

**Due:** Mon. Feb 25, 2002

In this lab, we explore the transient response of a second-order system as its stiffness and damping are varied. As always, be sure to show your work and attach a plot of each response that you obtain.

rod length (mm)	voice coil	$s_{p1}$ (rad/sec)	$s_{p2}$ (rad/sec)	$k$ (N/m)	$c$ (N·s/m)
50 mm	open				
50 mm	closed				
100 mm	open				
100 mm	closed				
165 mm	open				
165 mm	closed				

- For each of the conditions indicated in the table above, measure the response of the system
  - to an initial displacement with zero initial velocity
  - to an initial velocity with zero initial displacement

Note: Because of the way that the clamp is constructed, the length of the spring rod is measured from the end of the adjustable clamp to the *centerline* of the shaft.

- From the measured responses, determine the poles  $s_{p1}$  and  $s_{p2}$ , stiffness  $k$ , and damping  $c$ .
  - For lightly damped responses, use the damped natural frequency and the rate of decay to determine the poles. You can also use the provided MATLAB function `s2sim(sp1,sp2)` to verify your results.
  - For highly damped responses, run `s2sim(sp1,sp2)` and vary the values of `sp1` and `sp2` until `s2sim` produces responses that resemble the ones that you measured.
- Plot the poles that you obtained from your measurements on the same  $s$ -plane plot that you made in the prelab. Explain any discrepancies between the computed and measured values.

**Extra-Credit**

4. Tune the system to the “optimum” designs you found in Problem 5 of the prelab. Modify your design as necessary to obtain the best performance. If the actual ”optimum” design varied from your predicted design, explain the variance. With the given specifications for Problem 5-b is there really an ”optimal” design?

## Transferring Data from Oscilloscope to Matlab<sup>®</sup>

The LDVT output for this Lab is displayed on an oscilloscope. As part of this lab, you need to compare your results to the predicted results (Step 4). To transfer the data, you will need to save to oscilloscope data to a 3.5” DOS formatted diskette. To save scope data onto a floppy disk, you need to do the following:

Insert a formatted (3.5 inches) floppy (DOS Format) into the floppy disk drive of the Oscilloscope. Have the waveform that you need to record on the display of the scope and press the **Save/Recall Waveform** button on the scope. This brings up the **Waveform save** menu on the scope display. Press the button corresponding to **Save Format** on the main menu first. Choose **MathCad** from the submenu to save data in the MathCad or ASCII format. Then, press the **Save Wfm Ch1/2** button on the main menu to save the file to disk.

To read the data into Matlab<sup>®</sup>, first copy the data file from the floppy disk to your working directory. Assuming that your data was saved in the file `lab1.dat` in your current working directory, at the Matlab<sup>®</sup> prompt type:

```
>> load lab1.dat
>> plot(lab1(5:504))
>> title ('Put in the title for plot here')
```

Note that the first four pieces of data give details of the record length, sampling time etc. Actual data starts only from the fifth entry of the data vector. You will need to generate a time scale for the X axis using regular Matlab<sup>®</sup> commands. The sampling time for the data is included in the first two data entries. You can use this time to generate a time vector.

In the above we have assumed that the scope is set to acquire record lengths of 500 points. You can change the record length to up to 30,000 points using menus on the scope. However since longer records tend to slow down the scope update rate, we suggest leaving the record length set to 500.

It is also possible to save data in *tif* format. This allows easy inclusion in a Word document for adding data to your lab reports. The *tif* format is selected in the scope’s save format menu.