by augmenting the system with an integrator and using unity feedback, that is, by setting $\dot{x}_I = r - y$, where x_I is the state of the integrator. To see this, first use state feedback of the form $u = -Kx - K_I x_I$ so that the poles of the augmented system are at -3, $-2 \pm j\sqrt{3}$

Prob 2 | For the system

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$
$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$$

design a state feedback controller that satisfies the following specifications:

- Closed-loop poles have a damping coefficient $\zeta = 0.707$
- Step-response peak time is under 3.14sec

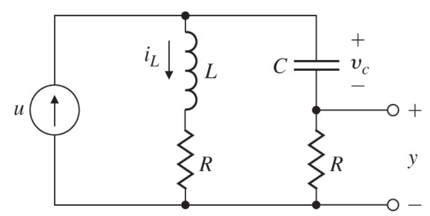
Prob 3 | Consider the following system

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ 0 & -10 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$
$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$$

a) Design a state feedback controller so that the closed-loop step response has an overshoot of less than 25% and a 1% settling time under 0.115sec

b) Use the step command in Matlab to verify that your design meets the specifications. If it does not, modify your feedback gains accordingly.

Prob 4 | Consider the electric circuit shown in the figure below, that you designed a controller for in the fifth exercise



a) What condition(s) on R, L and C will guarantee that the system is observable?

Prob 5 | Consider the system

$$A = \begin{bmatrix} -2 & 1 \\ 1 & 0 \end{bmatrix} \qquad B = \begin{bmatrix} 1 \\ 0 \end{bmatrix} \qquad C = \begin{bmatrix} 1 & 2 \end{bmatrix}$$

and assume that you are using feedback of the form $u = -Kx + r$ where r is a reference input signal

a) Show that (A, C) is observable

b) Show that there exists a K such that $(A - BK, C)$ is unobservable

c) Compute a K of the form $K = \begin{bmatrix} 1 & K_2 \end{bmatrix}$ that will make the system unobservable as in part (b), that is, find K_2 so that the closed-loop system is not observable

d) Compare the open-loop transfer function with the transfer function of the closed-loop system of part (c). What is the unobservability due to?