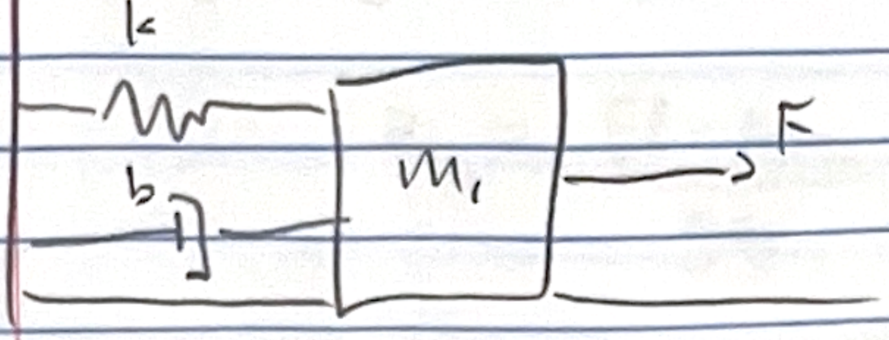
HW 4

P. 4



$$F - b\dot{z} = kz + m\ddot{z}$$

$$\ddot{z} = \frac{F - b\dot{z} - kz}{m}$$

$$\dot{x} = \begin{pmatrix} \dot{z} \\ \ddot{z} \end{pmatrix} = \begin{pmatrix} \dot{z} \\ \frac{F - b\dot{z} - kz}{m} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$$

$$\dot{z}_{eq} = 0$$

$$\frac{F - b(0) - kz}{m} = 0$$

$$z_{eq} = F/k$$

Jacobian:

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -k/m & -b/m \end{bmatrix} x - \begin{bmatrix} 0 \\ 1/m \end{bmatrix} u$$

Feedback

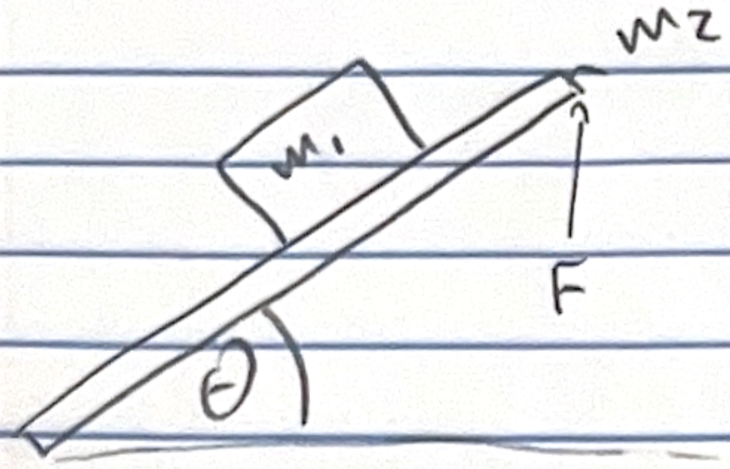
$$F - b\dot{z} = kz + m\ddot{z}$$

$$F = kz + \tilde{F}$$

$$kz + \tilde{F} - b\dot{z} = kz + m\ddot{z}$$

$$\tilde{F} - b\dot{z} = m\ddot{z}$$

E.4



$$\ddot{\theta} = \frac{-2m_1 z \dot{\theta} \dot{z} - l g m_2 \cos\theta - g m_1 z \cos\theta + F l \cos\theta}{\frac{1}{3} l^2 m_2 + m_1 z^2}$$

$$\ddot{z} = z\dot{\theta}^2 - g\sin\theta$$

$$x = \begin{pmatrix} z \\ \theta \\ \dot{z} \\ \dot{\theta} \end{pmatrix} = \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix}$$

$$\dot{x} = \begin{pmatrix} \dot{z} \\ \dot{\theta} \\ \ddot{z} \\ \ddot{\theta} \end{pmatrix} = \begin{pmatrix} \dot{z} \\ \dot{\theta} \\ z\dot{\theta}^2 - g\sin\theta \\ \dfrac{-2m_1 z \dot{\theta} \dot{z} - l g m_2 \cos\theta - g m_1 z \cos\theta + F l \cos\theta}{\frac{1}{3} l^2 m_2 + m_1 z^2} \end{pmatrix} = [0]^4$$

$\dot{z} = 0$

$\dot{\theta} = 0$

~~$z(0)^2 - g\sin\theta = 0$~~

$\theta_{eq} = \sin^{-1}(0) = 0$

$$\frac{-2m_1 z(0)(0) - l g m_2 \cos\theta - g m_1 z \cos(0) + F_e l \cos\theta}{\frac{1}{3} l^2 m_2 + m_1 z^2} = 0$$

$\Downarrow$

$$\frac{-l g m_2 - g m_1 z + F_e l}{\frac{1}{3} l^2 m_2 + m_1 z^2} = 0$$

$A\tilde{x} - B\tilde{u}$

$$-lgm_2 - gm_1 z + F_{el} = 0$$

$$z_{eq} = \frac{F_{el} - lgm_2}{gm_1}$$

$$0 = -lgm_2 + F_{el}$$

$$F_{el} = gm_2$$

$$\ddot{z} = z\dot{\theta}^2 - g\sin\theta_{eq}$$

$$0 = 0 - g\sin\theta_{eq}$$

$$\theta_{eq} = \sin^{-1}(0)$$

$$\theta_{eq} = 0$$

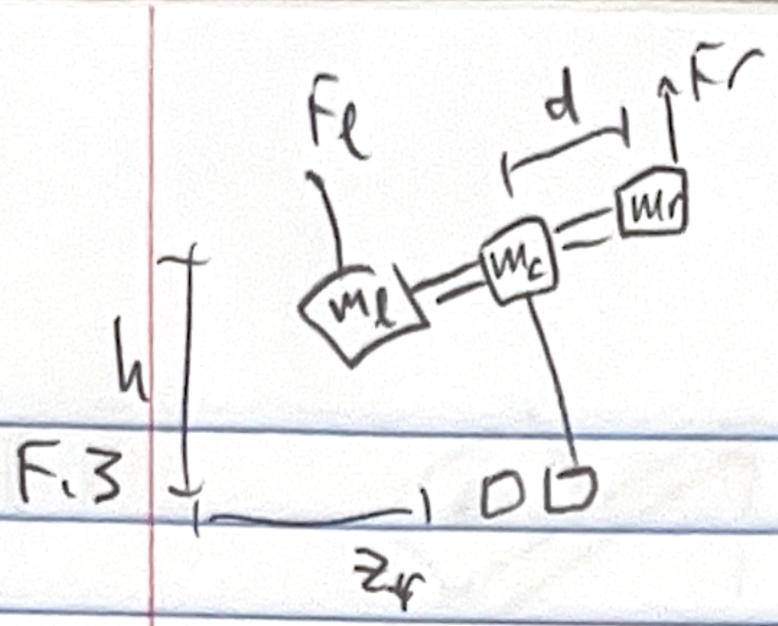
$$F_{el} = z_{eq} gm_1 + lgm_2$$

$$F_e = \frac{z_{eq} gm_1}{l} + gm_2$$

$$A = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & -g & 0 & 1 \\ 0 & 0 & 0 & 0 \\ \frac{-3gm_1}{l^2 m_2} & 0 & 0 & 0 \end{bmatrix}$$

Feedback $m_1\ddot{z} = m_1 z\dot{\theta}^2 - m_1 g\sin\theta$

not possible?



$$\dot{z} = \frac{-F_l \sin\theta - F_r \sin\theta - \mu \dot{z}}{2m + m_c}$$

$$\ddot{h} = \frac{(F_l + F_r)\cos\theta + g(2m + m_c)}{2m + m_c}$$

$$\ddot{\theta} = \frac{d(-F_l + F_r) + J_c \theta}{2d^2 m}$$

$\dot{z} = 0$

$\dot{h} = 0$

$\theta = 0 \qquad \theta_e = 0$

$\ddot{z}$ $\qquad \frac{\sin\theta(-F_l - F_r)}{2m + m_c} = 0$

$$\theta_e = \sin^{-1}(0) = 0$$

$\ddot{h}$ $\qquad \frac{(F_l + F_r)\cos\theta + g(2m + m_c)}{}$

$\ddot{\theta}$ $\qquad d(-F_l + F_r) + 0$

Feedback not possible?