ECE 209 - FOURIER SERIES - INVESTIGATION 25
STEADY STATE RESPONSES TO PERIODIC INPUTS - PART II

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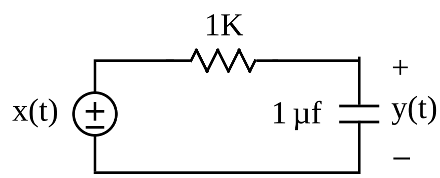
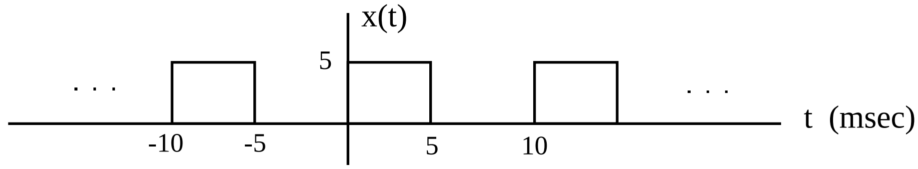
To do "well" on this investigation you must not only get the right answers but must also do neat, complete and concise writeups that make obvious what each problem is, how you're solving the problem and what your answer is. You also need to include drawings of all circuits as well as appropriate graphs and tables.

The objective of this investigation is to continue doing frequency domain analysis of linear circuits with periodic inputs.

1. The objective of this problem is to first make use of results from ECE 207 to obtain the steady state response of the following circuit



to the following pulse train



using time domain analysis. And then demonstrate how it can be done with frequency domain analysis.

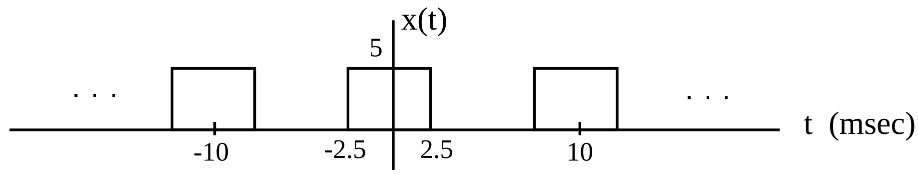
a. From ECE 207 we know that as long as the pulse is ON for at least 5τ and then OFF for at least 5τ then the capacitor will have time to for all practical purposes charge and then discharge as follows

$$y(t) = \begin{cases} 5 - 5e^{-t/\tau} & 0 \le t \le 5 \text{ msec} \\ 5e^{-(t-0.005)/\tau} & 5 \text{ msec} \le t \le 10 \text{ msec} \end{cases}$$

Find τ and then make use of it to write out the expressions for y(t) for when the pulse is ON and then OFF.

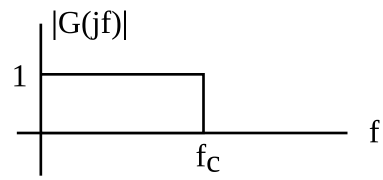
b. Use Mathcad to obtain a graph of your y(t) in part (a)
c. Use frequency domain analysis to express y(t) as a sum of sinusoids. Include at least the first ten harmonics
d. Make use of Mathcad to obtain a graph of your y(t) in part (c)
e. Compare your time and frequency domain results. In particular compare your graphs in parts (b) and (d)

2. The objective of this problem is to make use of frequency domain analysis to see how the steady state response of a lowpass filter with a periodic input as follows



is affected by changes in the circuit's bandwidth.

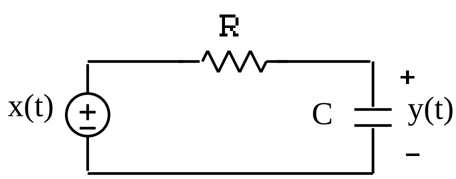
a. Let us begin with an ideal lowpass circuit with frequency response as follows



Make use of Mathcad to obtain graphs of the steady state output of y(t) for f_c equal to $0.5f_o$, $2f_o$, $6f_o$ and $10f_o$

b. Describe and explain what happens to y(t) as f_c increases in part (a)

c. Now let's suppose we have a first order RC circuit as follows



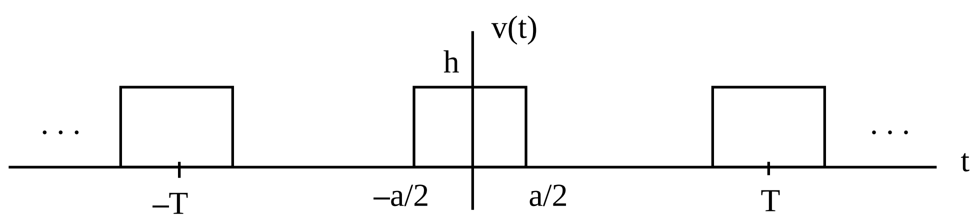
with transfer function

$$G(j\omega) = \frac{\omega_{3dB}}{j\omega + \omega_{3dB}}$$

Make use of Mathcad to obtain graphs of the steady state output of y(t) for $f_{3dB} = 0.5f_o$, $2f_o$, $6f_o$ and $10f_o$

d. Describe and explain what happens to y(t) as f_{3dB} increases in part (c)

3. Given a second order circuit with the following pulse train input as follows



with T = 1 msec, h = 2 volts and a = 0.4 msec. What values would you choose for ω_p and Q_p so that the steady state response is approximately equal to "just" the first harmonic.