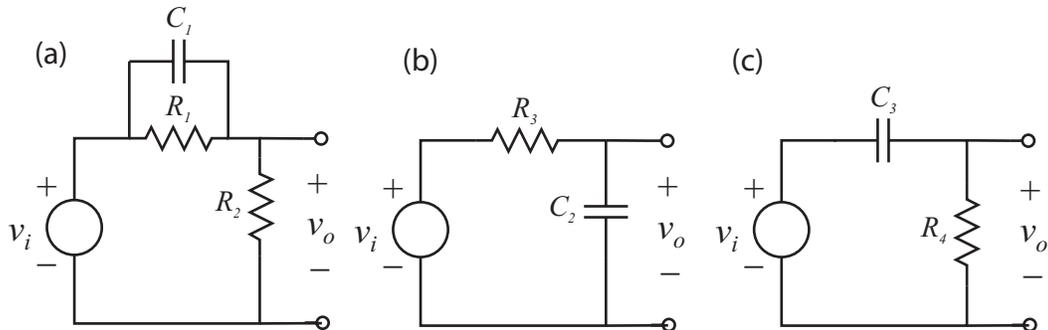


Massachusetts Institute of Technology
Department of Mechanical Engineering
2.003 Modeling Dynamics and Control I
Spring 2004
Lab 5

First Part



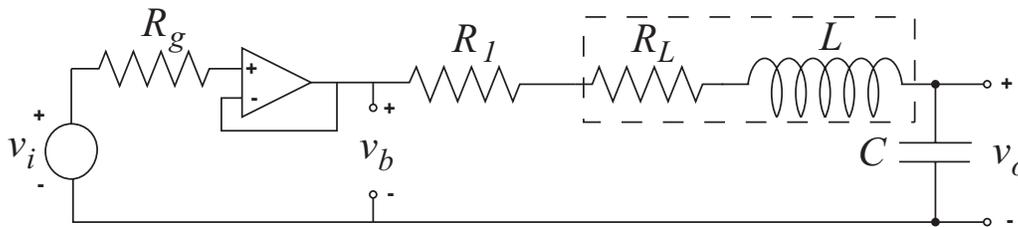
Using the supplied components, construct each of the circuits shown in the figure above on a breadboard. Use the values given in the prelab ($R_1 = 100 \text{ k}\Omega$, $R_2 = 47 \text{ k}\Omega$, $R_3 = R_4 = 10 \text{ k}\Omega$, $C_1 = 0.1 \text{ }\mu\text{F}$, and $C_2 = C_3 = 0.047 \text{ }\mu\text{F}$). At each station, you will find a diagram showing the locations of the conductors within a breadboard and a guide to resistor color codes.

1. For each circuit, use the function generator to apply a step in the input voltage v_i and set the oscilloscope to record both the input v_i and output v_o of the circuit. Record the step response and determine the time constant τ . Compare the measured responses with those that you computed in the prelab.
2. The properties of electronics components vary somewhat from their designated values. Using a multimeter, directly measure the resistance R_4 of the resistor that you used in circuit (c). Based on the measured time responses, compute the value of C_3 .

Second Part

In this part, we will measure the step response of a 2nd order RLC circuit. The inductance and capacitance of the circuit are fixed at the values given in the prelab: $L = 4.7 \text{ mH}$ and $C = 0.22 \text{ }\mu\text{F}$. The prelab modelled the function generator as an ideal voltage source. However the function generator has an internal resistance of $R_g = 50\Omega$. To keep the circuit response in correspondence with the calculations in your prelab we will include a unity-gain op amp buffer between the signal generator and the circuit. For the

present purposes, the details of the op amp circuit are unimportant. During lab, we will wire the circuit as shown below.



The input impedance of the buffer is very high and its output impedance is very low. Thus it forces v_b to be nearly identical to v_i so long as the output current does not exceed the limits of the op amp. **Note:** To avoid saturating the current output capabilities of the op-amp, v_i must be kept below ≈ 100 mV.

1. Use a multimeter to measure the resistance R_L of the inductor, and compute the value of R_1 that results in $\zeta \approx 0.15$. (Note that due to the buffer, the signal generator output resistance $R_g = 50\Omega$ does not affect the result.)
2. Assemble the circuit with a resistance close to the value that you computed, using the output of the op amp as v_b . (You can use any combination of the resistors in your kit.) **Do not alter the connections that we have made to the op amp.** Calculate the pole locations based on the value of R_1 that you used when assembling your circuit.
3. Record the response of v_o to a step in v_i and verify that your design comes close to the desired behavior. (There will be some error in the values of L and C that you used in your calculations, so it is reasonable for the pole locations to differ from what you computed by around 10%.) Compare the predicted and measured responses using `simdata.m` as was done in Lab 4.

The steps for comparing the predicted and measured responses are:

- (i) Save data from oscilloscope onto a floppy disk in Spreadsheet Format and note the file name.
 - (ii) Change current Matlab directory to `A:\` and type `simdata(nval)` at the Matlab command line where `nval` are the last two digits of the filename.
 - (iii) Follow the instructions at the command prompt.
4. Use the `simdata.m` routine to fit the experimental response and thereby determine the best fit model pole locations. Record these best fit pole locations.