

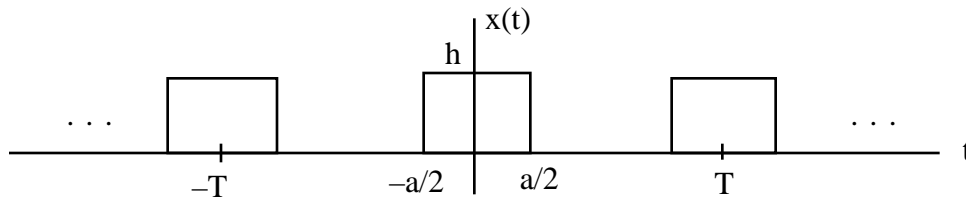
# ECE 209 - FOURIER SERIES - INVESTIGATION 23 THE SPECTRUMS OF PERIODIC SIGNALS - PART II

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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 see how changes in the following pulse train affects its Fourier Series



The initial parameters of the pulse train are as follows:

Period  $T = 10$  msec; Amplitude  $h = 10$ ; Pulse Width  $a = 5$  msec

1. Calculate the Fourier parameters  $c_0, c_1, \dots, c_5, \theta_1, \dots, \theta_5$  for  $x(t)$

$$x(t) = c_0 + \sum_{k=1}^5 c_k \cos(k\omega_0 t + \theta_k)$$

2. Suppose we add a constant of value  $C = 2$  to the pulse train  $x(t)$  above as follows

$$x_1(t) = x(t) + 2$$

- a. Sketch  $x_1(t)$
- b. Calculate the  $c_k$ 's and  $\theta_k$ 's of  $x_1(t)$
- c. Describe what happened to the  $c_k$ 's and  $\theta_k$ 's when the constant was added to  $x(t)$
- d. How would you expect the adding of a constant  $C$  to a periodic signal to affect its Fourier Series parameters  $c_0, c_k$  and  $\theta_k$

3. Suppose we double the magnitude of the pulse train  $x(t)$  above as follows

$$x_2(t) = 2x(t)$$

- a. Sketch  $x_2(t)$
- b. Calculate the  $c_k$ 's and  $\theta_k$ 's of  $x_2(t)$
- c. Describe what happened to the  $c_k$ 's and  $\theta_k$ 's when  $x(t)$  was multiplied by a factor of two
- d. How would you expect the multiplying of a periodic signal by a factor  $K$  to affect its Fourier Series parameters  $c_0, c_k$  and  $\theta_k$

4. Suppose we delay the pulse train  $x(t)$  by  $t_0 = 2$  msec as follows

$$x_3(t) = x(t - 2 \times 10^{-3})$$

- a. Sketch  $x_3(t)$
- b. Calculate the  $c_k$ 's and  $\omega_k$ 's of  $x_3(t)$
- c. Describe what happened to the  $c_k$ 's and  $\omega_k$ 's when  $x(t)$  was delayed by  $t_0 = 2$  msec
- d. How would you expect the delaying of a periodic signal by a time  $t_0$  to affect its Fourier Series parameters  $c_0$ ,  $c_k$  and  $\omega_k$

5. Suppose we double the frequency of the pulse train  $x(t)$  above as follows

$$x_4(t) = x(2t)$$

- a. Sketch  $x_4(t)$
- b. Calculate the  $c_k$ 's and  $\omega_k$ 's of  $x_4(t)$
- c. Describe what happened to the  $c_k$ 's and  $\omega_k$ 's when the frequency of  $x(t)$  was doubled
- d. How would you expect the multiplying of the frequency of a periodic signal by a factor  $K$  to affect its Fourier Series parameters  $c_0$ ,  $c_k$  and  $\omega_k$