ME 333 Project: Electrical analogy of mass-spring-dashpot system.

(Due: Monday 2nd December 2013 10:35 AM)

Introduction

Consider the shown spring-mass dashpot mechanical system (MS) illustrated by Figure 1. It required to simulate the behavior of this system by building an equivalent electrical system (ES) using electrical analogy.

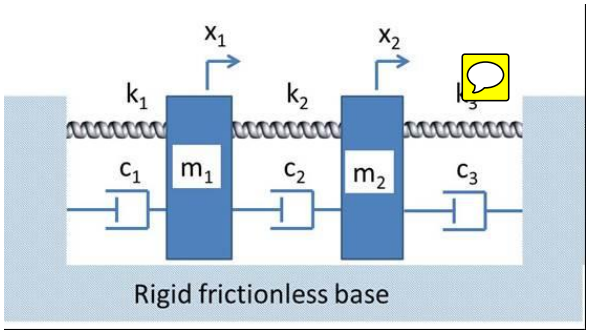

Figure 1. A schematic spring-mass dashpot system.

Model

Model this system as a multi-degree-of-freedom spring-mass-damper one with a rigid frictionless base.

Objective and Constraints

Simulate this mechanical system (MS) with equivalent electrical components (i.e. resistors, capacitors and inductors). Select the magnitudes of resistors, capacitors and inductors from commercial catalogue. Your design must also satisfy the following constraints:

(1) The time domain of electrical system should be identical with that of mechanical system.

(2) The magnitudes of mechanical components are arbitrary according to this table

Table 1 Design variables and constraints.

Parameter	Minimum limit	Design variable	Maximum limit
Mass 1	4 kg	< m_1 <	5 kg
Mass 2	3 kg	< m_2 <	4 kg
Spring 1	1000 N/m	< k_1 <	2000 N/m
Spring 2	3000 N/m	< k_2 <	4000 N/m
Spring 3	500 N/m	< k_3 <	4000 N/m
Dashpot 1	1 kg/s	< c_1 <	30 kg/s
Dashpot 2	1 kg/s	< c_2 <	10 kg/s
Dashpot 3	1 kg/s	< c_3 <	10 kg/s

Design tasks

(1) Choose the magnitudes of mechanical components from Table 1.
(2) Build the mathematical models of the mechanical system (MS) based on the values chosen from Table 1.
(3) Build the mathematical model of equivalent electrical system (ES).
(4) Choose the magnitudes of resistors, capacitors and inductors from commercial catalogue that result into ES equivalent to MS.
(5) Build Simulink model that solve for MS assuming $x_1(0) = 0.1$ m and $x_2(0) = 0.0$ m. Assume zero initial speeds.
(6) Work in groups that have a maximum of four students each.

Presentation of Results

Your written report should include
(1) Build the mathematical models of the mechanical system (MS) based on the values chosen from Table 1.
(2) Build the mathematical model of equivalent electrical system (ES).
(3) Choose the magnitudes of mechanical components from Table 1.
(4) Choose the magnitudes of resistors, capacitors and inductors from commercial catalogue that result into ES equivalent to MS.
(5) Verify that both ES and ME are equivalent and if not go to step (3) otherwise proceed to step 6.
(6) Build Simulink model that solve for MS assuming $x_1(0) = 0.1$ m and $x_2(0) = 0.0$ m. Assume zero initial speeds.

Marks of report:

Choosing of the magnitudes of mechanical components.	**(*2 marks*)**
Building of the mathematical models of (MS)	**(*1 marks*)**
Building of the mathematical model of (ES).	**(*7 marks*)**
Choosing the magnitudes of resistors, capacitors and inductors from commercial catalogue that result into ES equivalent to MS.	**(*5 marks*)**
Verify that both ES and ME are equivalent.	**(*5 marks*)**
Building Simulink model that solve for MS assuming $x_1(0) = 0.1$ m and $x_2(0) = 0.0$ m. Assume zero initial speeds.	**(*5 marks*)**

Your oral representation should include (on Wednesday 4 December 2013).

a. Media use by Power-point files. **(*2 marks*)**
b. Group presentation by group leader. **(*3 marks*)**

Late submission of project report (after 10:35 AM) means one day late. Each late day results into 25% mark reduction). No submission accepted after two days.