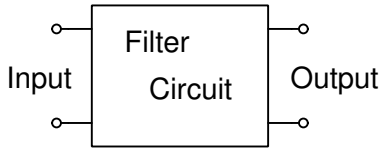
ECE214: Electrical Circuits Laboratory

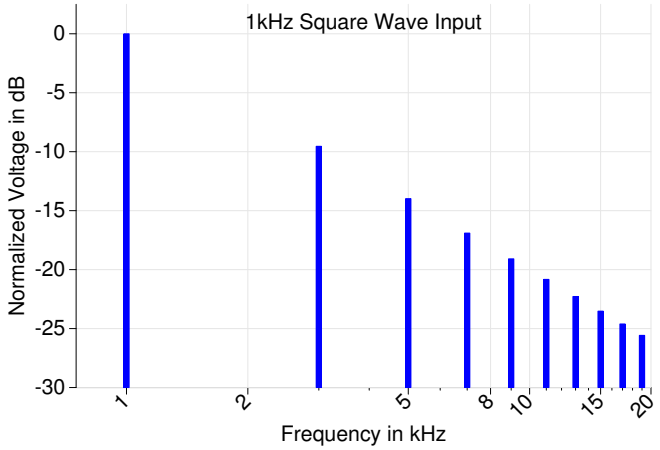
Lab #3 — RC Filters

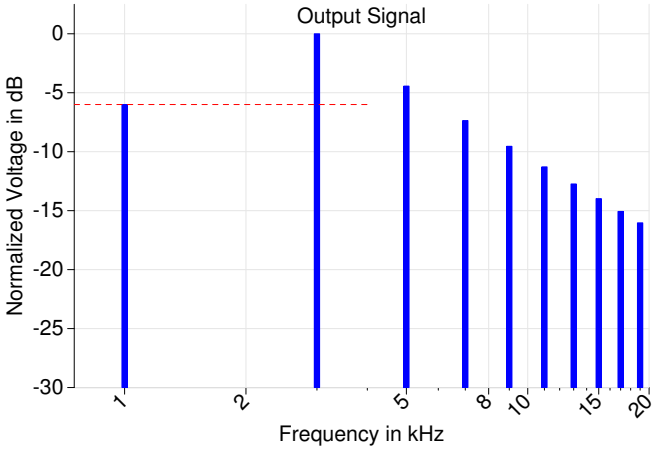
Week of 3 February 2015

1 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.







2 Pre-lab

1. Design a RC filter circuit, with the minimum number of components, to meet the following specification:

   (a) Input: Square wave with a frequency of 1 kHz.

   (b) Output: 3rd harmonic at least 6dB above fundamental frequency and 3rd harmonic larger than all other harmonics.

   (c) Analyze the filter circuit in Micro-cap using both “ac” and “transient” analysis. In Micro-cap, use a 5 V peak square wave at a frequency of 1 kHz as the input to the filter. Use “ac” analysis to generate the frequency response of the filter. Use “transient” analysis for 100 ms to generate the time-domain response of the input and output signals. Use the FFT feature to generate the frequency-domain response of the input and output signals. (See page 3 for using the FFT feature to generate the frequency-domain response of a time-domain signal in Micro-cap.)

   (d) In your notebook, have plots 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.

3 Lab Procedure

Build the filter you designed in the pre-lab.

1. Connect a 5 V peak square wave at a frequency of 1 kHz from the FG to the input of the filter. Measure the 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.

2. Does the output of the filter meet the specifications? If "Yes," you are done with the Lab Procedure.

3. If the specification is not met, redesign the filter, then build and test the new filter. Repeat this step until the filter circuit meets the specification.

4 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.

FFT and Micro-cap

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.