Answers to ES205 Exam 1, 1997

Problem 1

$$\frac{V_o}{V_1} = -\frac{R_1}{R_1 C L s^2 + (L + R_1 R_3 C)s + R_1}$$

$$\omega_n = \sqrt{\frac{R_1}{R_3 L C}}, \quad \zeta = \frac{\omega_n}{2}\left(\frac{L + R_1 R_3 C}{R_1}\right)$$

Problem 2

$$\begin{bmatrix} m_1 & 0 & 0 \\ 0 & J_1 & 0 \\ 0 & 0 & J_2 \end{bmatrix}\begin{Bmatrix} \ddot{x}_1 \\ \ddot{\theta}_1 \\ \ddot{\theta}_3 \end{Bmatrix} + \begin{bmatrix} c_1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & c_2 \end{bmatrix}\begin{Bmatrix} \dot{x}_1 \\ \dot{\theta}_1 \\ \dot{\theta}_3 \end{Bmatrix} + \begin{bmatrix} k_1 & -k_1 r_1 & 0 \\ -k_1 r_1 & k_1 r_1^2 + k_2 & -\frac{r_3}{r_2} k_2 \\ 0 & -\frac{r_3}{r_2} k_2 & k_3 + \left(\frac{r_3}{r_2}\right)^2 k_2 \end{bmatrix}\begin{Bmatrix} x_1 \\ \theta_1 \\ \theta_3 \end{Bmatrix} = \begin{Bmatrix} f(t) \\ 0 \\ 0 \end{Bmatrix}$$

Problem 3

I had 7 equations and 7 unknowns.