

## HW #6 Solutions

1.

$$s^2 + 0.6s + [(10\pi)^2 + (0.3)^2] = 0$$

$$\ddot{x} + 0.6\dot{x} + [(10\pi)^2 + (0.3)^2]x = 0$$

$$x(t) = Ae^{-0.3t} \cos(10\pi t + B)$$

2.

$$50s^2 + 15s + 1 = 0$$

$$50\ddot{x} + 15\dot{x} + x = 0$$

$$x(t) = A \exp\left(\frac{-1}{5}t\right) + B \exp\left(\frac{-1}{10}t\right)$$

3.

$$x(t) = Ae^{-5t} + B \cos(5t + C)$$

4.

$$\tau = \frac{m}{2DV_o} = \sqrt{\frac{m}{4Dg}}$$

Pulleys and Spring

$$\left(J_1 + \frac{R_1^2}{R_2^2} J_2\right) \ddot{\theta}_1 + \left(b_1 + \frac{R_1^2}{R_2^2} b_2\right) \dot{\theta}_1 + kR_1^2 \theta_1 = FR_1$$

Pulley and Cart

$$\left(m + \frac{J}{R_2^2}\right)\ddot{x} + \left(\frac{R_1^2}{R_2^2}b\right)\dot{x} + kx = \frac{R_1}{R_2}bV(t)$$

Drive Shaft to wheel

$$I_1\ddot{\theta}_1 + b\dot{\theta}_1 + k\theta_1 = k\theta_2$$

$$\left[I_2 + \frac{R_1^2}{R_2^2}(I_3 + I_4)\right]\ddot{\theta}_2 + \left(2\frac{R_1^2}{R_2^2}b\right)\dot{\theta}_2 + k\theta_2 = k\theta_1$$

$$\theta_3 = \left(\frac{R_1}{R_2}\right)\theta_2$$