Tutorial 2

Question 7. Design a full state feedback control $u = -Kx$ for the dynamic system described by

$$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 2 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u(t) \tag{10}$$

such that the closed-loop system has the poles at $\{-2, -1 \pm 2j\}$.

Question 8. The dynamics of a rocket is described by

$$\dot{x} = \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u(t) \tag{11}$$

$$y = [0 \;\; 1] x \tag{12}$$

The control input is designed as $u = -2x_1 - x_2$. Determine the roots of the characteristic equation.

Question 9. For the dynamic system described in Question 8, how to change the control input such that the roots of the closed-loop systems are at $\{-2 \pm j\}$.

Question 10. Consider a second order system

$$\begin{aligned} \dot{x} &= \begin{bmatrix} 1 & 0 \\ 3 & 1 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u(t) && (13) \\ y &= [0 \;\; 1]x && (14) \end{aligned}$$

Design an observer such that the observer poles are at $\{-1 \pm j\}$.

Question 11. Design a full state observer for the dynamic system described by

$$\begin{aligned} \dot{x} &= \begin{bmatrix} -2 & 1 & 0 \\ -2 & 0 & 1 \\ 1 & 0 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u(t) && (15) \\ y &= [1 \;\; 0 \;\; 0]x && (16) \end{aligned}$$

such that the observer has the poles at $\{-2, -1 \pm 2j\}$.

Question 12. Consider a state space compensator for the system

$$\dot{x} = \begin{bmatrix} 1 & 0 \\ 3 & 2 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u(t) \quad (17)$$

$$y = [0 \;\; 1]x \quad (18)$$

with the closed loop poles at $\{-1 \pm j\}$, and the observer poles at $\{-2 \pm j\}$.