

MODEL LINIER PENDULUM TERBALIK

Assumsi: sudut θ cukup kecil $\rightarrow x_3 \approx \emptyset$

$$\ddot{x}_2 = \frac{F(t) - mg \sin x_3 \cos x_3 + m l \dot{x}_4^2 \sin x_3}{(M+m) - m \cos^2 x_3}$$

$$x_3 \approx \emptyset \rightarrow \sin x_3 \approx \sin (\text{sudut kecil [rad]}) \approx x_3$$

$$\cos x_3 \approx \cos \emptyset = 1$$

$$\dot{x}_4 = \dot{x}_3 \approx \emptyset \text{ (kecil sekali)}$$

hasil linierisasi:

$$\ddot{x}_2 = \frac{F(t) - mg x_3}{M} = -\frac{mg}{M} x_3 + \frac{1}{M} F(t)$$

$$\ddot{x}_4 = \frac{g \sin x_3 - \ddot{x}_2 \cos x_3}{l} \approx \frac{g x_3 - \left[-\frac{mg}{M} x_3 + \frac{1}{M} F(t) \right]}{l}$$

$$\approx \frac{g}{l} x_3 + \frac{mg}{Ml} x_3 - \frac{1}{Ml} F(t) = \frac{(M+m)g}{Ml} x_3 - \frac{1}{Ml} F(t)$$

Model Linier:

$$\dot{\mathbf{x}} = \begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \\ \dot{x}_4 \end{bmatrix} = \underbrace{\begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & -\frac{mg}{M} & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & \frac{(M+m)g}{Ml} & 0 \end{bmatrix}}_{\text{matrix A}} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} + \underbrace{\begin{bmatrix} 0 \\ \frac{1}{M} \\ 0 \\ -\frac{1}{Ml} \end{bmatrix}}_{\text{matrix B}} F(t)$$