ECE 218 Signals and Systems Laboratory 8

I. Preparation

1) A continuous time periodic signal x(t) with period T can be written as sum of complex harmonic exponential signals. This procedure is called Fourier series representation of a signal.

$$x(t) = \sum_{k=-\infty}^{k=+\infty} X[k] e^{jkw_0 t} \tag{1}$$

where $w_0 = \frac{2\pi}{T}$. $X[k]$ are called the Fourier series coefficient and found using eqn. (2).

$$X[k] = \frac{1}{T} \int_T x(t) e^{-jkw_0 t} dt \tag{2}$$

The Fourier series coefficient of the signal x(t) in Fig. 1 is given as $X[k] = 0.25 \frac{(1-e^{-jk\pi})}{jk\pi/2}$ $; k \neq 0$ and $X[0] = 0.5$ Since the k values cannot take infinite values practically we can use a large k values to approximate the signals, i.e.,

$$x_N(t) = \sum_{k=-N}^{k=+N} X[k] e^{jkw_0 t} \tag{3}$$

where $w_0 = \frac{2\pi}{T}$. $X[k]$ are called the Fourier series coefficient and found using eqn. (2) Now consider the following matlab code which is written for the signal x(t) in Fig. 1. Fourier series coefficient are $X[k] = 0.25(1 - e^{-jk\pi})/(jk\pi/2)$.

$t = -5 : 0.01 : 5;$
$xt = zeros(1, length(t));$
$N = 10;$
$for \;\; k = -N : N$
$xk = 0.25*(1-exp(-j*k*pi))/(j*(k+0.001)*pi/2);$
$xt = xt + xk * exp(k * j * 0.5 * pi * t);$
end
$xt = 0.5 + xt;$
$plot(t, xt)$

Write the above matlab code and change the N values and see the result, determine N value when used the shape resembles a square better.

2) Find the Fourier series coefficient of all the other signals in Fig. 1.

II. Experimental Work

1) Write matlab programs that for Fourier series approximation of the periodic signals in Fig. 1. Change N values and see each plot.

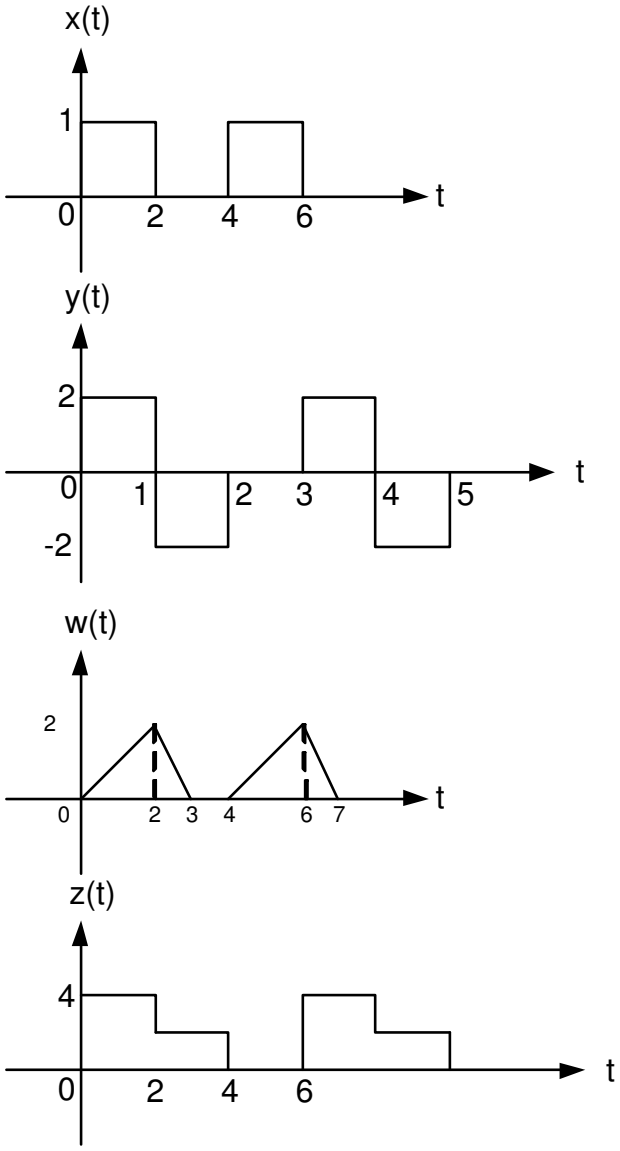

Fig. 1. Continuous time periodic signals.

2) Write CT periodic signals in Fig. 1 in time domain, find their Fourier series approximation. Determine the error between two signals by subtracting them from each other. Plot the error signal. When error increases what happens. Can you determine a threshold value for N, as you further increase N the error does not change much.

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