Your task during this lab is to tune the second-order system of Lab 3 for the three different performance specifications listed below. The instructions on the following page will help you get started.

1. Minimize the 10-90% rise time $t_{r(10-90)}$ if no overshoot is permitted.
2. Minimize $t_{r(10-90)}$ if 10% overshoot is permitted.
3. Minimize $t_{r(10-90)}$ if there is no restriction on overshoot.

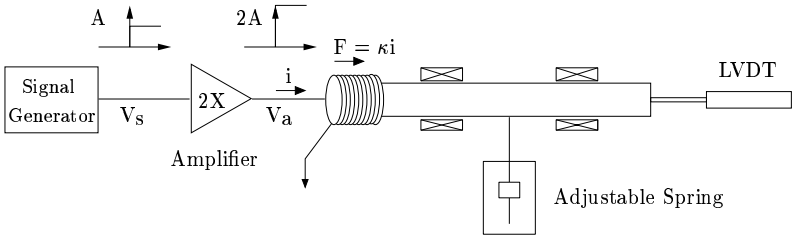
In each case, adjust the length of the spring rod until you have attained the desired specification. Save the response once you are satisfied that that you have in fact obtained the optimal design. Measure the rise time $t_{r(10-90)}$, the overshoot M_p, the 4% settling time $t_{s(4\%)}$, and the pole locations s_{p1} and s_{p2}.

	$t_{r(10-90)}$ (sec)	M_p (%)	$t_{s(4\%)}$ (sec)	s_{p1} (rad/sec)	s_{p2} (rad/sec)
1					
2					
3					

Questions:

1. Make an s-plane sketch indicating where the poles must be located if the settling time $t_{s(4\%)}$ must be less than 0.1 second and the overshoot M_p must be less than 10%.
2. According to the approximate formula for the settling time $t_{s(4\%)}$, how should $t_{s(4\%)}$ change as the length of the spring rod is varied? Did your measurements agree with this prediction? Explain.

Procedure for Lab 4:



For this lab, the system is connected as indicated in the figure above. The amplifier drives the output voltage V_a, such that $V_a = 2V_s$. The amplifier drives the current i to create the force on the shaft. The equivalent damping term κ^2/R due to the actuator is present because the amplifier is a voltage source.

1. Before turning on the power supply, verify that
   (a) The output range is set between 0 and 2 Volts.
   (b) The waveform type is set to a square wave.
   (c) The spring length is as short as possible.
2. Turn on the power supply and
   (a) Set the oscilloscope to show both channels simultaneously and adjust the period of the square wave so that the system has enough time to come to equilibrium during each pulse.
   (b) Adjust the amplitude of the square wave so that the system moves on the order of 4 mm during each cycle. (You will find it easier to measure overshoot and settling time if the amplitude of the response is an integer number of grid squares.)
3. In order to "zoom in" on a portion of the response, you will find it useful to
   (a) Use the signal generator to add an offset that brings the portion of the response that you wish to examine close to zero on the scope.
   (b) Expand the voltage scale to a value at which you can measure the desired features of the response.
4. Once you are satisfied with the response, save it to a floppy and use the supplied function `getdata` to make a scaled plot in Matlab®.