

Answers to ES205 Exam 1, 2004

**Problem 1**

1.1)  $E = \frac{\omega_n^2 (0.23m_{\text{beam}}) \ell^3}{3I}$

1.2)

$$\begin{Bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{Bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -2 & 0 & -4 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \end{Bmatrix} + \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 3 & 1 \end{bmatrix} \begin{Bmatrix} f \\ \dot{f} \end{Bmatrix}$$

$$\begin{Bmatrix} y_1 \\ y_2 \end{Bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \end{Bmatrix} + \begin{bmatrix} 0 & 0 \\ -10 & 0 \end{bmatrix} \begin{Bmatrix} f \\ \dot{f} \end{Bmatrix}$$

1.3)

a)  $8\ddot{v}_o + 4\dot{v}_o + 2v_o = 3v_{in}$

b) 3

c) 0.433 rad/s

1.4)  $\ddot{y} + 5\dot{y} + 7y = 3\dot{u} + 12u$

**Problem 2**

a)  $\frac{D}{k} \dot{\theta} + \theta = \theta_a$

b) 0.03

c) 30 dyn-cm-s

**Problem 3**

I had eight equations and eight unknowns although you can do this with two nodal equations.

**Problem 4**

I had six equations and six unknowns..