Computer Simulation Problems 1

1 Determine a state variable representation for the following transfer functions (without feedback) using the **ss** function:

(1) $\mathrm{G(s)} = \frac{1}{s+10}$

(2) $\mathrm{G(s)} = \frac{s^2+5s+3}{s^2+8s+5}$

2 Determine a transfer function representation for the following state variable models using the **tf** function:

(1) $\mathbf{A} = \begin{bmatrix} 0 & 1 \\ 2 & 8 \end{bmatrix}$, $\mathbf{B} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$, $\mathbf{C} = [1 \quad 0]$

(2) $\mathbf{A} = \begin{bmatrix} 1 & 1 & 0 \\ -2 & 0 & 4 \\ 5 & 4 & -7 \end{bmatrix}$, $\mathbf{B} = \begin{bmatrix} -1 \\ 0 \\ 1 \end{bmatrix}$, $\mathbf{C} = [0 \quad 1 \quad 0]$

3 Consider the two systems:

$$\dot{\mathbf{x}}_\mathbf{1} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -4 & -5 & -8 \end{bmatrix}\mathbf{x}_\mathbf{1} + \begin{bmatrix} 0 \\ 0 \\ 4 \end{bmatrix} u,$$

$$\mathrm{y} = [1 \quad 0 \quad 0]\mathbf{x}_\mathbf{1}$$

and

$$\dot{\mathbf{x}}_\mathbf{2} = \begin{bmatrix} 0.5000 & 0.5000 & 0.7071 \\ -0.5000 & -0.5000 & 0.7071 \\ -6.3640 & -0.7071 & -8.000 \end{bmatrix}\mathbf{x}_\mathbf{2} + \begin{bmatrix} 0 \\ 0 \\ 4 \end{bmatrix} u,$$

$$\mathrm{y} = [0.7071 \quad -0.7071 \quad 0]\mathbf{x}_\mathbf{2}$$

(1) Using the **tf** function, determine the transfer function $\mathrm{Y(s)/U(s)}$ for the above two systems.

(2) Compare the results in (1) and comment.

4 Consider the closed-loop control system in Figure 1.

(1) Determine a state variable representation of the controller.

(2) Repeat part (1) for the process

(3) With the controller and process in state variable form, use the series and feedback functions to compute a closed-loop system representation in state variable form and plot the closed-loop system impulse response.

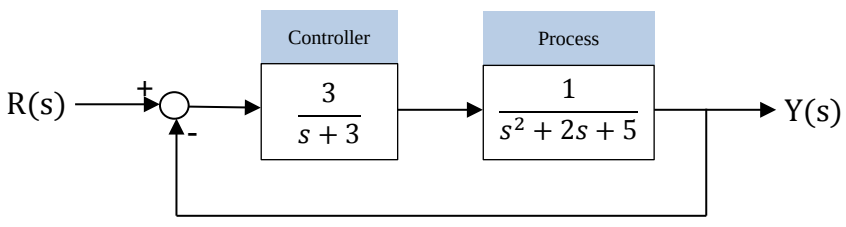

Figure 1 A closed-loop feedback control system

5 Consider the following system

$$\dot{\mathbf{x}} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}\mathbf{x} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$
$$\mathrm{y} = [1 \quad 0]\mathbf{x}$$

with

$$\mathrm{x}(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}.$$

Using the **lsim** function obtain and plot the system response (for $x_1(t)$ and $x_2(t)$) when $u(\mathrm{t}) = 0$.

6 Consider the state variable model with parameter K given by

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

Plot the characteristic values of the system as a function of K in the range $0 \leq K \leq 100$. Determine that range of K for which all the characteristic values lie in the left half-plane.