MEG 421 Automatic Control Laboratory

Lab #1 Introduction to Computer-Based Dynamic System Analysis I.

A control system simulation software package, named VIS SIM, is installed on the college PC network and on several lab PC's in room TBE-B 121, Measurements Lab. A copy of the software manual is available in the VisSim directory for your reference. Simply click on **Help**. Also refer to the instructions. The first two exercises are designed to give you an introduction to this powerful software package and its capabilities. If you prefer, you may use Matlab instead of VisSim for all control lab assignments.

1. Start

From windows, double-click on the VisSim icon if present, or go to the VisSim45 directory → double click on the Vissim32 icon. A new Window labeled 'VisSim Diagram1' appears.

2. Dynamic System Simulation

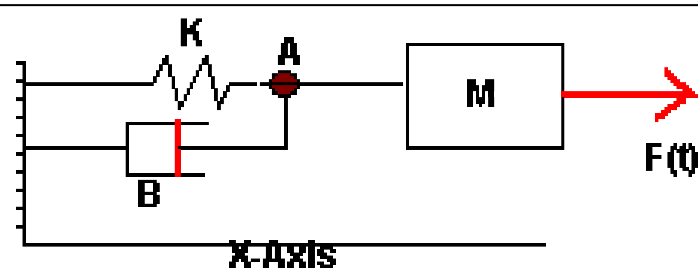


Figure 1 Dynamic System

Assignment For the dynamic system shown in the figure at right, parameters are given as: m= 600 kg; B = 100 N/s; K = 150 N/m, F(t) = 500 N.

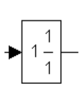
(a) Find the transfer function (Laplace transform). Input is F(t), output is the displacement x(t). The differential equation is:

$$M\cdot\frac{d^2}{dt^2}(x) + B\cdot\left(\frac{d}{dt}x\right) + K\cdot x = F(t)$$

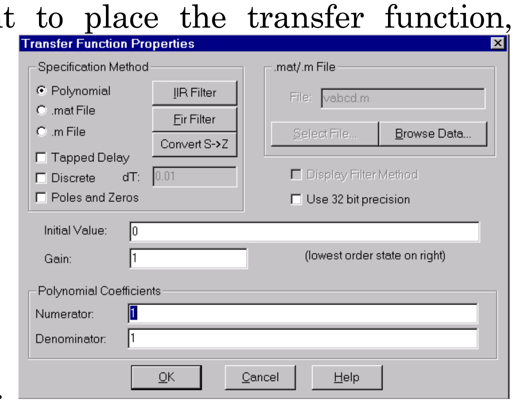
(b) Create a VisSim Model of the system, and simulate its step response

First: find the system's transfer function.

Second: enter transfer function in VisSim: Select Blocks → Linear System → TransferFunction. A small dashed rectangle appears. Drag the rectangle to the location where you want to place the transfer function, and click. An undefined block



appears.



Right-click on the new block and enter the transfer function coefficients in the two bottom rows.

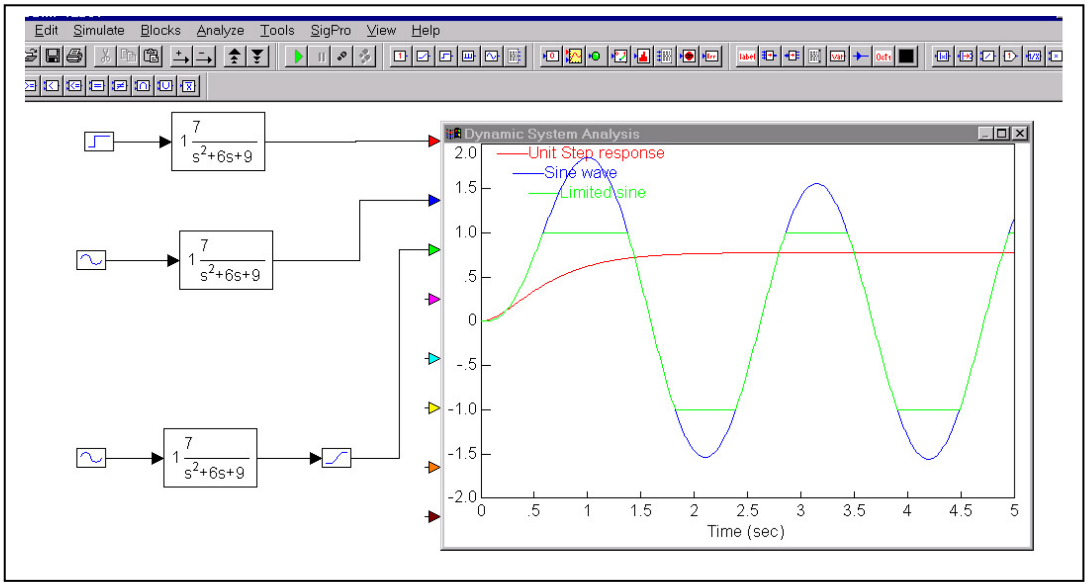
Example: A transfer function $G(s) = \dfrac{7}{s^2 + 6s + 9}$ would be entered as:

Numerator: 7; Denominator: 1 6 9 (Separate numbers in a row by spaces). Click ok. The correct transfer function appears. The transfer function has an input connector at left, and an output connector at right.

Third: Drag the Step icon to the left of the transfer function, or use the menus: Blocks→ Signal Producer → Step. The step size is 500 units (in Newtons).
Connect the transfer function Input to the Step block's output: Place mouse at the transfer function's Input arrow, drag to the step output. A connection line appears.
Fourth: Create a plot for the simulation results: Drag the plot icon to the right of the transfer function, or use the menus: Blocks→ Signal Consumer → Plot. Connect one of the Plot's arrows to the transfer function's output. Change the plot window to a desired size.
Fifth: Simulate. Press the <F5> function key. The simulation result appears in the plot. Right click on the plot, select labels,and add a title and a Label for each trace. Title and label(s) are required for each plot in your lab report.
Change the simulation parameters: Click on Simulate → Simulation properties. A menu appears. If you wish for instance to terminate the simulation at 5 seconds, enter 5 in the box labeled 'End'. Repeat the simulation.

Sixth: Evaluate the same system with a different input, a sine wave u = 4*500*sin(3t). That is a sine of amplitude 4*500 and angular frequency $\omega = 3$ rad/s. We are using the 500 multiplier in order to maintain a scale
Proceed as follows: duplicate the transfer function, add a sine input, edit the sine's amplitude and frequency (remember that f (Hz) = $\omega/2\pi$.) Connect to another trace of the plot.
Seventh: Nonlinearities. All real systems are nonlinear. As an example, we will consider a limiter, which limits the maximum output. For instance, your stereo amplifier has a maximum output signal given by the amplifier design. If you try to play music beyond the amplifier's capability, the music will become quite distorted and unpleasant to hear.
Copy the system and sine input. Connect the output to a limiter (Blocks → Nonlinear → limit), and connect the limiter to the plot.

The completed example is shown below:



Your Assignment:

Find the transfer function of the dynamic system of Fig. 1, develop a VisSim Simulation, and plot the simulation results for a 500*Unit step input, for a sine input u = 4*500*sin(3t), and for a sine input u = 4*500*sin(3t) with a limiter (Bounds at -1, +1).

Submit: your analysis, one plot with both step and sine input responses.

Before you leave: You may want to save your work so that you can retrieve it again without retyping. Save your model to USB memory or to a diskette in the A:drive. Enter a filename you can remember (e.g. Smith421lab1).

Save occasionally your work during the lab in order to safeguard against crashes. Please remember to bring USB memory or a diskette to the lab!