

0. Be sure to sign-up and do Lab 3 and PLEASE use my numbers from the Prelab Sol'n:

$$Kc(0) = 1.8923 \quad Kc(1) = 0.5106 \quad Nx(0) = 1 \quad Nx(1) = 0 \quad Nu(0) = 0$$

1. a) Determine how many eigenvalues (modes) are observable for the state variable model (i.e., check the rank of the observability matrix, O):

$$\begin{aligned} \dot{x} &= Ax + Bw \\ y &= Cx \end{aligned}$$

i) $A = \begin{bmatrix} 1 & 2 \\ 2 & 1 \end{bmatrix} C = \begin{bmatrix} 1 & 1 \end{bmatrix}$ ii) $A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix} C = \begin{bmatrix} 1 & 0 & -1 \end{bmatrix}$ iii) $A = \begin{bmatrix} 0 & -1 \\ 1 & -2 \end{bmatrix} C = \begin{bmatrix} 0 & 1 \end{bmatrix}$

b) Given the system,

$$\begin{aligned} \dot{x} &= \begin{bmatrix} 3/2 & -1/2 & 0 \\ 1/2 & 5/2 & 1 \\ 1 & 1 & 2 \end{bmatrix} x + \begin{bmatrix} 1/2 \\ 1/2 \\ 0 \end{bmatrix} w \\ y &= \begin{bmatrix} 2 & 2 & 0 \\ 3 & 1 & 2 \end{bmatrix} x \end{aligned}$$

- Is the system stable? Controllable? Observable?
- Find a full state feedback regulator law, $w = -kx$, such that the closed-loop eigenvalues are $\{-2 -4 -5\}$
- What is the settling-time of the closed-loop system
- Design an observer with eigenvalues 2 times deeper in the LHP than the deepest eigenvalue of the closed-loop system
- Draw a block diagram of the combined observer-regulator