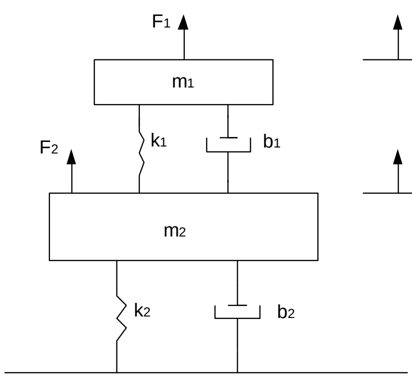
ELEC-E8116 Model-based control systems /exercises 3

Problem 1. Consider the mass/spring/damper system shown in the figure. The control forces are F_1 and F_2. Parameter values: k_1=1, k_2=4, b_1=0.2, b_2=0.1, m_1=1, m_2=2.

- **a.** Form a differential model of the system.
- **b.** Form a state-space representation of the system.
- **c.** Plot the singular values as functions of frequency (Matlab).
- **d.** Calculate the H_∞-norm of the obtained system (Matlab).



Problem 2. (Matlab) Consider the transfer function matrix

$$G(s) = \begin{bmatrix} \dfrac{10(s+1)}{s^2+0.2s+100} & \dfrac{1}{s+1} \\ \dfrac{s+2}{s^2+0.1s+10} & \dfrac{5(s+1)}{(s+2)(s+3)} \end{bmatrix}$$

Determine a realization and plot the singular values.

Problem 3. Two systems are given by the two transfer function matrices below. Calculate the poles and zeros

$$G_1(s) = \begin{bmatrix} \dfrac{2(s+1)(s+2)}{s(s+3)(s+4)} & \dfrac{s+2}{(s+1)(s+3)} \end{bmatrix} \qquad G_2(s) = \begin{bmatrix} \dfrac{1}{s+1} & \dfrac{s+3}{(s+1)(s-2)} \\ \dfrac{10}{(s-2)} & \dfrac{5}{s+3} \end{bmatrix}$$

Problem 4. By considering the static system $G(s) = \begin{bmatrix} 0 & 100 \\ 0 & 0 \end{bmatrix}$, prove that eigenvalues do not give a reliable view about the gain of a multivariable system. What is a better alternative?