<table>
<tr><td colspan="3">MSS Lab
Part A: Lumped Element Simulation (Saber)
Exercise 2: Basic mechanical simulation</td><td>Prof. Dr.-Ing. G.Schmitz
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1 Introduction

In this lab we want to do some simulations with mechanical models and learn some more about the simulation concerning exactness, initial point settings (holdnodes), Vary Analysis and Frequency Analysis.

2 Execution of the exercises

In the exercise you will first design a simple spring – mass - system and analyze it using the "Transient Analysis Function". This time certain parameters of the components are given others you have to calculate from observations. Save the sketches and the final results.

2.1 Simulation of a basic spring – mass - system

In exercise 1 you learned already to invoke Saber Sketch and the parts library. Now place to the sketch:

a) a helical spring with a relaxation length of 10cm

b) a mass of 100g

Imagine that somebody has made an experiment to get the spring stiffness. He has hung a tablet of chocolate with 100g to the spring and measured the elongation of the spring. The spring is now 20cm long.

Calculate the spring stiffness for the model.

2.1.1 Now simulate the experiment with saber using the above mentioned parts.

For the spring you should use the model "Spring Translational".

The relaxation length of the spring is named "initial deformation" or "delta0" depending on the used template.

Use the settings "End-Time = 20" and "Time Step = 10m"

What do you find as result? Do you get the expected effect?

2.1.2 Use the "Holdnode" feature of the simulation

In the DC-Analysis Form you should enter a holdnode in the form "n_1 -0.05". That means, for the calculation of the initial operating point, the node n_1 is set to 5cm. Also you must set now "Release Holdnode" to "no".

Performing the simulation you should find now an oscillation beginning with the initial position. Is it a damped oscillation? Is this correct?

2.1.3 Try 0.01u as initial time step.

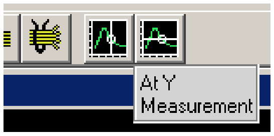
Do the simulation again with 0.01u as time step. How does the result change?
What do we learn about the exactness of the simulations?

2.2 Modification of the model

For the next simulations you should modify the design to get a more realistic simulation.

2.2.1 Add a damping element

Add a damper and try to find the correct settings for the damping factor which is defined as applying a force as a reaction to a movement with the velocity v in the opposite direction of the movement:
force = -d·velocity(pos1 - pos2)
You should set the damping factor so that the oscillation is damped to half of the initial amplitude after 5 seconds. You can use the measurement functions of Saber-Scope to get a Level- Line:



2.2.2 What about the weight of the mass?

Try to find a solution for entering a weight to the design.

2.2.3 Use a pulse source for introducing a single pulsed force

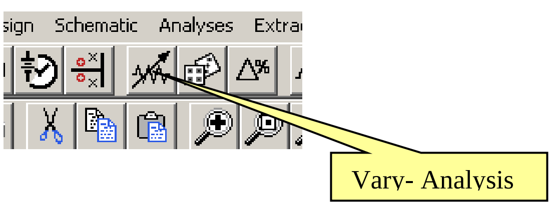
Now you can switch off the Holdnodes. Use a source for a pulsed force with the parameters 1N as the pulse value, 1 second as the pulse width and also 1 second as delay, before the pulse is raised.

2.2.4 Use a sine source to excite the system near it's resonance

Replace the pulse source by a sine source and set the amplitude to 10mN and the frequency to a value near the resonance frequency. Now try to find out the optimal frequency to excite the system to it's largest amplitude.
(Extend the simulation to 20 seconds)

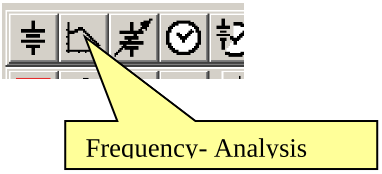
2.2.5 Use the Vary- Analysis to get a quicker and more exact result

To do the variations manually costs a lot of time. So why shouldn't Saber do the work for you. For this purpose the Vary- Analysis can be used:



You can build up loops (even nested loops) with variations of the values of all the parts you have in your design.
As parameter you can use the frequency of the sine source defining 0.1 steps from 0.5 to 2.0 Hz. Or you use 20 steps from 0.1 to 2.0

2.2.6 Now perform a frequency analysis using the built in function



A totally different kind of Analysis is the Frequency Analysis where the design is analyzed concerning it’s frequency response calculated as amplitude and phase.

Perform the simulation using 0.5 Hz As start frequency and 4.0 Hz as end frequency (log)