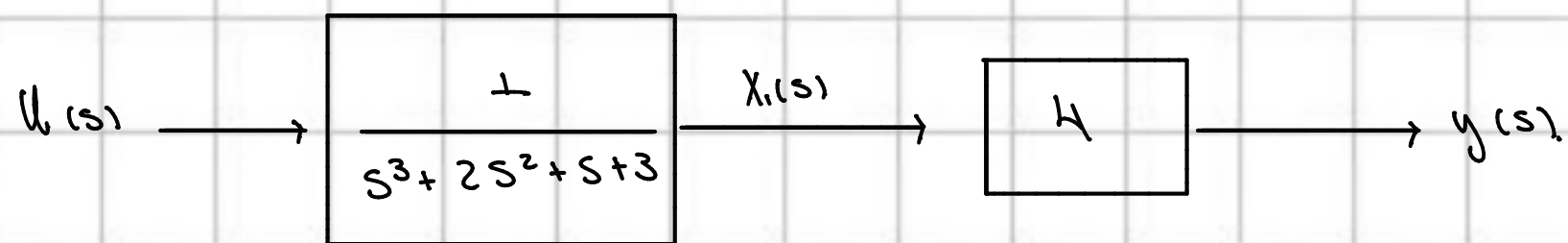


• Bonus Parcial FABIÁN LEONARDO CANARGO BERNATE.

Punto 1: Encontrar expresión canónica en el espacio de estados

$$G(s) = \frac{4}{s^3 + 2s^2 + s + 3}.$$

Forma Canónica Controlable



$$X_1(s) (s^3 + 2s^2 + s + 3) = U(s).$$

$$Y(s) = X_1(s) 4.$$

$$\ddot{X}_1 + 2\dot{X}_1 + \dot{X}_1 + 3X_1 = U.$$

$$\dot{X}_3 + 2X_3 + X_2 + 3X_1 = U.$$

• Para expresión en espacio de estado.

$$X_1 = X_1 \quad X_2 = \dot{X}_1 \quad X_3 = \ddot{X}_1$$

• Derivar

$$\dot{X}_1 = \dot{X}_1 = X_2.$$

$$\dot{X}_2 = \ddot{X}_1 = X_3.$$

$$\dot{X}_3 = \ddot{X}_3 \text{ Despejar.}$$

$$\dot{X}_1 = X_2$$

$$\dot{X}_2 = X_3.$$

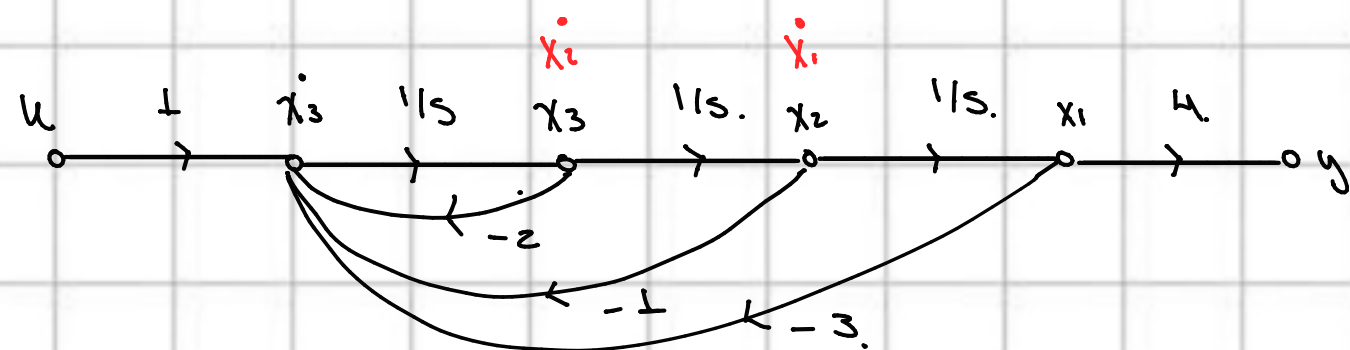
$$\dot{X}_3 = U - 2X_3 - X_2 - 3X_1.$$

• Forma Matricial

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \\ \dot{X}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -3 & -1 & -2 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} U.$$

$$y = \begin{bmatrix} 4 & 0 & 0 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix}$$

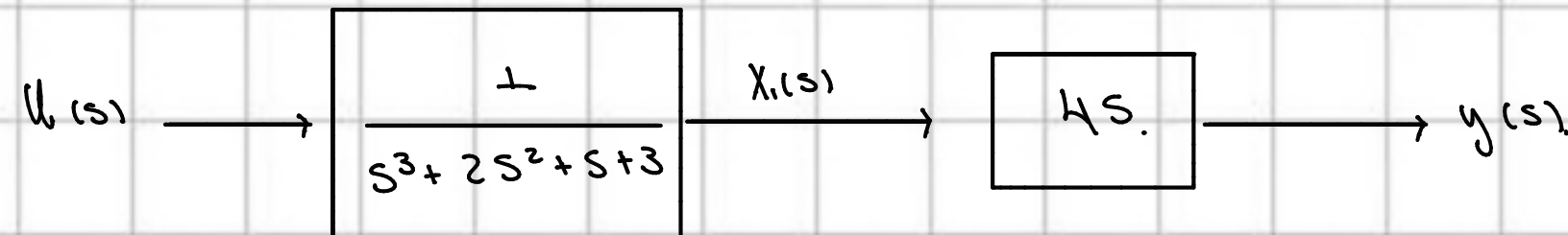
• Diagrama de Flujo de Señal



Punto 2.

$$G(s) = \frac{4s}{s^3 + 2s^2 + s + 3}.$$

Forma Canónica Controlable



$$X_1(s) (s^3 + 2s^2 + s + 3) = U(s).$$

$$Y(s) = X_1(s) (4s)$$

$$\ddot{X}_1 + 2\dot{X}_1 + \dot{X}_1 + 3X_1 = U.$$

$$\dot{X}_3 + 2X_3 + X_2 + 3X_1 = U.$$

Para expresión en espacio de estado.

$$Y(s) = 4\dot{X}_1$$

$$Y(s) = 4X_2$$

$$X_1 = X_1 \quad X_2 = \dot{X}_1 \quad X_3 = \ddot{X}_1$$

• Derivar

$$\dot{X}_1 = \dot{X}_1 = X_2.$$

$$\dot{X}_2 = \ddot{X}_1 = X_3.$$

$$\dot{X}_3 = \ddot{X}_3 \text{ Despejar.}$$

$$\dot{X}_1 = X_2$$

$$\dot{X}_2 = X_3.$$

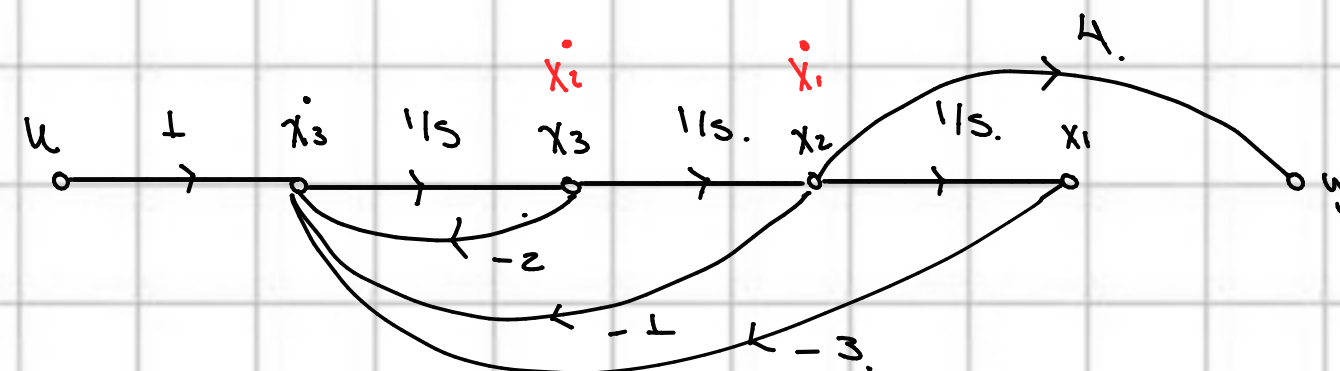
$$\dot{X}_3 = U - 2X_3 - X_2 - 3X_1.$$

• Forma Matricial

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \\ \dot{X}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -3 & -1 & -2 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} U.$$

$$y = \begin{bmatrix} 0 & 4 & 0 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix}$$

• Diagrama de Flujo de Señal

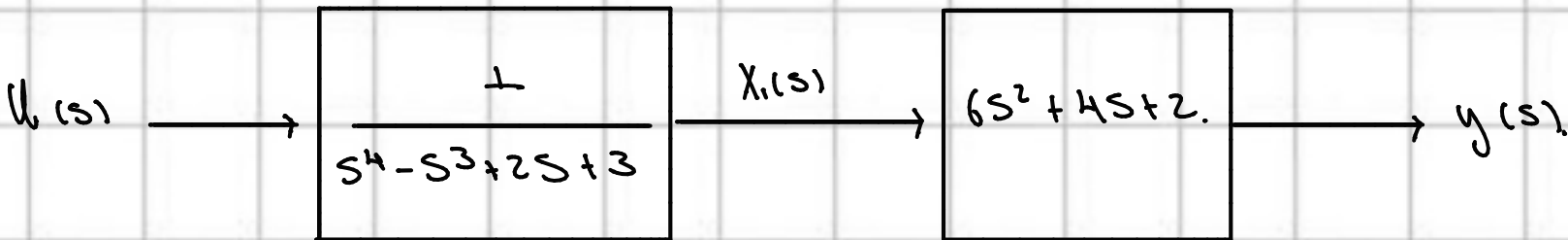




Punto 3.

$$G(s) = \frac{6s^2 + 4s + 2}{s^4 - s^3 + 2s + 3}$$

Forma Canónica Controlable



$$x_1(s) (s^4 - s^3 + 2s + 3) = u(s)$$

$$\ddot{\ddot{x}}_1 - \ddot{x}_1 + 2\dot{x}_1 + 3x_1 = u(s)$$

$$x_1 = x_1 \quad x_2 = \dot{x}_1 \quad x_3 = \ddot{x}_1 \quad x_4 = \ddot{\ddot{x}}_1$$

Derivar.

$$\begin{aligned} \dot{x}_1 &= \dot{x}_1 = x_2 & \ddot{\ddot{\ddot{x}}}_1 - \ddot{\ddot{x}}_1 + 2\dot{\ddot{x}}_1 + 3\ddot{x}_1 &= u(s) \\ \dot{x}_2 &= \dot{x}_2 = x_3 & \dot{x}_4 - x_4 + 2x_2 + 3x_1 &= u \\ \dot{x}_3 &= \dot{x}_3 = x_4 & \dot{x}_4 &= u + x_4 - 2x_2 - 3x_1 \\ \dot{x}_4 &= \ddot{\ddot{\ddot{x}}}_1 & \text{Despejar} & \end{aligned}$$

$$y(s) = x_1(s) (6s^2 + 4s + 2)$$

$$y(s) = 6\ddot{\ddot{x}}_1 + 4\dot{\ddot{x}}_1 + 2\ddot{x}_1 \longrightarrow 6x_3 + 4x_2 + 2x_1$$

Forma Matricial

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \\ \dot{x}_4 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -3 & -2 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 2 & 4 & 6 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix}$$

Diagrama de Flujo de Señal

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \\ \dot{x}_4 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -3 & -2 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 2 & 4 & 6 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix}$$

