Computation exercise 1: Dynamics of motion systems

Mechatronic systems
376.050
2013W

1. For the floating mass shown in Fig. 1, write the differential equation and obtain the transfer function from the force *F* to the position *x*. [10 %]

2. Fig. 2 shows a damped mass-spring system.

   a. Write the differential equation and derive the transfer function from the force *F* to the position *x*. Also calculate the un-damped natural frequency. [15 %]
   b. Discuss the effect of the damping, comparing the two cases: no damping and low damping. [15%]

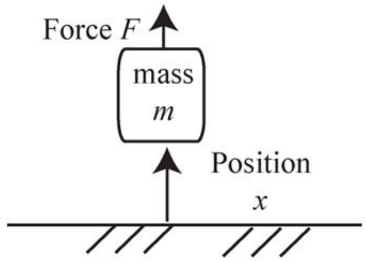

Fig 1. Floating mass.

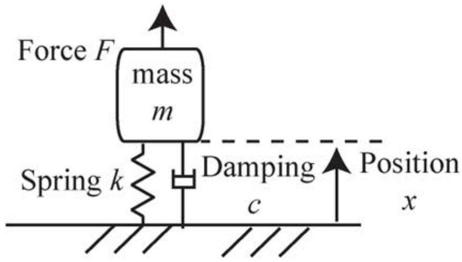

Fig2. Mass-spring system.

3. A positioning system can be modeled as a lumped mass model in Fig.3, when its moving mass m_1 has a component m_2. Spring constant *k* and damping coefficient *c* represent the mechanical connection of these masses. The values of these parameters are given in Table1.

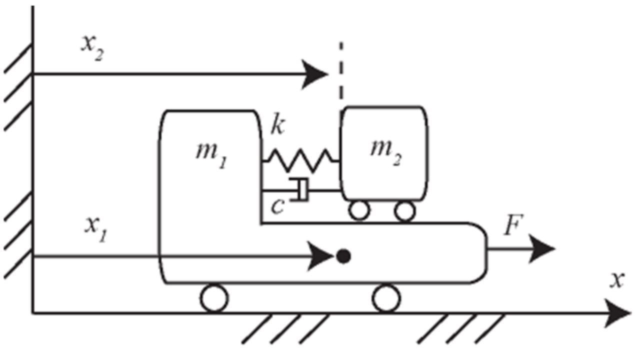

Table 1: Parameters

Parameter	Value	Unit
m_1	1	kg
m_2	5	kg
k	10^6	N/m
c	10	N/(m/s)

Fig. 3: A lumped mass model of a positioning system.

   a. Derive the differential equations for m_1 and m_2, respectively. [15 %]

   b. Derive the transfer function from force *F* to position x_1 and x_2, respectively. [15 %]

   c. Draw Bode plots of the transfer functions obtained in (b), and discuss how the variation of the mechanical parameters changes the plots. [15 %]

   d. On the graph of the transfer functions in (c), draw Bode plots of the following transfer functions. They are floating mass models with mass of m_1 and m_1+m_2. [15 %]

$$P_1(s) = \frac{1}{m_1 s^2}, \quad P_2(s) = \frac{1}{(m_1 + m_2)s^2}$$