HW 9 Answers for Selected Problems

4.24) $m_1\ddot{x}_1 = -k_1x_1 + k_2(x_2 - x_1)$

$m_1\ddot{x}_2 = -k_3x_2 - k_2(x_2 - x_1)$

4.25) $I_1\ddot{\theta}_1 = -k_1\theta_1 - k_2(\theta_1 - \theta_2)$

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

4.26) $m_1L_2^2\ddot{\theta}_1 + (m_1gL_2 + kL_1^2)\theta_1 = kL_1^2\theta_2$

$m_2L_2^2\ddot{\theta}_2 + (m_2gL_2 + kL_1^2)\theta_2 = kL_1^2\theta_1$

4.29) $Assuming\ that\ x > R_2\theta, we\ can\ write\ the\ equations\ as$

$m\ddot{x} = f - k(x - R_2\theta) = f - k(x - 2R_1\theta)$

$I_2\ddot{\theta} = k(x - R_2\theta)R_2 - (kR_1\theta)R\_1 = 2kR_1(x - 2R_1\theta) - kR_1^2\theta$

$Note\ that\ the\ mass\ m_2\ is\ not\ needed\ because\ its\ effect\ is\ contained\ in\ I_2.$

4.52) a) $m_1\ddot{x}_1 = -c\dot{x}_1 + k(x_2 - x_1)$

$m_2\ddot{x}_2 = f - k(x_2 - x_1)$

b) $m_1\ddot{x}_1 = -kx_1 + c(\dot{x}_2 - \dot{x}_1)$

$m_2\ddot{x}_2 = f - c(\dot{x}_2 - \dot{x}_1)$

c) $m_1\ddot{x}_1 = -c\dot{x}_1 - k_1x_1 + k_2(x_2 - x_1)$

$m_2\ddot{x}_2 = f - k_2(x_2 - x_1)$

d) $m_1\ddot{x}_1 = -c\dot{x}_1 - k_1x_1 + k_2(x_2 - x_1) + c_2(\dot{x}_2 - \dot{x}_1)$

$m_2\ddot{x}_1 = f - k_2(x_2 - x_1) - c_2(\dot{x}_2 - \dot{x}_1)$

4.56) $I_p\ddot{\theta}_p = k_T(\phi - \theta_p) - c_T(\dot{\theta}_p - \dot{\theta}_d)$

$I_d\ddot{\theta}_d = c_T(\dot{\theta}_p - \dot{\theta}_d)$

4.79) $(m_r + m_c)\ddot{x} + m_rL(\ddot{\theta}cos\theta - \dot{\theta}^2sin\theta) + c\dot{x} + kx = 0$

$m_rL^2\ddot{\theta} - m_rL(cos\theta)\ddot{x} + m_rgsin\theta = 0$

4.80) $\frac{3}{2}m\ddot{x}_1 + kx_1 = \frac{1}{2}m\ddot{x}_2 + kx_2$

$\frac{5}{2}m\ddot{x}_2 + 2kx_2 = \frac{1}{2}m\ddot{x}_1 + kx_1 + f$

4.81) $\frac{3}{2}m\ddot{x}_1 + kx_1 - \frac{1}{2}m\ddot{x}_2 = f$

$\frac{3}{2}m\ddot{x}_2 + kx_2 - \frac{1}{2}m\ddot{x}_1 = 0$

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6.15) $$LC\ddot{v}_0 + RC\dot{v}_0 + v_0 = Ri_s$$

6.16) $$LRC\frac{d^2 i_1}{dt^2} + L\frac{di_1}{dt} + Ri_1 = RC\dot{v}_1 + v_1 - RC\dot{v}_2$$

$$LRC\frac{d^2 i_2}{dt^2} + L\frac{di_2}{dt} + Ri_2 = RC\dot{v}_1 - RC\dot{v}_2 - LC\ddot{v}_2$$

$$LRC\frac{d^2 i_3}{dt^2} + L\frac{di_3}{dt} + Ri_3 = v_1 + LC\ddot{v}_2$$

6.18) $$i_1, v_c \rightarrow L\frac{di_1}{dt} = v_1 - v_2 - v_c; \quad C\frac{dv_c}{dt} = i_1 - \frac{1}{R}v_c - \frac{1}{R}v_2$$

6.37) $$\frac{\Omega_L(s)}{V_f(s)} = \frac{NK_T}{(L_f s + R_f)(I_e s + c_e)} = \frac{NK_T}{L_f I_e s^2 + (R_f I_e + c_e L_f)s + c_e R_f}$$

$$\frac{\Omega_L(s)}{T_L(s)} = -\frac{1}{I_e s + c_e}$$

1) a) $$\frac{Y(s)}{U(s)} = \frac{(s+2)}{(s+3)(s+2)-1}$$

$$\frac{X(s)}{U(s)} = \frac{1}{(s+3)(s+2)-1}$$

b) $$s^2 + 5s + 5$$

c) $$s = \frac{-5 \pm \sqrt{5}}{2}$$

2) $$\frac{X_1[s]}{F[s]} = \frac{k_1}{(m_2 s^2 + k_1 + k_2)(m_1 s^2 + k_1) - k_1^2}$$

$$\frac{X_2[s]}{F[s]} = \frac{m_1 s^2 + k_1}{(m_2 s^2 + k_1 + k_2)(m_1 s^2 + k_1) - k_1^2}$$