ECE 463/663 - Homework #3

Canonical Forms, Similarity Transforms, LaGrangian Dynamics, Block Diagrams

Due Monday, January 31st

Please make the subject "ECE 463 HW#3" if submitting homework electronically to Jacob_Glower@yahoo.com (or on blackboard)

Canonical Forms

Problem 1-3) For the system

$$Y = \left(\frac{20(s+1.1)}{(s+1)(s+4)(s+5)} \right) X$$

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

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

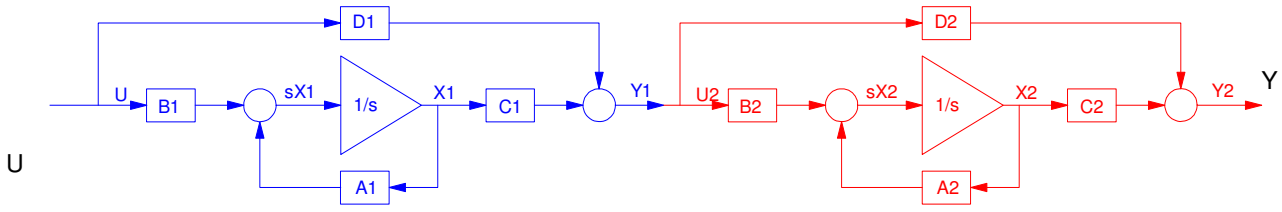
$$Y = V_3$$

Express these dynamic with the change in variable

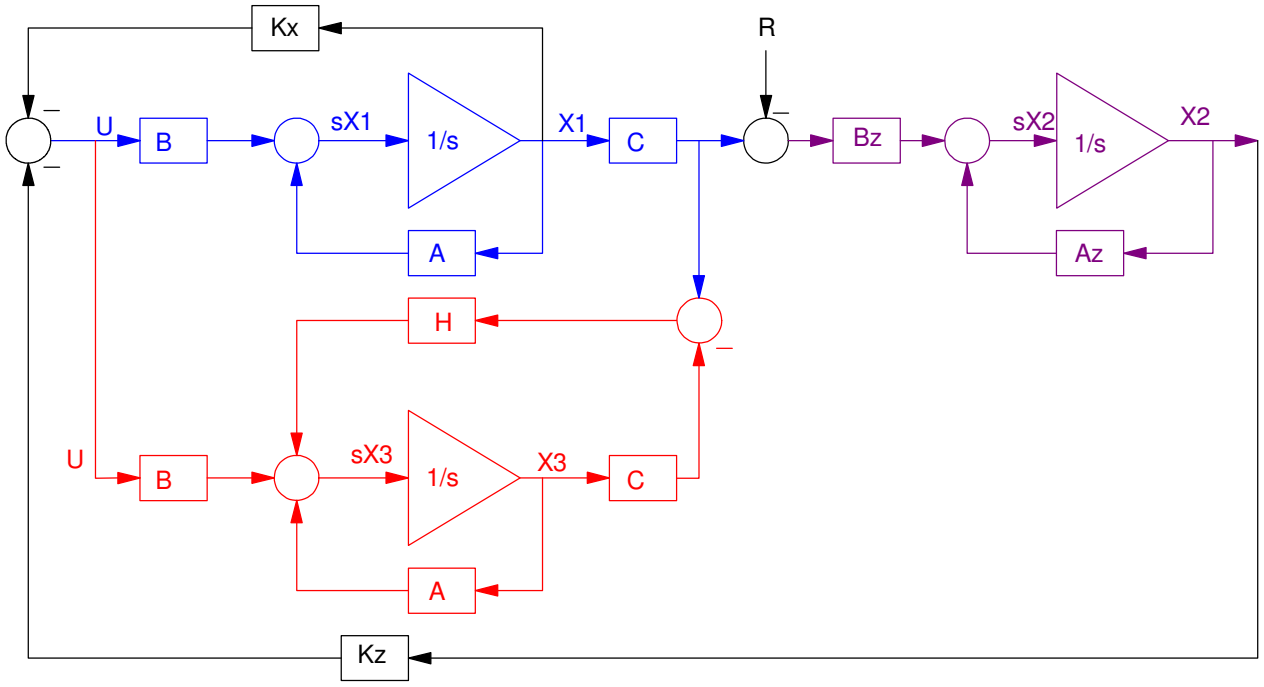
$$\begin{bmatrix} Z_1 \\ Z_2 \\ Z_3 \end{bmatrix} = \begin{bmatrix} V_2 \\ V_3 \\ V_1 + V_2 + V_3 \end{bmatrix}$$

Block Diagrams

5) Determine the state-space model for two systems in series:



6) Determine the state-space model for the following three interconnected systems:



LaGrangian Dynamics

A 1kg ball is rolling in a bowl with the shape

$$y = 0.1 \cdot |x|^{2.5}$$

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

8) Determine the dynamics for this ball as it rolls in the bowl