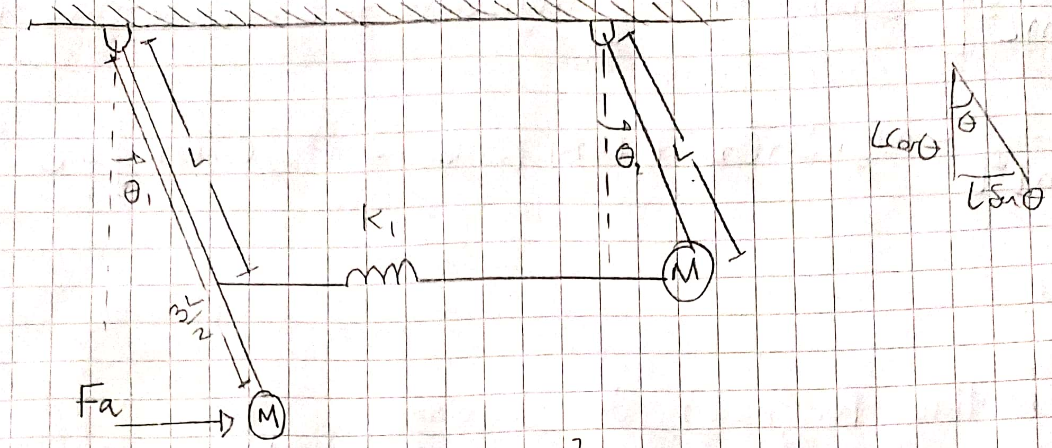
Brian Sebastián Caceres Pinzón 1803245.



$$T = \frac{1}{2} m \left(\frac{3}{2} L \dot{\theta}_1\right)^2 + \frac{1}{2} m \left(L \dot{\theta}_2\right)^2$$

$$T = \frac{1}{2} m \frac{9}{4} L^2 \dot{\theta}_1^2 + \frac{1}{2} m L^2 \dot{\theta}_2^2$$

$$T = \frac{1}{2} m L^2 \left(\frac{9}{4} \dot{\theta}_1^2 + \dot{\theta}_2^2\right)$$

$$u = mg\left(-\frac{3L\cos\theta_1}{2} - \left(-\frac{3L}{2}\right)\right) + mgL\left(1 - \cos\theta_2\right) + \frac{1}{2}\left(x_1 - x_2\right)^2 K_1$$

$$u = mg\left(\frac{3}{2} L - \frac{3}{2} L \cos\theta_1\right) + mgL\left(1 - \cos\theta_2\right) + \frac{1}{2}\left(L\sin\theta_1 - L\sin\theta_2\right)^2 K_1$$

$$u = mgL\left(\frac{3}{2} - \frac{3}{2}\cos\theta_1\right) + mgL\left(1 - \cos\theta_2\right) + \frac{1}{2}\left(L\sin\theta_1 - L\sin\theta_2\right)^2 K_1$$

$$u = mgL\left(\frac{5}{2} - \frac{3}{2}\cos\theta_1 - \cos\theta_2\right) + \frac{1}{2} L^2 \left(\sin\theta_1 - \sin\theta_2\right)^2 K_1$$

$$L = \frac{1}{2} m L^2 \left(\frac{9}{4}\dot{\theta}_1^2 + \dot{\theta}_2^2\right) - mgL\left(\frac{5}{2} - \frac{3}{2}\cos\theta_1 - \cos\theta_2\right) - \frac{1}{2} L^2 K_1 \left(\sin\theta_1 - \sin\theta_2\right)^2$$

$$\frac{d}{dt}\left[\frac{\partial L}{\partial \dot{\theta}_1}\right] - \frac{\partial L}{\partial \theta_1} = Fa \frac{3}{2} L \cos\theta.$$

$$\frac{d}{dt}\left[\frac{1}{\cancel{2}} \frac{9}{4} \cdot \cancel{2} m L^2 \dot{\theta}_1\right] - \left(-\frac{3}{2} mgL\sin\theta_1 - L^2 K_1 \left(\sin\theta_1 - \sin\theta_2\right)\cos\theta_1\right) = \frac{3}{2} Fa L \cos\theta$$

$$mL^2 \ddot{\theta}_1 + \frac{3}{2} mgL\sin\theta_1 + L^2 K_1 \left(\sin\theta_1 - \sin\theta_2\right)\cos\theta_1 = \frac{3}{2} Fa L \cos\theta$$

$$\frac{d}{dt}\left[\frac{\partial L}{\partial \dot{\theta}_2}\right] - \frac{\partial L}{\partial \theta_2} = 0$$

$$\frac{d}{dt}\left[mL^2 \dot{\theta}_2\right] - \left(-mgL\sin\theta_2 + L^2 K_1 \left(\sin\theta_1 - \sin\theta_2\right)\cos\theta_2\right) = 0$$

$$mL^2 \ddot{\theta}_2 + mgL\sin\theta_2 - L^2 K_1 \left(\sin\theta_1 - \sin\theta_2\right)\cos\theta_2 = 0$$

$$\dot{W}_1 = \frac{1}{mL^2}\left[\frac{3}{2} Fa L \cos\theta_1 - \frac{3}{2} mgL \sin\theta_1 - L^2 k_1 (\sin\theta_1 - \sin\theta_2)\cos\theta_1\right] = 0$$

$$\dot{W}_2 = \frac{1}{mL^2}\left[-mgL\sin\theta_2 + L^2 k_1 (\sin\theta_1 - \sin\theta_2)\cos\theta_2\right] = 0$$

$$\dot{\theta}_1 = W_1$$

$$\dot{\theta}_2 = W_2$$

Usando Matlab por medio de Jacobiano

$$\begin{bmatrix} \dot{W}_1\delta \\ \dot{W}_2\delta \\ \dot{\theta}_1\delta \\ \dot{\theta}_2\delta \end{bmatrix} = \begin{bmatrix} 0 & 0 & -\frac{\left(k_1 L^2 \cos^2\theta_1 - k_1 \sin\theta_1 \sigma_2 L^2 + \frac{3}{2} mgL\cos\theta_1 + \frac{3}{2} fa\sin\theta_1 L\right)}{L^2 m} & \sigma_1 \\ 0 & 0 & \sigma_1 & -\frac{\left(k_1 L^2 \cos^2\theta_2 + k_1 \sin\theta_2 L^2 + gmL\cos\theta_2\right)}{l^2 m} \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} W_1\delta \\ W_2\delta \\ \theta_1\delta \\ \theta_2\delta \end{bmatrix}$$

$$+ \begin{bmatrix} \frac{3\cos\theta_1}{2lm} \\ 0 \\ 0 \\ 0 \end{bmatrix} Fa\delta$$

$$\sigma_1 = \frac{k_1 \cos\theta_1 \cos\theta_2}{m}$$

$$\sigma_2 = \sin\theta_1 - \sin\theta_2$$

$m = 0{,}5$, $L = 1$, $g = 9{,}81$, $k_1 = 200$

$\bar{t}_2 = 30°$ despejando $\bar{t}_1$ de $\dot{W}_2$ con matlab.

$\bar{t}_1 = 30{,}93°$ y despejando $\bar{Fa}$ de $\dot{W}_1$ con matlab.

$\bar{Fa} = 4{,}8283\ N$

2

Constantes | Por despeje en matlab.

$m = 0{,}5$ | $\bar{X}_1 = 1 \; m$

$k = 1$

$k_2 = 2$ | $\bar{V}_1 = 1 \; m/s$

$K_m = 0{,}05$ | $\bar{i_a} = 68 \; A$

$K_w = 0{,}03$ | $\bar{V_{in}} = 680{,}03 \, V$

$r = 1$

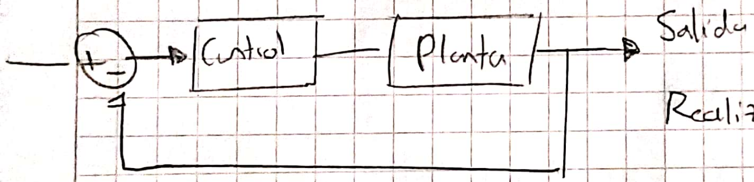
$R_a = 10$ → Usando matlab obtenemos ft:

$L_a = 0{,}9$

$b = 0{,}4$

$$ft = \frac{0{,}1111}{s^3 + 12{,}71 s^2 + 23{,}78 s + 66{,}67}$$

Controlador $\quad K_p + \frac{K_i}{s} + K_d s + K_d s^2 = \frac{K_p s + K_i + K_d s^2 + K_d s^3}{s}$



Realizando la Retroalimentación (Matlab).

$$ft = \frac{0{,}11 K_d s^3 + 0{,}11 K_d s^2 + 0{,}11 K_p s + 0{,}11 K_i}{s^4 + (0{,}11 K_{d2} + 12{,}71) s^3 + (0{,}11 K_d + 23{,}78) s^2 + (0{,}11 K_p + 66{,}67) s + 0{,}11 K_i}$$

Polinomio deseado

$\xi = 0{,}7 \qquad W_n = 2$

$s^2 + 2\xi W_n + W_n^2 \, (s + 5\xi W_n)^2$ → Reemplazando Matlab el ξ y W_n

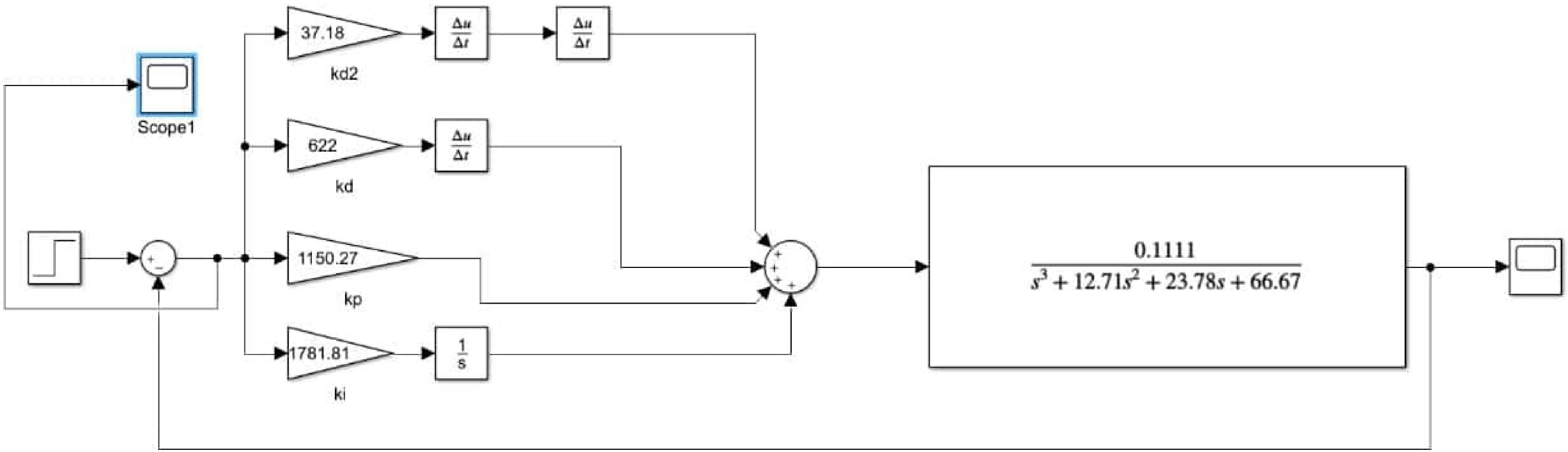
$$s^4 + 16{,}8 s^3 + 92{,}2 s^2 + 193{,}2 s + 196$$

$s^3 \quad 0{,}11 K_{d2} + 12{,}71 = 16{,}8 \quad \to K_{d2} = 37{,}18$

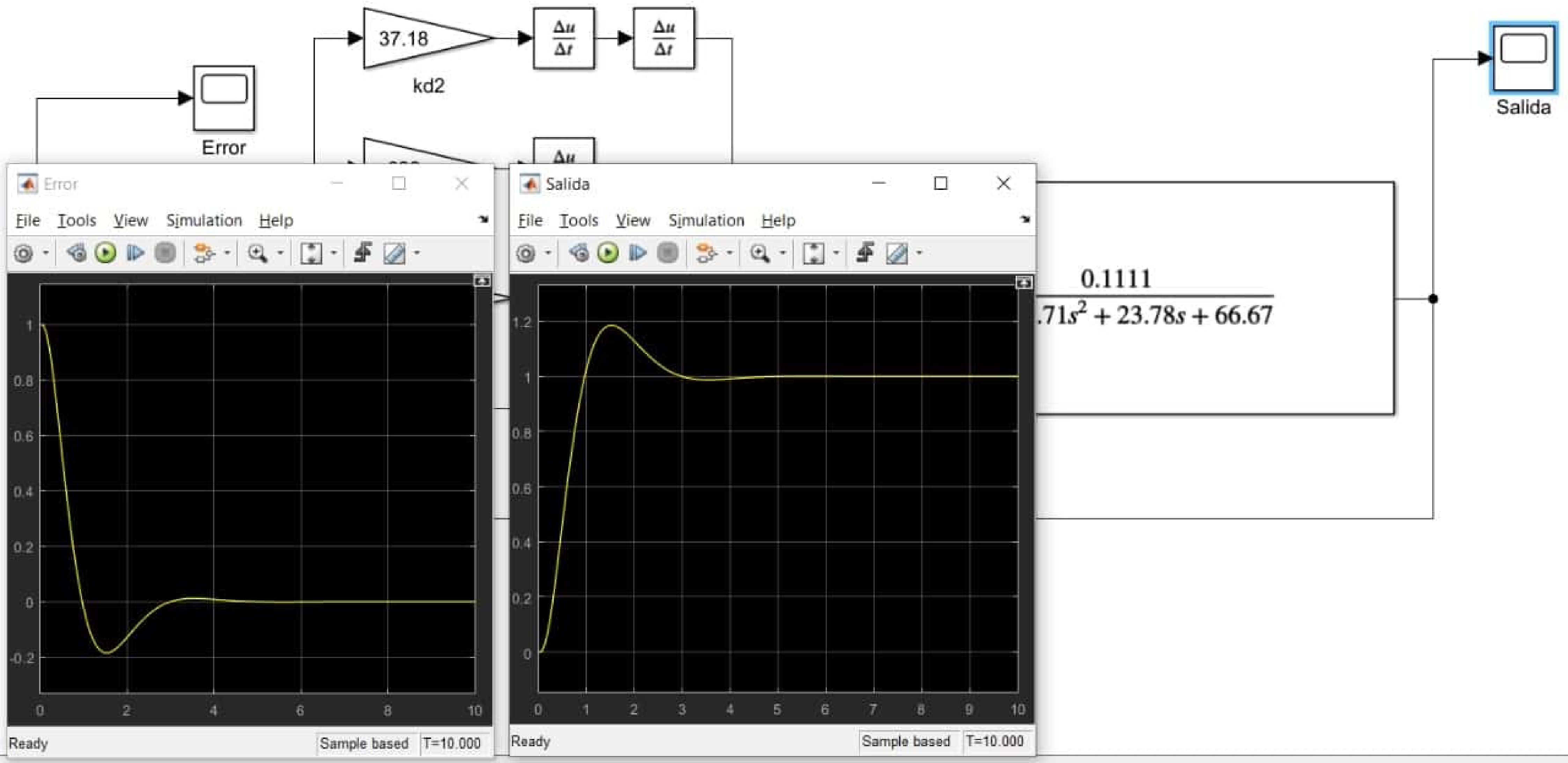
$s^2 \quad 0{,}11 K_{d1} + 23{,}78 = 92{,}2 \quad \to K_{d1} = 622$

$s^1 \quad 0{,}11 K_p + 66{,}67 = 193{,}2 \quad \to K_p = 1150{,}27$

$s^0 \quad 0{,}11 K_i = 196 \quad \to K_i = 1781{,}81$



37.18
kd2
Scope1
622
kd
1150.27
kp
1781.81
ki
1
s
0.1111
s^3 + 12.71s^2 + 23.78s + 66.67



37.18
kd2
Error
Salida
$\frac{\Delta u}{\Delta t}$
$\frac{0.1111}{.71s^2 + 23.78s + 66.67}$
File Tools View Simulation Help
Ready
Sample based
T=10.000