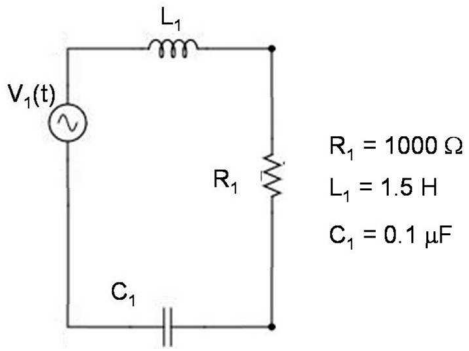
ME 374 Laboratory Experiment #4
Response of a 2nd Order System to Periodic Inputs

The purpose of this lab is to measure the response of the following electrical circuit and qualitatively predict the response.



The voltage source is a square wave with period T and amplitude 1.0 V peak-to-peak, i.e.,

$$v_s(t) = \begin{cases} 0.5, & 0 < t < T/2 \\ -0.5, & T/2 < t < T \end{cases}$$

Pre-Lab Problem

Answer the following pre-lab questions.

1. Derive the governing equation of the circuit using $v_s(t)$ as input and $v_c(t)$ as output.
2. Derive and plot the frequency response function from $v_s(t)$ to $v_c(t)$.
3. Expand $v_s(t)$ into a Fourier series. Calculate the Fourier coefficients and fundamental frequency ω_0 for square waves of periods T = 0.2 s, 0.02 s, 0.002 s,and 0.0002 s.
4. Plot the Fourier coefficients of the first 5 non-zero terms with respect to frequency for square waves of periods T = 0.2 s, 0.02 s, 0.002 s, and 0.0002 s. These plots are the line spectra of $v_s(t)$.

Laboratory Procedure

1) Set up the function generator to apply a square wave of amplitude 1.0 v peak-to-peak.

2) Connect the function generator to the circuit as shown above in the figure, and to Input-1 of the LabVIEW interface. Connect the voltage across the capacitor to the input-2 of the LabVIEW interface.

3) For each of the square wave frequencies in the table, record and plot three periods of the input and the response.

Square Wave Frequency		**Period**
$\frac{\text{rad}}{\text{sec}}$	Hz	milliseconds
31.42	5.	200
314.2	50.	20
3142.	500.	2
31420.	5000.	0.2

4) For each case, explain the nature of the recorded time response. Calculate the response using the line spectrum and frequency response function obtained from the pre-lab. Why do you believe that your calculations predict the measured response?

5) Switch the function generator to generate a triangle wave and examine the behavior across the same range of frequencies. Do you observe the same characteristics as in square-wave excitation?