Department of Mechanical Engineering
University of Bath

ME40064: System Modelling & Simulation
ME50344: Engineering Systems Simulation

Tutorial 8: Introduction to Simulink

1. This question reproduces the mass spring damper system introduced in Lecture 15:

    a. Using the integrator, gain, function, and summation blocks, create a Simulink block diagram of the mass, spring, damper system.
    b. Add in step forcing (defined using a source block).
    c. Save your model.
    d. Connect scope blocks in order to view the inputs and outputs of your system.
    e. Set a step force value in the parameter-setting window for that block.

    Click to run the model – you should see some error messages that show the values of m, c and k are undefined. Therefore, set the values of m = 250, c = 1000, and k = 20000 in the MATLAB command window. For this problem we can use the default solver settings without any issues.

2. Using this model we will investigate the effect of changing both the initial conditions and forcing functions on the solution:

    a. Set the step force value back to zero and instead give the mass an initial displacement. This is set with the integrator block that outputs the displacement, x. Run the simulation and plot the result of both displacement and velocity. Does this behave as you expect?

    b. Now replace the step function with a sinusoidal force icon and simulate with zero initial conditions. Try changing the parameters values for c and k, and see how this changes the solution for different combinations.

3. We will now model a non-linear spring stiffness (a hardening spring), which has a discontinuity at a particular displacement, as shown in Figure 1.

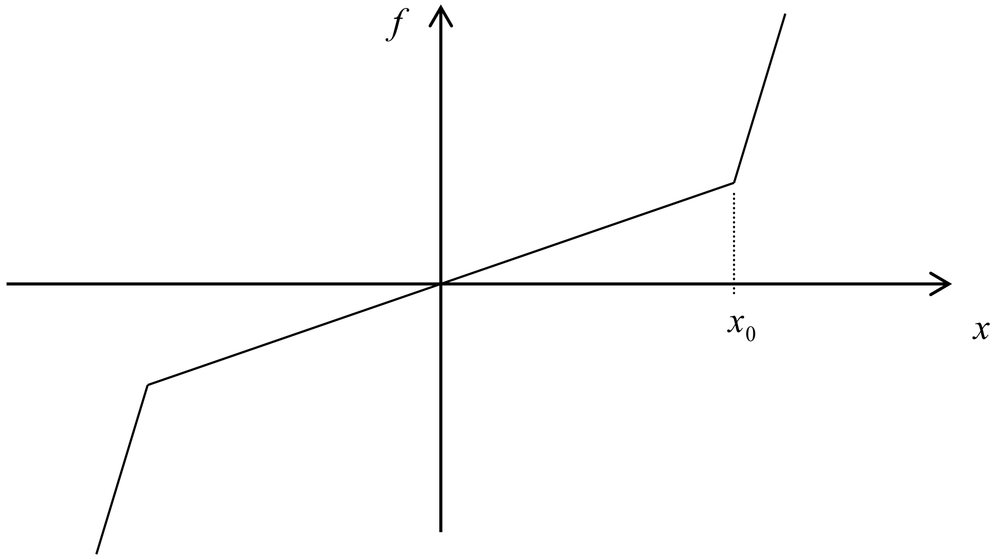

Figure 1: Discontinuous piecewise linear function - this can be used to represent spring hardening. In Simulink a lookup table block can be used to specify this type of function.

We will model this discontinuity using a lookup table to represent the discontinuity at $x=x_0$ and the two different spring stiffnesses (represented by the two gradients). Assume that the hardening stiffness is 20 times larger than k. Set x_0 = 0.2 and simulate the response to sinusoidal forcing. Keep increasing the amplitude of the forcing function until the non-linear spring behaviour is evident in the solution. What do you see?

4. Now modify your system to use a look-up table block to model a viscous damper that has a rate constant c = 600 when the spring is contracting, and c = 1200 when the spring is extending. Run the simulation and comment on how the solution has changed.