

### HW 3 Solutions

$$4.4) \quad f = \frac{k_1 L_2^2 + k_2 L_3^2}{L_1^2} = k_e x$$

$$4.8) \quad k_e = \frac{5k}{8}$$

4.11)

$$\begin{aligned} m_1 \ddot{x}_1 + (k_1 + k_2)x_1 &= k_2 x_2 \\ m_2 \ddot{x}_2 + k_2 x_2 &= f + k_2 x_1 \end{aligned}$$

$$4.12) \quad mL_3^2 \ddot{\theta} + (k_1 L_1^2 + k_2 L_2^2 + mgL_3)\theta = k_2 L_2 x$$

$$4.13) \quad m\ddot{x} + \frac{k}{4}x = f + mg$$

$$4.15) \quad \text{a) } I\ddot{\theta} + Wh \sin(\theta) = 0$$

$$\text{b) } I\ddot{\theta} + Wh\theta = 0$$

$$T = 2\pi \sqrt{\frac{I}{Wh}}$$

4.16)

$$\frac{\Theta(s)}{\Phi(s)} = \frac{k_1}{Is^2 + (k_1 + k_2)}$$

4.17)

$$\left(m + \frac{J}{R^2}\right)\ddot{x} + kx = ky$$

$$x(t) = 1 - \cos\left(10\sqrt{\frac{2}{3}}t\right)$$

4.19)

$$I_1 \ddot{\theta}_1 + (k_1 + k_2) \theta_1 = k_2 \theta_2$$
$$I_2 \ddot{\theta}_2 + (k_2 + k_3) \theta_2 = T_2 + k_2 \theta_1$$

4.20)

$$m_1 L_2^2 \ddot{\theta}_1 + (m_1 g L_2 + k L_1^2) \theta_1 = k L_1^2 \theta_2$$
$$m_2 L_2^2 \ddot{\theta}_2 + (m_2 g L_2 + k L_1^2) \theta_2 = k L_1^2 \theta_1$$

4.22)

$$1.5 m \ddot{x} + (k_1 + k_2) x = 0$$

4.23)

$$(m_1 + 4m_2) \ddot{x} + kx = 0$$

4.24)

$$(m_1 + 6m_2) \ddot{x} + 4kx = 0$$

4.26)

$$\omega_n = \sqrt{\frac{k}{1.5m}}$$

4.27)

$$\omega_n = \frac{L_2}{L_1} \sqrt{\frac{k}{m}}$$

4.28)

$$(I_r + m_{eff} L_2^2) \ddot{\theta} + k_2 L_2^2 \cos(\theta) \sin(\theta) = f_c(t) L_1$$

$$m_{eff} = m_v + \frac{1}{3} m_s$$