Homework 4

Due: 4 October 2019

1. Observer design

   The dynamics of the ECP rectilinear MSD system in 3DOF mode are given below in state space form. Use the parameters $m_1 = m_2 = m_3 = 2\text{kg}$, $k_1 = k_2 = k_3 = 200\text{N/m}$, and $b_1 = b_2 = b_3 = 1\text{N-s/m}$ for both problems in this assignment.

   Design a full order observer for this system, such that the observer poles are at *s* = {-50, -60, -70, -80, -90, -100}. Use the eigenstructure assignment algorithm (not Ackermann's formula or 'place').

$$\begin{Bmatrix} \dot{z}_1 \\ \dot{z}_2 \\ \dot{z}_3 \\ \dot{z}_4 \\ \dot{z}_5 \\ \dot{z}_6 \end{Bmatrix} = \begin{bmatrix} \mathbf{0} & \boldsymbol{I} \\ \mathbf{K} & \mathbf{Q} \end{bmatrix} \begin{Bmatrix} z_1 \\ z_2 \\ z_3 \\ z_4 \\ z_5 \\ z_6 \end{Bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ \frac{1}{m_1} \\ 0 \\ 0 \end{bmatrix} F; \quad \mathbf{K} = \begin{bmatrix} -\frac{k_1+k_2}{m_1} & \frac{k_2}{m_1} & 0 \\ \frac{k_2}{m_2} & -\frac{k_2+k_3}{m_2} & \frac{k_3}{m_2} \\ 0 & \frac{k_3}{m_3} & -\frac{k_3}{m_3} \end{bmatrix}; \quad \mathbf{Q} = \begin{bmatrix} -\frac{b_1}{m_1} & 0 & 0 \\ 0 & -\frac{b_2}{m_2} & 0 \\ 0 & 0 & -\frac{b_3}{m_3} \end{bmatrix}$$

$$\begin{Bmatrix} y_1 \\ y_2 \end{Bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{Bmatrix} z_1 \\ z_2 \\ z_3 \\ z_4 \\ z_5 \\ z_6 \end{Bmatrix}$$

2. Maximize the function $V = x_1 x_2 x_3$ subject to the constraint function $S = x_1 x_2 + 2x_1 x_3 + 2x_2 x_3$. Use the Lagrange multiplier method.