

# ECE 463/663 - Homework #3

Canonical Forms, Similarity Transforms, LaGrangian Dynamics, Controllability. Due Monday, Feb 3rd

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

Problem 1-3) For the system

$$Y = \left( \frac{2(s+5)(s+10)}{(s+6)(s+7)(s+8)} \right) X$$

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

$$\begin{bmatrix} sV_1 \\ sV_2 \\ sV_3 \end{bmatrix} = \begin{bmatrix} -15 & 5 & 0 \\ 5 & -15 & 5 \\ 0 & 5 & -10 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} + \begin{bmatrix} 5 \\ 0 \\ 0 \end{bmatrix} V_0$$

$$Y = V_3$$

Express these dynamic with the change in variable

$$\begin{bmatrix} Z_1 \\ Z_2 \\ Z_3 \end{bmatrix} = \begin{bmatrix} V_3 \\ V_2 - 2V_3 \\ V_1 - 5V_2 + 5V_3 \end{bmatrix}$$

## *LaGrangian Dynamics*

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

$$y = 2 \cosh(x) - 2 = e^x + e^{-x} - 2$$

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

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

