$\dot{x}_1 = x_2$

$\dot{x}_2 = \left(\frac{-1}{\left(\frac{Jb}{R^2} + M \right)} \right) mg \operatorname{sen} \cup$

$m_2 = 0.02$
$g = -9.81$
$Jb = 1 \times 10^{-6}$
$R = 0.01$
$J = 0.02$

Jacobiano

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ \frac{-mg \cos(x_3)}{M + \frac{Jb}{R^2}} \end{bmatrix} \cup$$

$$\gamma = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Linealización

$\overline{x_1} = 0.1 \ [m]$

$\dot{x}_2 = \dot{x}_1 = 0$

$0 = \left(\frac{-1}{\left(\frac{Jb}{R^2} + M \right)} \right) mg \operatorname{sen} \cup$

$\cup = 0$

$G = \frac{3.27 \cos(\cup)}{30 s^2}$

Espacio de estados

$$A = \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix} \qquad B = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

$$C = \begin{bmatrix} 0 & 0.54 \end{bmatrix}$$

Matriz de controlabilidad

$$R = \begin{bmatrix} B & AB \end{bmatrix}$$

$$Pc = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \qquad det(pc) = 1 \rightarrow \text{Es controlable}$$

Matriz de observabilidad

$$Po = \begin{bmatrix} C \\ CA \end{bmatrix}$$

$$Po = \begin{bmatrix} 0 & 6.54 \\ 6.54 & 0 \end{bmatrix} \qquad det(po) = -42.77 \rightarrow \text{Es observable}$$

Servo sistema.

$$Pc = det\left[SI - \begin{bmatrix} A-BK & BKi \\ -C & 0 \end{bmatrix} \right] \qquad K = \begin{bmatrix} K_1 & K_2 \end{bmatrix}$$

$$Pc = \begin{bmatrix} -K_1 & -K_2 & K_1 \\ 1 & 0 & 0 \\ 0 & -\frac{327}{50} & 0 \end{bmatrix}$$

$$Pc = s^3 + K_1 s^2 + K_2 s + \frac{327 K_i}{50}$$

$PD = s^3 + 6.857 s^2 + 7.465 s + 5.339$

se iguala $PD = Pc$

$6.857 = k_1$ $\quad k_1 = 6.857$

$7.465 = k_2$ $\quad k_2 = 7.465$

$5.339 = \frac{327}{50} k_i$ $\quad k_i = 0.8164$

observador de estados

$$L = \begin{bmatrix} L_1 \\ L_2 \end{bmatrix}$$

$$Pco = det\left[sI - (A - LC)\right]$$

$$Pco = det\left[\begin{bmatrix} s & 0 \\ 0 & s \end{bmatrix} - \begin{bmatrix} 0 & -327 L_1/50 \\ 1 & -327 L_2/50 \end{bmatrix}\right]$$

$$Pco = s^2 + \frac{327}{50} L_2 s + \frac{327 L_1}{50}$$

$$Pdo = s^2 + 320s + 102400$$

se iguala $Pdo = Pco$

$\frac{327}{50} L_2 = 320$ $\quad L_1 = 1563.7$

$L_2 = 48.92$

$\frac{327 L_1}{50} = 102400$