System Simulation Problem #5

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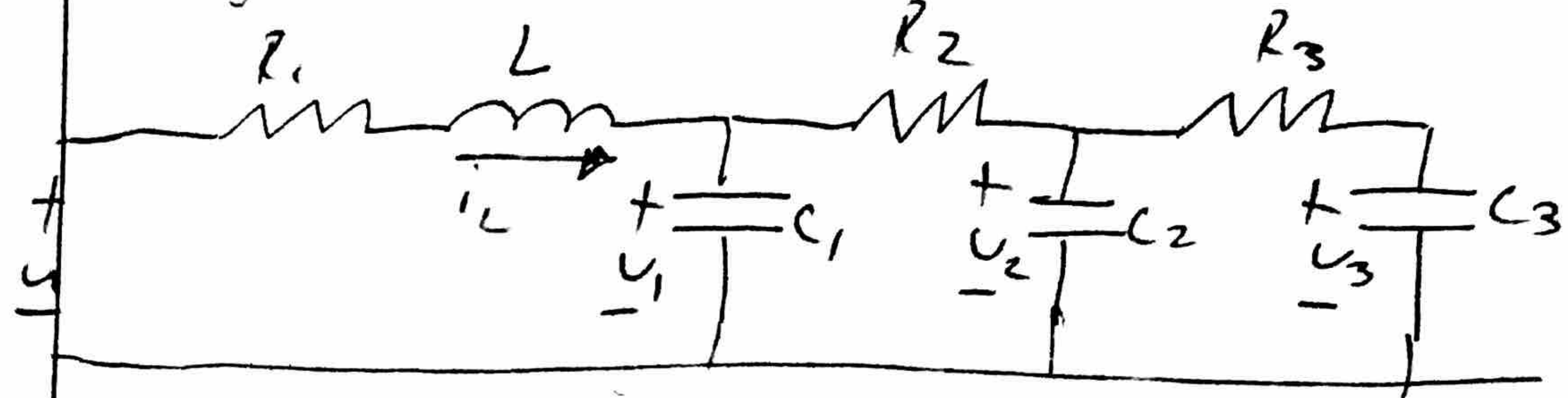

(A) a) $v_1 = x_1$; $v_2 = x_2$; $v_3 = x_3$; $i_L = x_4$

b) $x_4 = \dot{x}_1 C_1 + \dfrac{-x_2 + x_1}{R_2}$

c) $u = R_1 x_4 + L\dot{x}_4 + x_1$

$$\frac{x_2 - x_1}{R_2} = \dot{x}_2 C_2 + \frac{-x_3 + x_2}{R_3}$$

$$\frac{-x_3 + x_2}{R_3} = \dot{x}_3 C_3$$

d)

$$\dot{X} = \begin{array}{c} \begin{array}{cccc} x_1 & x_2 & x_3 & x_4 \end{array} \\ \begin{pmatrix} \frac{-1}{C_1R_2} & \frac{1}{C_1R_2} & 0 & \frac{1}{C_1} \\ \frac{1}{C_2R_2} & \frac{-1}{C_2R_2}+\frac{-1}{C_2R_3} & \frac{1}{C_2R_3} & 0 \\ 0 & \frac{1}{C_3R_3} & \frac{-1}{C_3R_3} & 0 \\ \frac{-1}{L} & 0 & 0 & \frac{-R_1}{L} \end{pmatrix} \end{array} X + \begin{pmatrix} 0 \\ 0 \\ 0 \\ 1/L \end{pmatrix} u$$

(e) The given matrix $\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix}$ gives each capacitor voltage (ie: x_1, x_2 x_3) as an output for the matrix give in part A-d. If we wanted to change our outputs the the matrix would change. For example, x_1 & x_2 as outputs would give the matrix $\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{pmatrix}$.