Due Wednesday, February 17 EE572 HW#9

1. Consider the following discrete-time multi-input state variable model:

$$x_{k+1} = \begin{bmatrix} -2 & 2 \\ 0 & -2 \end{bmatrix} x_k + \begin{bmatrix} 2 & -1 \\ -1 & 1 \end{bmatrix} w_k \; 0$$

a) Find the eigenvalues of the open-loop system.

b) Is the system stable?

c) Is the system controllable?

c) If yes, design a feedback regulator law, $w_k = -\underline{k}x_k$ such that the closed-loop system has eigenvalues {.5 .25}.

d) What is the settling time of the closed-loop system if T_s = 10msec?

e) If $x_{k+1} = \hat{A}x_k + \hat{B}w_k \; 0$ determine which systems are stabilizable:

i) $\hat{A} = \begin{bmatrix} -1 & -3 \\ 3/2 & 7/2 \end{bmatrix} \hat{B} = \begin{bmatrix} -1 \\ 1 \end{bmatrix} 0$ ii) $\hat{A} = \begin{bmatrix} 11 & 10 \\ -5 & -4 \end{bmatrix} \hat{B} = \begin{bmatrix} -1 & -2 \\ 1 & 2 \end{bmatrix} 0$ iii) $\hat{A} = \begin{bmatrix} 0 & -2 \\ 1 & 3 \end{bmatrix} \hat{B} = \begin{bmatrix} -1 & 4 \\ 1 & -2 \end{bmatrix} 0$

2. Consider the following discrete-time state variable model:

$$x_{k+1} = \begin{bmatrix} 4 & 0 & 0 \\ 0 & 1/2 & 0 \\ 0 & 0 & 2 \end{bmatrix} x_k + \begin{bmatrix} 2 & 0 \\ 0 & 0 \\ 0 & -2 \end{bmatrix} w_k \qquad x_0 = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix} 0$$

a) Find the eigenvalues of the open-loop system.

b) Is the system stable?

c) Is the system controllable? Is it stabilizable?

c) If yes, design a feedback regulator law, $w_k = -\underline{k}x_k$ such that all the controllable eigenvalues are {1/4}.

d) What is the settling time of the closed-loop system if T_s = 10 msec?