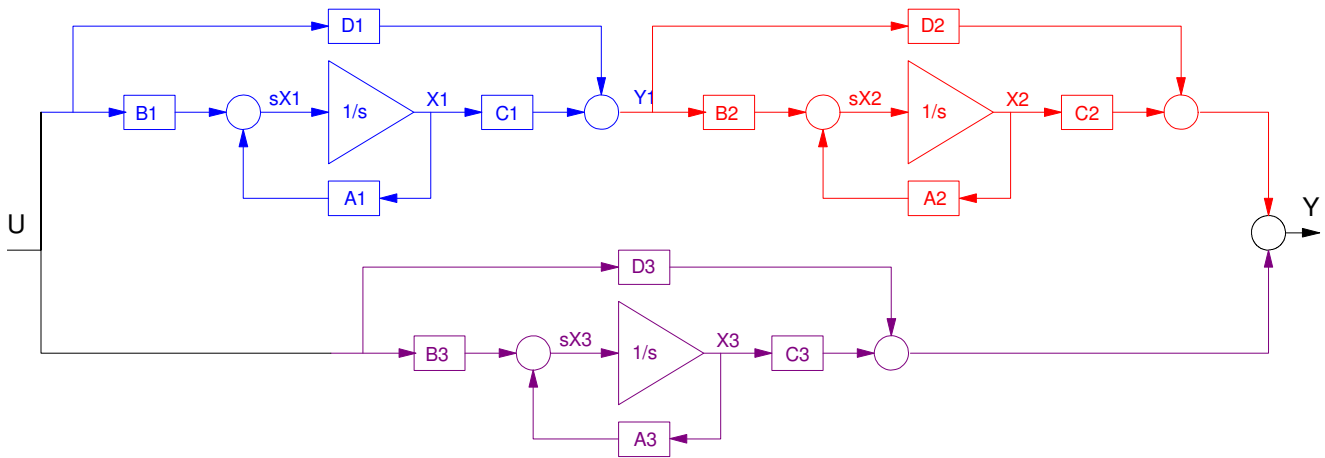


ECE 463/663 - Homework #2

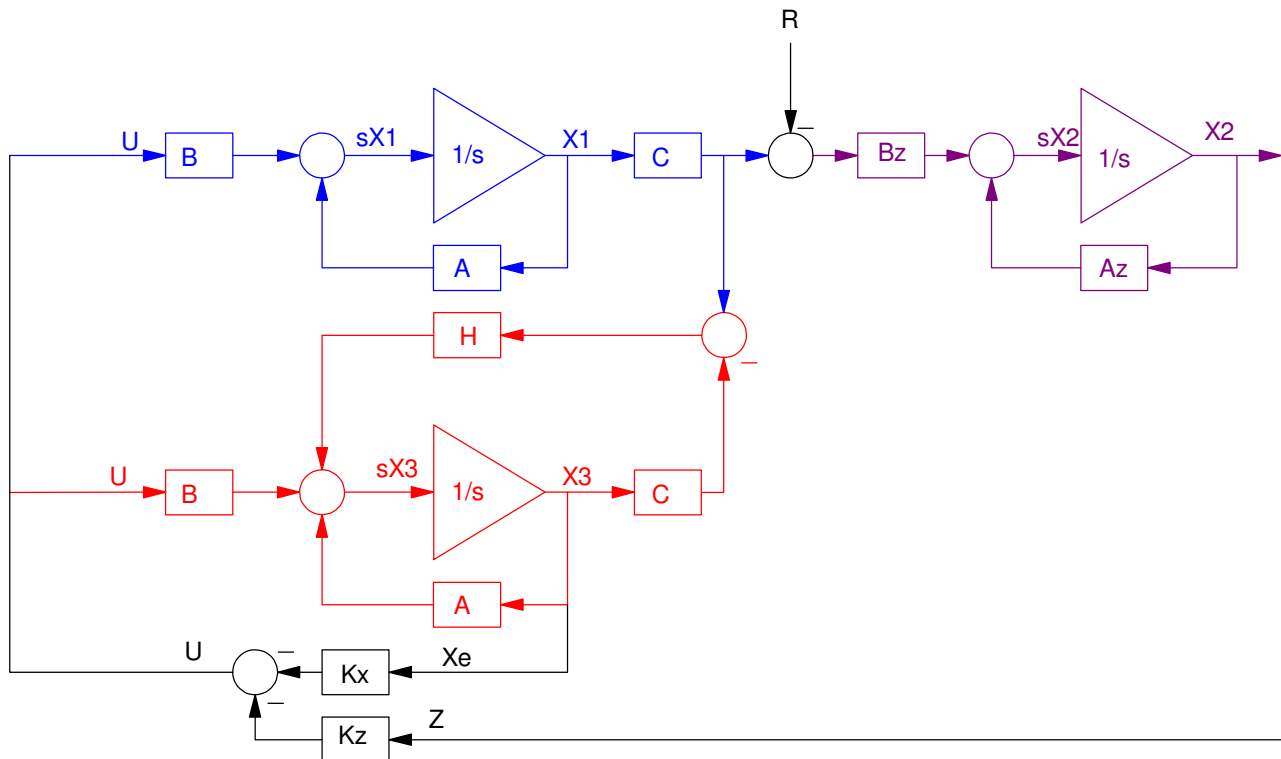
State-Space, Eigenvalues, Canonical Forms

State-Space

1) Give the state-space model for the following block diagram

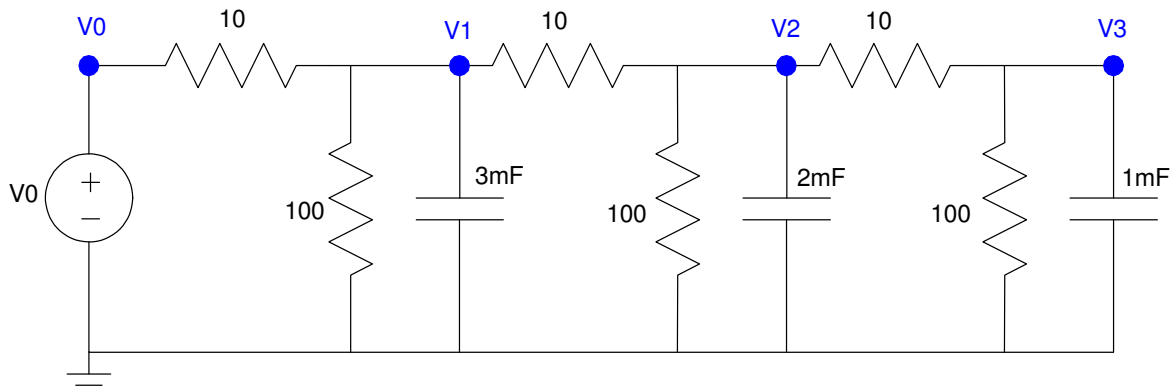


2) Give the state-space model for the following block diagram



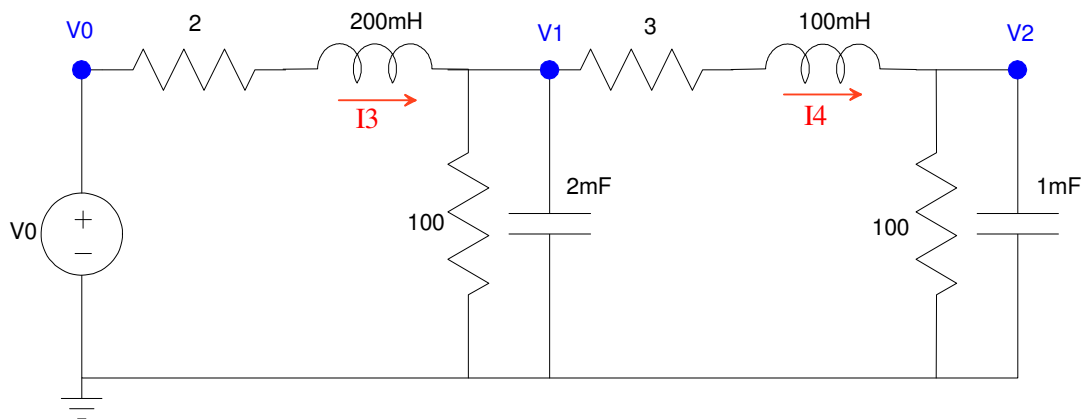
State-Space and Eigenvalues

Problems 3-5: Use the following RC circuit



- 3) Write the differential equations that describe this circuit
- 4) Find the transfer function from V_0 to V_3
- 5) Assume $V_0=0$ and $V_3(0) = 1$. What initial conditions on V_1 and V_2 result in
 - $V_3(t)$ decaying as fast as possible?
 - $V_3(t)$ decaying as slow as possible?

Problems 6-8: Use the following RLC circuit



- 6) Write the differential equations that describe this circuit
- 7) Find the transfer function from V_0 to V_2
- 8) Assume $V_0=0$ and $V_2(0) = 1$. What initial conditions result in
 - $V_2(t)$ decaying as fast as possible?
 - $V_2(t)$ decaying as slow as possible?

Canonical Forms

9) Let the transfer function from X to Y be

$$Y = \left(\frac{10(s+2)}{s(s+5)(s+20)} \right) X$$

Specify the {A, B, C, D} matrix that describe this system in state-space form:

- In controller canonical form
- In Jordan (diagonal) canonical form

Similarity Transforms

10) Let X and Y be related by the following state-space model

$$sX = \begin{bmatrix} -2 & 1 & 0 \\ 1 & -2 & 1 \\ 0 & 1 & -1 \end{bmatrix} X + \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} U$$

$$Y = \begin{bmatrix} 1 & 2 & 3 \end{bmatrix} X$$

What is the state-space model if you do a change of variable:

$$Z = \begin{bmatrix} x_1 + x_2 \\ x_1 - x_3 \\ x_1 + x_2 + x_3 \end{bmatrix} = \begin{bmatrix} 1 & 1 & 0 \\ 1 & 0 & -1 \\ 1 & 1 & 1 \end{bmatrix} X$$