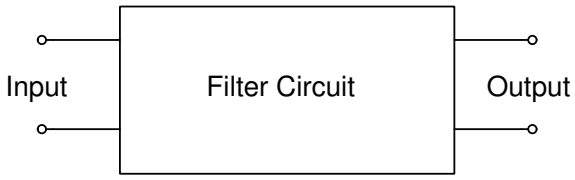
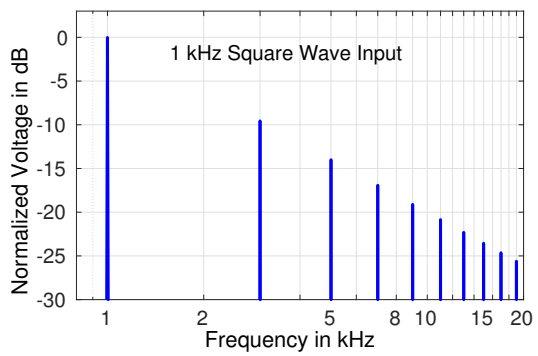
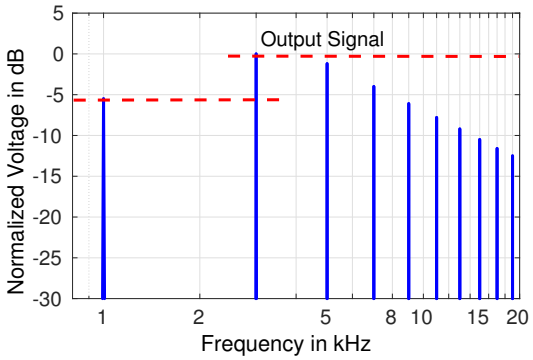
ECE 214 - Lab #3 — RC Filter

9 February 2016

Introduction: In this lab you will design and build a filter to reduce the fundamental frequency from a 1 kHz square wave as illustrated below. You will learn the difference between "ac" and "transient" circuit simulations and how to use the FFT function in Micro-cap and on the digital oscilloscope.







Pre Lab:

1. Use your knowledge from ECE 210 to design a filter, using the minimum number of components, to meet the following specification:
   (a) Input: Square wave with a frequency of 1 kHz.
   (b) Output: Fundamental frequency at least -6 dB below the 3rd harmonic and the 3rd harmonic larger than all other harmonics.
2. Analyze the filter circuit in Micro-cap using both "ac" and "transient" analysis.
   (a) In Micro-cap, use a 5 V peak-to-peak square wave at a frequency of 1 kKz as the input to the filter.
   (b) Using "ac" analysis, generate the frequency response of the filter.
   (c) Using "transient" analysis, generate the time-domain signals at the input and output of the filter for a duration of 100 ms.
   (d) Using the FFT feature in Micro-cap, generate the frequency-domain response of the time-domain square-wave input signal and time-domain output signal of the filter. (See page 3 for instructions on how to use the FFT feature of Micro-cap.)

3. In your notebook, record the output from the Micro-cap simulations showing the frequency response of the filter and the input and output of the filter in both the time–domain and the frequency–domain.

4. Make sure you understand how the results from the "transient" simulation, "ac" simulation and the FFT function are related.

Lab Procedure:

1. Build the filter you designed in the pre lab.

2. Connect a 5 V peak-to-peak square wave signal at a frequency of 1 kHz from the FG to the input of the filter. Measure the input and output of the filter on the scope in both the time-domain and the frequency-domain. Record the time- and frequency-domain signals in your notebook. Make sure all axes and peaks are properly labeled. Photographs of the scope screen are an efficient way to record this data.

3. Does the output of the filter meet the specifications?

   (a) If "Yes," you are done with the lab procedure and are ready for the post lab.

   (b) If "No," Use your knowledge from ECE 210 to redesign the filter, using the minimum number of components, to meet the specification listed in step 1 of the pre lab. Repeat the lab starting with step 2 in the pre lab.

Post Lab:

Compare the measured results with the simulated results from Micro-cap. Make sure you understand the difference between the "ac" analysis in Micro-cap and the FFT of the transient response. Explain any differences between the simulations and measured results in your notebook.

To generate the FFT of the time-domain signal in Micro-cap: Once you have the transient signal on the screen, click `Transient --> FFT Windows --> Add FFT Window`. In the `Plot` tab, select: `db(Harm)` and in the `expression field` enter the node of the circuit you want to examine. Set the `FFT` and `Scales and Formats` tabs as shown below. Use the cursor to determine the peak amplitudes.