Indian Institute of Technology Madras

Engineering Design Department

ED 5220 – Vehicle Dynamics Tutorial/Lab

Jan - May 2024

Assignment –1 : Introduction to Simulink/Simscape 1D/Simscape 3D

Date: Sun, 25 February 2024	**Due Date**: Sun, 03 March 2024 11.59 pm

Instructions:

- *Solutions to be submitted ONLY moodle in .pdf and/or .zip files only. Each student should submit his/her individual set of solutions.*
- *Typed/scanned copy of written solutions are allowed. Graphs to be labelled, with axes titles and units.*
- *Solution file (.pdf) and/or .zip file to be named as A<tutorial no>_<roll no.>. For example, week 1 session solution file of student be named as A1_ED20B000.pdf*
- Late submissions will be penalized

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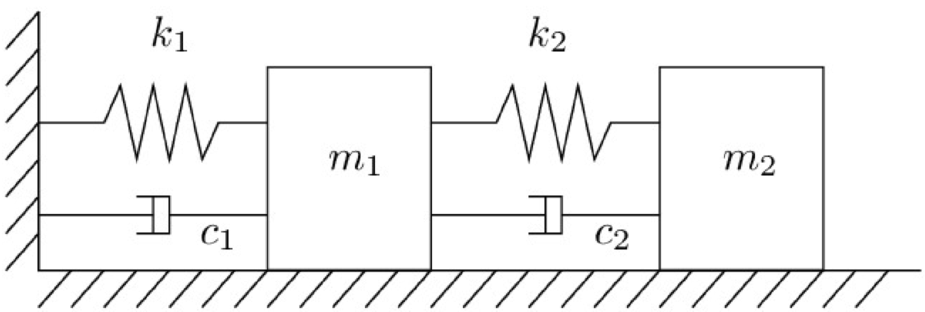
1. Solve the double mass spring damper system for horizontal motion (X direction) in

   (a) Simulink – derive necessary equations of motion

   (b) Simscape 1D

   (c) Simscape 3D/Simscape multibody

   plot and compare displacements and velocities of both masses obtained in each of the cases



Parameters are as follows

```
k1 = 400; % stiffness N/m
c1 = 10; % damper N*s/m
m1 = 3.6; % mass kg
x0_1 = 0.05; % initial displacement m


k2 = 200; % stiffness N/m
c2 = 20; % damper N*s/m
m2 = 1.6; % mass kg
x0_2 = 0.05; % initial displacement m
```

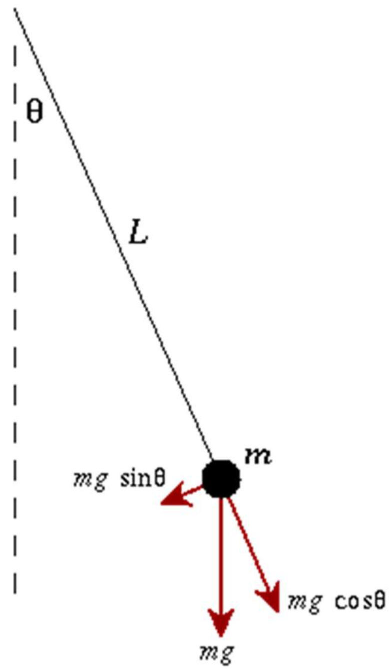
2. Solve for a simple pendulum with damping due to air resistance in

   (a) Simulink – derive equations of motion

   (b) Simscape 1D – **Hint:** for small angles, spring coefficient can be approximated to multiplication factor, k, of angle in the equation derived in (a) of the form $m\ddot{\theta} + c\ddot{\theta} + k\theta = 0$.

   (c) Simscape 3D/Simscape multibody – A `spherical solid` (ball) of radius 0.025m and density 15500 kg/m^3 is connected to one end of `cylindrical solid` (string) of radius 0.001m and length 1m. The other end of `cylindrical solid` is connected to `Revolute Joint` and to inertial world frame via rigid transformation blocks. The `Revolute Joint` is oriented such that its Z-axis coincides with world's X-axis and ball hanging downwards.

Plot and compare angle and angular velocity in each of the above cases.



Parameters are as follows

```
mass = 1; % mass of ball (kg)
c = 1; % damping coeff (N*m/(rad/s))
l = 1; % length of string (m)
theta_0 = 10; % initial angular
deformation (deg)
```

Note: mass and inertia of string are negligible

Hint: