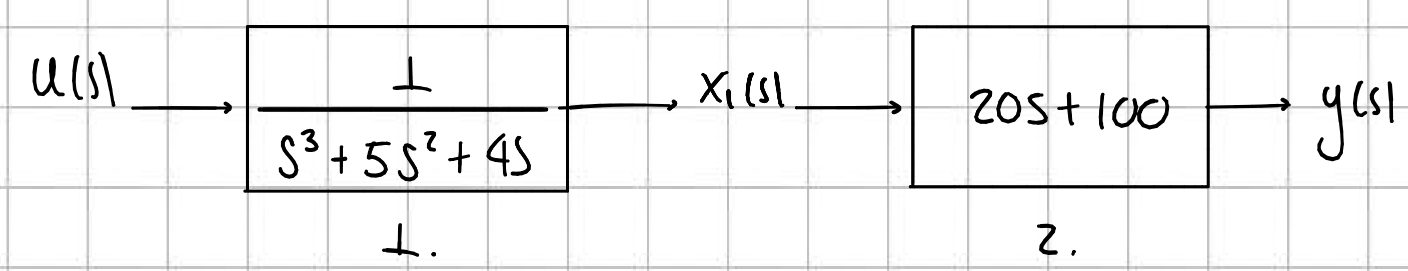
Transcripción #1

· Sistema de control por realimentación de estados.

$$\rightarrow G(s) = \frac{20(s+5)}{s(s+1)(s+4)} \quad \begin{cases} OS = 9{,}5\% \\ t_s = 0{,}74 \text{ seg} \end{cases}$$



Para el bloque 1.

$$u(s) = X_1(s)(s^3+5s^2+4s)$$

$$\rightarrow \mathcal{L}^{-1} = \dddot{x} + 5\ddot{x} + 4\dot{x} = u$$

Para el bloque 2.

$$(20s+100)X_1(s) = y(s)$$

$$\rightarrow \mathcal{L}^{-1} = 20\dot{x} + 100 = y$$

$$x_1 = x \qquad x_2 = \dot{x}_1 \qquad x_3 = \ddot{x}_1 \qquad \dot{x}_3 = \dddot{x}_1$$

$$\rightarrow \dot{x}_3 + 5x_3 + 4x_2 = u \rightarrow \dot{x}_3 = u - 5x_3 - 4x_2$$

$$y = 20x_2 + 100x_1$$

$$= \begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -4 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 100 & 20 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

→ Considerando el amortiguamiento

$$\%OS = e^{-(\zeta\pi/\sqrt{1-\zeta^2})} \cdot 100$$

$$= 0{,}095 = e^{-(\zeta\pi/\sqrt{1-\zeta^2})} \cdot 100 \rightarrow \ln(0{,}095) = -\frac{\zeta\pi}{\sqrt{1-\zeta^2}}$$

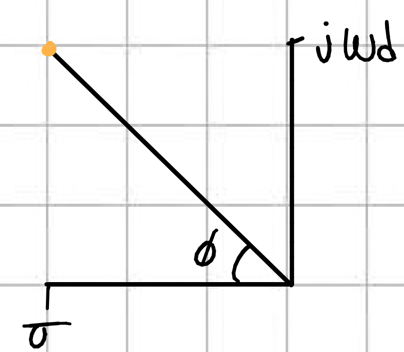
$$= (2{,}3539)^2(1-\zeta^2) = (\zeta\pi)^2$$

$$= (2{,}3534)^2(1-\zeta^2) - (\zeta\pi)^2 = 0$$

$$= 5{,}5407 = \zeta^2(\pi^2 + 5{,}5407)$$

$$\rightarrow \zeta^2 = \frac{5{,}5407}{\pi^2 + 5{,}5407} = \zeta = 0{,}5996$$

→ Plano S



$\zeta = \cos\phi$

· $s = \sigma + j\omega_d \rightarrow \sigma = \zeta\omega_n$

$\phi = \cos^{-1}(0{,}5996) = 53{,}16°$

$t_s = \frac{4}{\sigma} \rightarrow 0{,}74 = \frac{4}{\sigma}$

$= \sigma = 5{,}41$

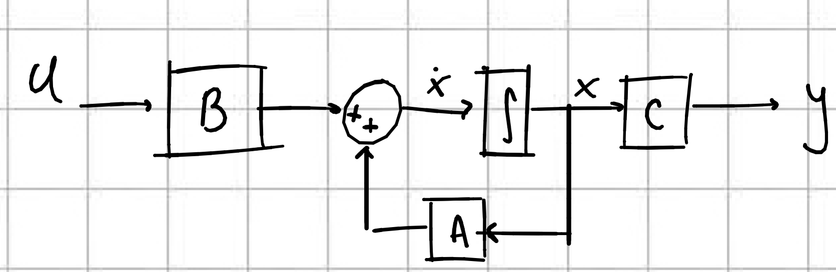
$\sigma = \zeta\omega_n \qquad \omega_d = \omega_n\sqrt{1-\zeta^2}$

$5{,}405 = 0{,}5977\,\omega_n \rightarrow \omega_n = 9{,}02 \text{ rad/s}$

$\rightarrow \tan(\phi) = \frac{\omega_d}{5{,}41} \rightarrow \omega_d = \tan(53{,}16)(5{,}41)$

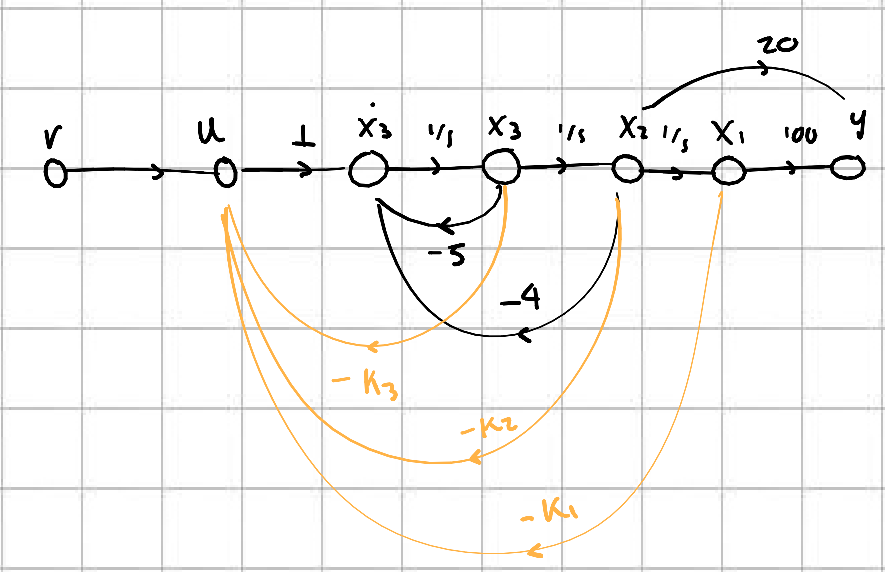
$= 7{,}21$

→ Realimentación en espacio de estados



$\dot{x} = Ax + Bu \qquad y = Cx$

→ Para la matriz mostrada anteriormente el diagrama de flujo de señal.



$$\dot{x}_3 = -4x_2 - 5x_3 + u \longrightarrow \dot{x}_3 = -4x_2 - 5x_3 + (-k_3x_3 - k_2x_2 - k_1x_1) + v$$

$$= -k_1x_1 - (4+k_2)x_2 - (5+k_3)x_3 + v$$

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -k_1 & -(4+k_2) & -(5+k_3) \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} v$$

$$\det\left(sI - A(BK)]\right) = s^3 + (5+k_3)s^2 + (4+k_2)s + k_1 = 0$$

Ecuacion caracteristica del sistema