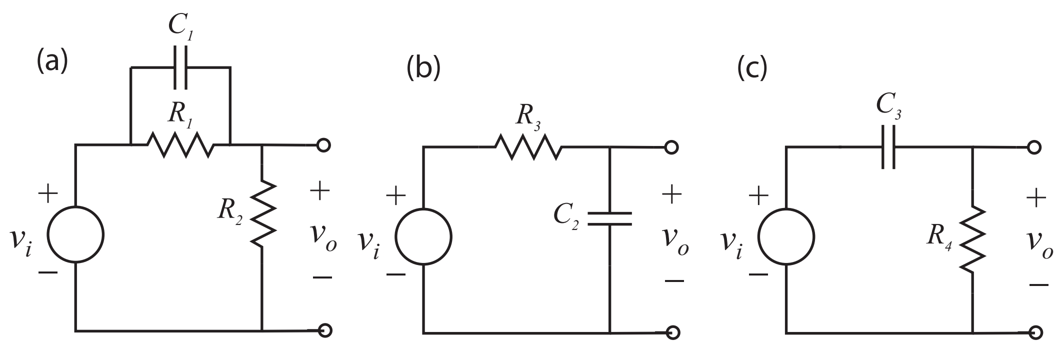
Massachusetts Institute of Technology
Department of Mechanical Engineering
2.003 Modeling Dynamics and Control I
Spring 2005
Prelab 5

First Part

In this part, we will measure the step response of the 1st order RC circuits shown in the figure below.

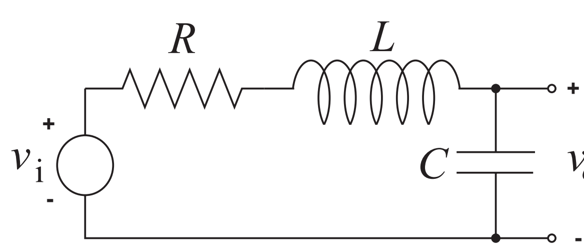


1. For each circuit, write the governing differential equation in terms of v_i and v_o.

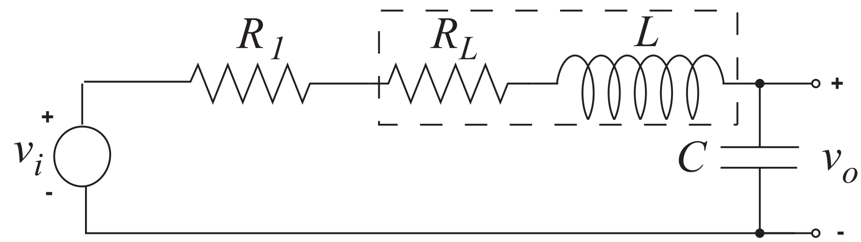
2. Calculate and make an accurate plot of the step response from initial rest for each circuit. Note that for (a) and (c), $v_o(t)$ is discontinuous from $t = 0^-$ to $t = 0^+$. Use the following values: $R_1 = 100$ kΩ, $R_2 = 47$ kΩ, $R_3 = R_4 = 10$ kΩ, $C_1 = 0.1$ μF, and $C_2 = C_3 = 0.047$ μF.

Second Part

In this part, we will calculate and measure the step response of the 2nd order RLC circuit sketched below with $L = 4.7$ mH, $C = 0.22$ μF, and various values of R.



The inductor has an internal resistance R_L of approximately 10 Ω. Therefore a more accurate model of the circuit that we will build in lab is:



where $R = R_1 + R_L$. Here R_1 is the resistor that you get to pick and R_L is the inductor resistance. Derive the governing differential equation relating the input voltage v_i to the output voltage v_o. Determine the values of R_1 that yield each of the following specifications (with $R_L = 10\Omega$):

1. The system is underdamped with $\zeta = 0.15$
2. The system is critically damped.
3. The system is overdamped and the slowest pole has a time constant $\tau = 0.1$ ms.

In each case, use Matlab to plot the response of v_o to a step in v_i.

Note: Be sure to bring a copy of your Matlab plotting routine to the lab for use in overlaying experimental data.