a) KVL:

$$+v_1 - L_1\frac{di_1}{dt} - Ri_1 - R\underbrace{(i_1+i_2)}_{\text{KCL}} = 0$$

$$+v_2 - L_2\frac{di_2}{dt} - R(i_1+i_2) = 0$$

b) Let $x_1 = i_1$ and $x_2 = i_2$

$$\Rightarrow \dot{x}_1 = \frac{di_1}{dt} = \frac{1}{L_1}(v_1 - 2Ri_1 - Ri_2) = \frac{1}{L_1}(v_1 - 2Rx_1 - Rx_2)$$

$$\dot{x}_2 = \frac{di_2}{dt} = \frac{1}{L_2}(v_2 - Ri_1 - Ri_2) = \frac{1}{L_2}(v_2 - Rx_1 - Rx_2)$$

$$\Rightarrow \begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -\frac{2R}{L_1} & -\frac{R}{L_1} \\ -\frac{R}{L_2} & -\frac{R}{L_2} \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} \frac{1}{L_1} & 0 \\ 0 & \frac{1}{L_2} \end{bmatrix}\begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \underbrace{\begin{bmatrix} 0 \end{bmatrix}}_{2\times 2}\begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

P_2 -

a) $$\begin{cases} v_1 - L_1 \frac{di_1}{dt} - \frac{1}{C}\int i_1 dt - R(i_1 + i_2) = 0 \\ v_2 - L_2 \frac{di_2}{dt} - R(i_1 + i_2) = 0 \end{cases}$$

b) Let $x_1 = \int i_1 dt$; $x_2 = i_1$; $x_3 = i_2$

$$\dot{x}_1 = \dot{i}_1 = x_2$$

$$\dot{x}_2 = \frac{di_1}{dt} = \frac{1}{L_1}\left(v_1 - \frac{1}{C}\int i_1 dt - R(i_1 + i_2)\right) = \frac{1}{L_1}\left(v_1 - \frac{1}{C}x_1 - Rx_2 - R\right)$$

$$\dot{x}_3 = \frac{di_2}{dt} = \frac{1}{L_2}\left(v_2 - R(i_1 + i_2)\right) = \frac{1}{L_2}\left(v_2 - Rx_2 - Rx_3\right)$$

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ -\frac{1}{L_1 C_1} & -\frac{R}{L_1} & -\frac{R}{L_1} \\ 0 & -\frac{R}{L_2} & -\frac{R}{L_2} \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \end{Bmatrix} + \begin{bmatrix} 0 & 0 \\ \frac{1}{L_1} & 0 \\ 0 & \frac{1}{L_2} \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \end{Bmatrix} + [0] \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

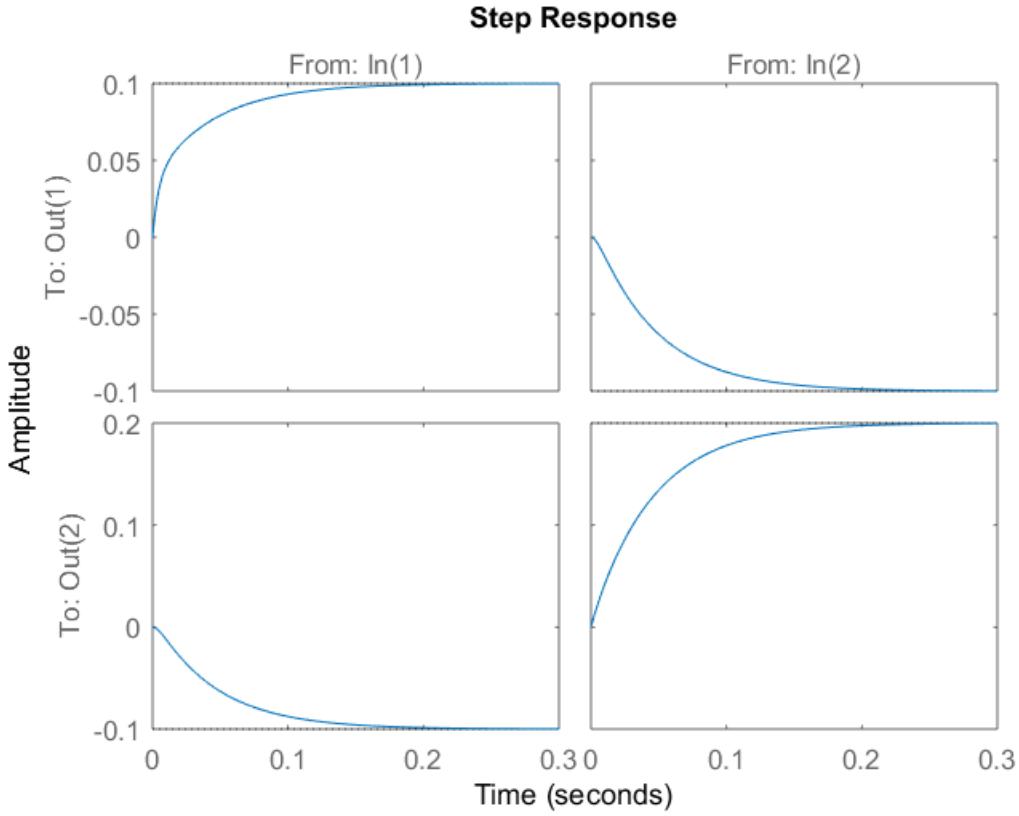
Part 1

```
R = 10;
L1 = 0.1;
L2 = 0.2;

A = [-2*R/L1 -R/L1; -R/L2 -R/L2];
B = [1/L1 0; 0 1/L2];
C = [1 0; 0 1];
D = 0;

sys1 = ss(A, B, C, D);

figure; step(sys1);
```



Part 2

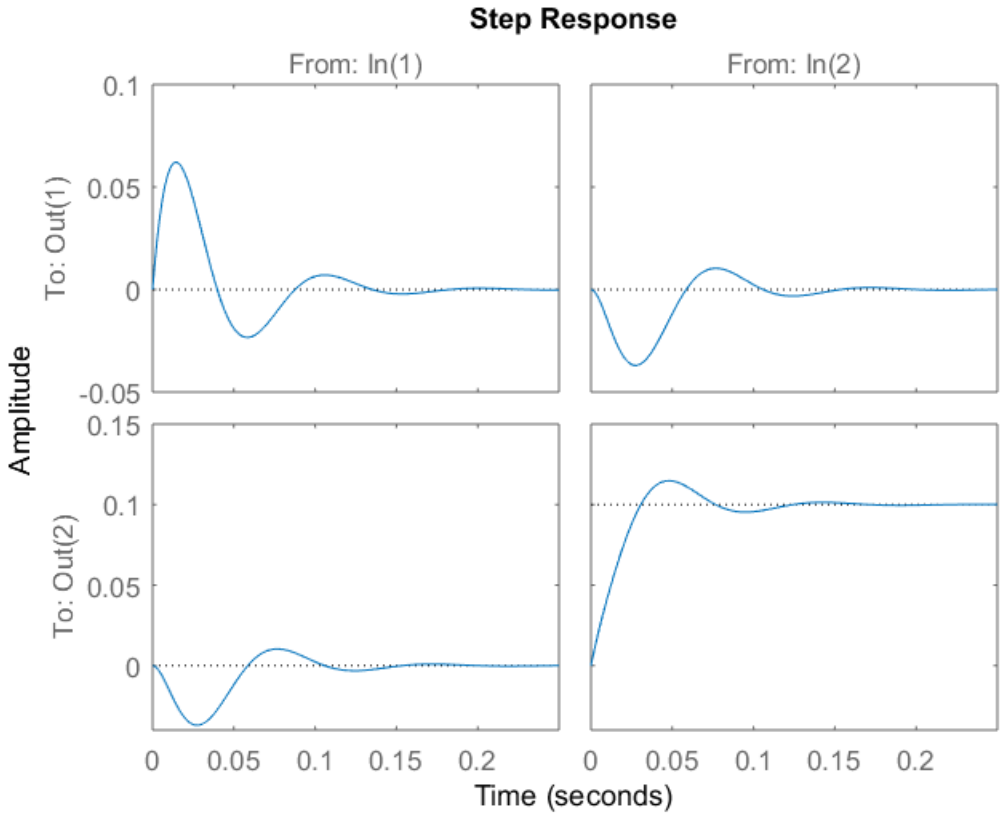
```
R = 10;
L1 = 0.1;
L2 = 0.2;
C = 1000e-6;

A = [0  1  0; -1/(L1*C) -R/L1 -R/L1; 0 -R/L2 -R/L2];
B = [0 0; 1/L1 0; 0 1/L2];
```

```
C = [0 1 0;0 0 1];
D = 0;

sys2 = ss(A, B, C, D);

figure; step(sys2);
```



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