ECE 463/663 - Homework #3

Canonical Forms, Similarity Transforms, LaGrangian Dynamics, Block Diagrams
Due Monday, January 30th
Please submit as a hard copy or submit on BlackBoard

Canonical Forms

Problem 1-3) For the system

$$Y = \left(\frac{50(s+7.1)}{(s+2)(s+7)(s+10)} \right) U$$

1) Express this system in controller canonical form. (Give the A, B, C, D matrices)

2) Express this system in cascade form

3) Express this system in Jordan (diagonal) form

4) Assume a system's dynamics are

$$\begin{bmatrix} sV_1 \\ sV_2 \\ sV_3 \\ sV_4 \end{bmatrix} = \begin{bmatrix} -5 & 1 & 0 & 0 \\ 1 & -5 & 1 & 0 \\ 0 & 1 & -5 & 1 \\ 0 & 0 & 1 & -5 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix} + \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{bmatrix} V_0$$

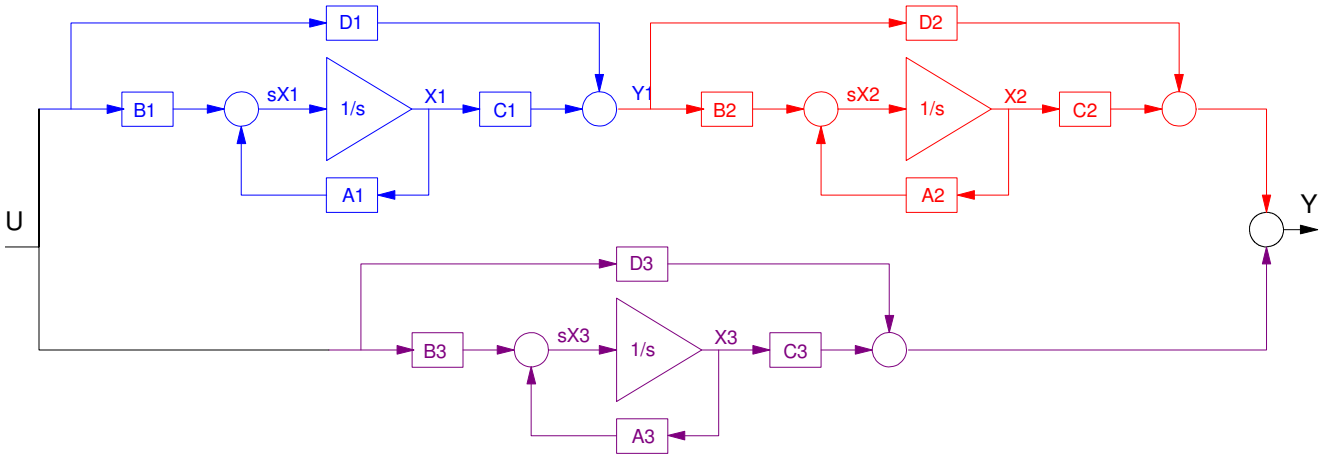
$$Y = V_3$$

Express these dynamic with the change in variable

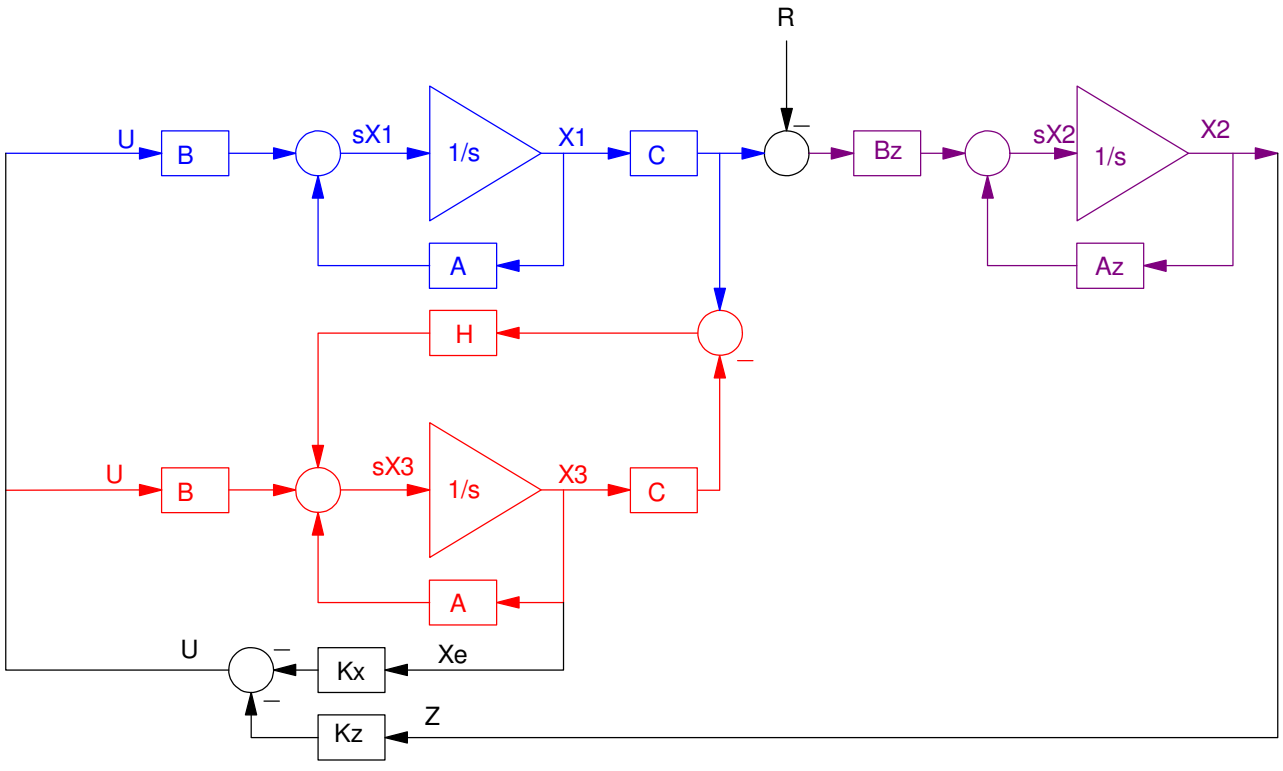
$$\begin{bmatrix} Z_1 \\ Z_2 \\ Z_3 \\ Z_4 \end{bmatrix} = \begin{bmatrix} V_1 - V_2 \\ V_2 - V_3 \\ V_3 - V_4 \\ V_1 + V_2 + V_3 + V_4 \end{bmatrix}$$

Block Diagrams

5) Determine the state-space model the following system:



6) Determine the state-space model for the following system:



LaGrangian Dynamics

A 1kg ball is rolling on a surface defined by:

$$y = 0.2 \cdot (x-2)(x)(x+2)$$

7) Determine the kinetic and potential energy of this ball as a function of x: Gravity is in the -y direction. Assuming a solid sphere:

8) Determine the dynamics for this ball as it rolls on this surface