Computation exercise 1(a): Dynamics

Mechatronic systems
376.050
2016W

Important: Answers must be a hard copy and submitted to the office in CA0421 by 22th of November, 2016 at 4pm. The work must be original.

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.

   i. 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 %]
   ii. Discuss the influence of the damping on the peak gain of the transfer function and the frequency of that peak. [15%]

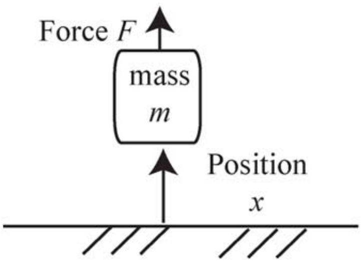

Fig 1. Floating mass.

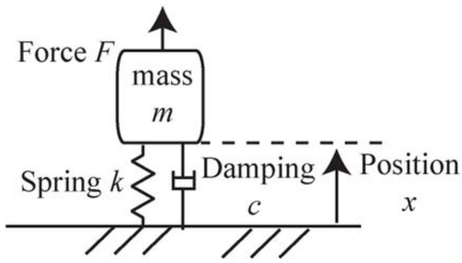

Fig2. Mass-spring system.

3. A positioning system using an electromagnetic actuator (e.g. Lorentz or reluctance actuator) can be modeled as a lumped mass model in Fig.3. Mass m_1 and m_2 connected by spring constant *k* and damping coefficient *c* represent the dynamics of the moving part. The values of these parameters are given in Table1.

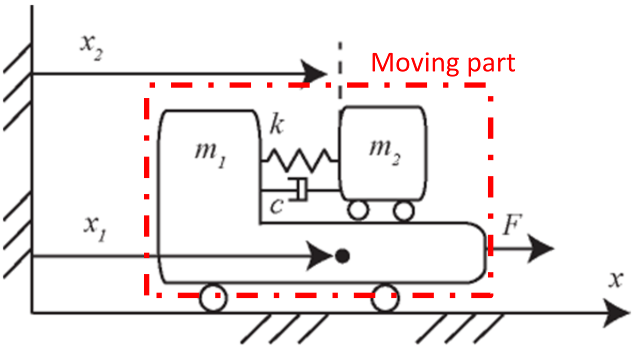

Table 1: Parameters

Parameter	Value	Unit
m_1	2.5	kg
m_2	4	kg
k	10^5	N/m
c	10	N/(m/s)

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

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

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

   iii. Draw Bode plots of the transfer functions obtained in (ii) [15 %]

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

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