Alexandria University

Faculty of Engineering

Division of Communications & Electronics

EE391: Control Systems and Components

Sheet 4: State Feedback and State Observers

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1. Given

$$\dot{\boldsymbol{x}} = \begin{bmatrix} 2 & 1 \\ -1 & 1 \end{bmatrix} \boldsymbol{x} + \begin{bmatrix} 1 \\ \mathbf{2} \end{bmatrix} u \qquad y = [1 \quad 1]\boldsymbol{x}$$

   Find the state feedback gain **K** so that the state feedback system has -1 and -2 as its eigenvalues. Compute **K** directly without using any equivalence transformation.

2. Find the state feedback gain for the state feedback gain for the state equation

$$\dot{\boldsymbol{x}} = \begin{bmatrix} 1 & 1 & -2 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix} \boldsymbol{x} + \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} u$$

   so that the resulting system has eigenvalues -2 and -1±j1. Use the method you think is the simplest by hand to carry out the design.

3. Consider the continuous-time state equation

$$\dot{\boldsymbol{x}} = \begin{bmatrix} 1 & 1 & -2 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix} \boldsymbol{x} + \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} u$$
$$y = [2 \quad 0 \quad 0]\boldsymbol{x}$$

Let $u = pr - \boldsymbol{kx}$. Find the feedforward gain p and state feedback gain $\boldsymbol{k}$ so that the resulting system has eigenvalues -2 and -1±j1 and will track asymptotically any step reference input.