CENG290 Data Communications
Labwork 3

Fourier Series Representation of Square Waves

Any periodic signal can be represented by an infinite number of the sine and cosine harmonics of its fundemental frequency. Assuming the periodic function is defined as G() with a frequency of f and period T we have:

$$G(t) = a_0 + \sum_{n=1}^{\infty}(a_n cos(2\pi nft) + b_n sin(2\pi nft))$$

The coefficients a_0, a_n, and b_n are found as shown below:

$$a_0 = \frac{2}{T}\int_0^T G(t)dt$$

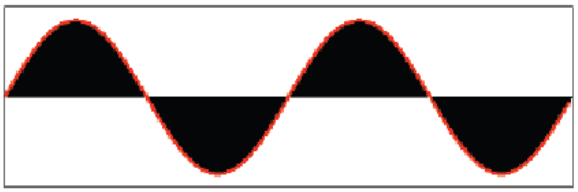
$$a_n = \frac{2}{T}\int_0^T G(t)cos(2\pi nft)dt$$

$$b_n = \frac{2}{T}\int_0^T G(t)sin(2\pi nft)dt$$

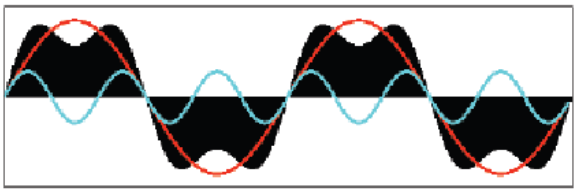
However, in practice it is not possible to have infinitely many harmonics transmitted over a communication system. The following figure depicts square waveform using different number of harmonics:

Square Wave

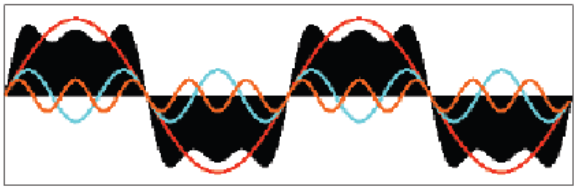
Frequencies: f



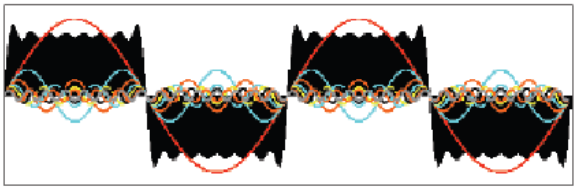
Frequencies: $f + 3f$



Frequencies: $f + 3f + 5f$



Frequencies: $f + 3f + 5f + \ldots + 15f$



Assume a square wave with amplitude = 1 and T = 2 is given. Find the first four coefficients a_0, a_n and b_n ($n \leq 4$). Then write a MATLAB function to get the number of harmonics ($n \leq 4$) as input and draw the square wave.