Item a)

Representação no espaço de estados:

$$\mathbf{x} = \begin{bmatrix} V_{C_1}(t) \\ V_{C_2}(t) \\ i_L(t) \end{bmatrix}, \qquad u(t) = V_i(t)\,, \qquad y(t) = V_o(t)\,,$$

$$\dot{\mathbf{x}} = \begin{bmatrix} -\frac{1}{C_1 R_1} & 0 & \frac{1}{C_1} \\ 0 & -\frac{1}{C_2 R_1} & -\frac{1}{C_2} \\ -\frac{1}{L} & \frac{1}{L} & 0 \end{bmatrix} \mathbf{x} \begin{bmatrix} 0 \\ \frac{1}{C_2 R_1} \\ 0 \end{bmatrix} u(t)$$

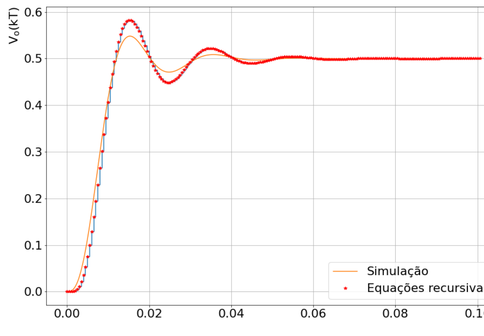
$$y(t) = \begin{bmatrix} 1,0 & 0,0 & 0,0 \end{bmatrix} \mathbf{x}\,,$$

$$\dot{\mathbf{x}} = \begin{bmatrix} -200,0 & 0,0 & 1000,0 \\ 0,0 & -200,0 & -1000,0 \\ -50,0 & 50,0 & 0,0 \end{bmatrix} \mathbf{x} \begin{bmatrix} 0,0 \\ 200,0 \\ 0,0 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 1,0 & 0,0 & 0,0 \end{bmatrix} \mathbf{x}$$

Item b)

Gráfico de Vo(kT):



Item c)

$$\mathbf{K}_e = \begin{bmatrix} 1,6 \\ 0,6 \end{bmatrix}$$

$$\hat{\mathbf{A}} = \begin{bmatrix} -200,0 & -2600,0 \\ 50,0 & -600,0 \end{bmatrix}$$

$$\hat{\mathbf{B}} = \begin{bmatrix} -1560,0 \\ -210,0 \end{bmatrix}$$

$$\hat{\mathbf{F}} = \begin{bmatrix} 200,0 \\ 0,0 \end{bmatrix}$$

$$\hat{\mathbf{C}} = \begin{bmatrix} 0,0 & 0,0 \\ 1,0 & 0,0 \\ 0,0 & 1,0 \end{bmatrix}$$

$$\hat{\mathbf{D}} = \begin{bmatrix} 1,0 \\ 1,6 \\ 0,6 \end{bmatrix}$$

Item d)

Conjunto de Equações mínimas:

Equação da discretização do integrador:

$$\tilde{\eta}(k) = \mathrm{T} \cdot \dot{\tilde{\eta}}(k-1) + \tilde{\eta}(k-1)$$

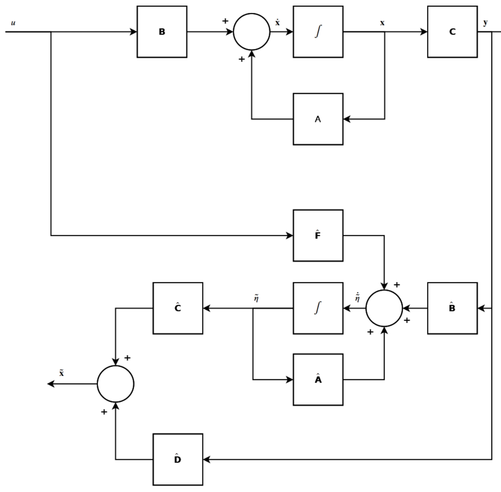
Equação diferencial de estados:

$$\dot{\tilde{\eta}}(k) = \begin{bmatrix} -200,0 & -2600,0 \\ 50,0 & -600,0 \end{bmatrix} \tilde{\eta}(k) + \begin{bmatrix} -1560,0 \\ -210,0 \end{bmatrix} \mathrm{Amostra}(k) + \begin{bmatrix} 200,0 \\ 0,0 \end{bmatrix} \mathrm{U}(k)$$

Equação de saída:

$$\tilde{\mathbf{x}}(k) = \begin{bmatrix} 0,0 & 0,0 \\ 1,0 & 0,0 \\ 0,0 & 1,0 \end{bmatrix} \tilde{\eta}(k) + \begin{bmatrix} 1,0 \\ 1,6 \\ 0,6 \end{bmatrix} \mathrm{Amostra}(k)$$

Diagrama em blocos:



Item e)

Matriz de ganho do controlador:

$$\hat{\mathbf{K}} = \begin{bmatrix} 678,0 & 36,5 & 1580,0 & -306250,0 \end{bmatrix}$$

Item f)

Parâmetro	Valor Teórico	Valor da Simulação
Mp (%)	4,598791	4,492519
tp (s)	0,008798219	0,009409409