Spectra of non-periodic signals

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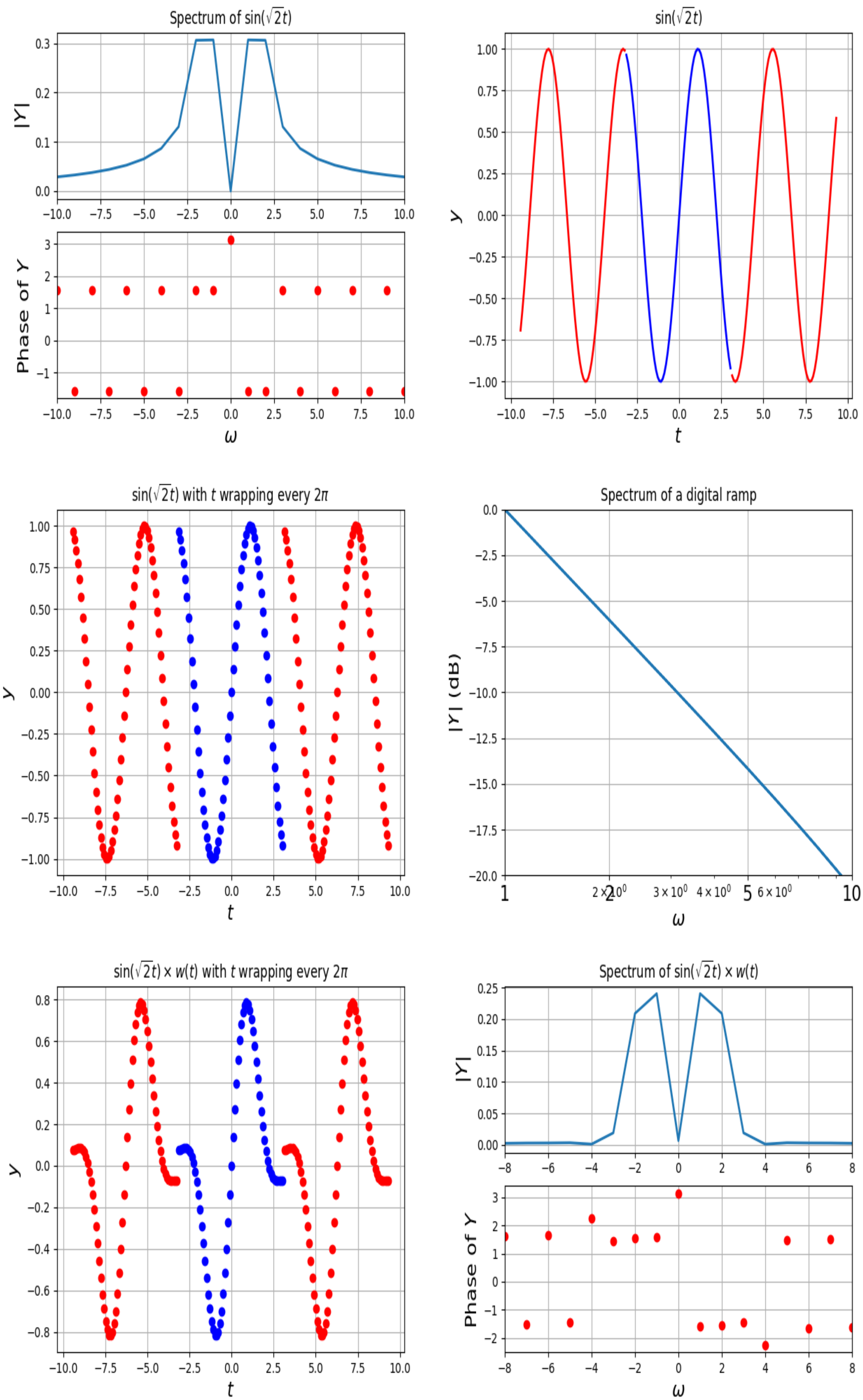
Abstract

Here we look at how to get spectrum of non-periodic signals. we will learn to use hamming window to supress gibbs phenomena

1 Introduction

- If we obtain the spectrum of $sin(\sqrt{2}t)$ using fft .we get spikes but they donot decay fast.The samples which are taken and repeated to obtain dft have large discontinuity at 2π.i.e samples when repeated dont actually replicate $sin(\sqrt{2}t)$.
- In order to supress discontiuity at 2π we multiply the signal with hamming function . The result is shown in below figures.
- When dft is now calculated for this new function we get spectrum with two peaks with fastly decaying amplitude nearby.

Figure 1: To obtain spectrum of $sin(\sqrt{2}t)$



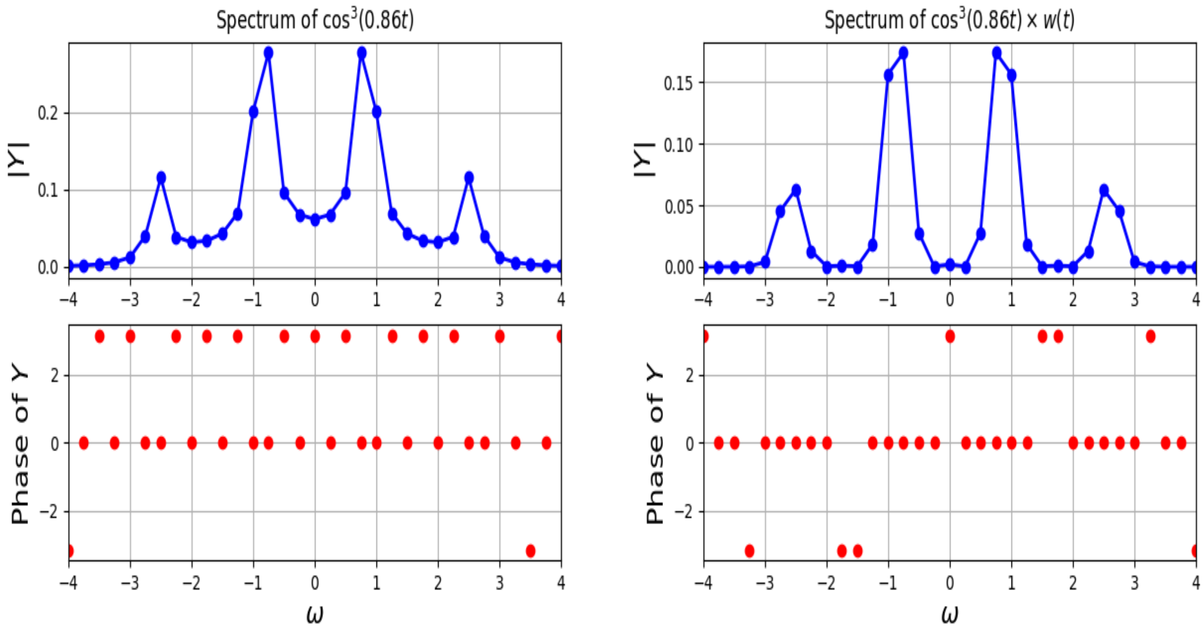
2 Spectrum of $cos^3(\omega_0 t)$

- The number of samples taken are 256 in between -4π to 4π.The hamming window function used for mod(n) less than (N-1)/2.

$$w[n] = 0.54 + 0.46cos(\frac{2\pi n}{N-1})$$

- The spectrum with and without hamming function are plotted in below figure.
- since it is peroidic with irrational multiple of π.The rational multiples of π taken for samples results not in a complete period but a part of it therfore it results in discontiuity when repeated.
- In order to supress discontinuity we use hamming window.

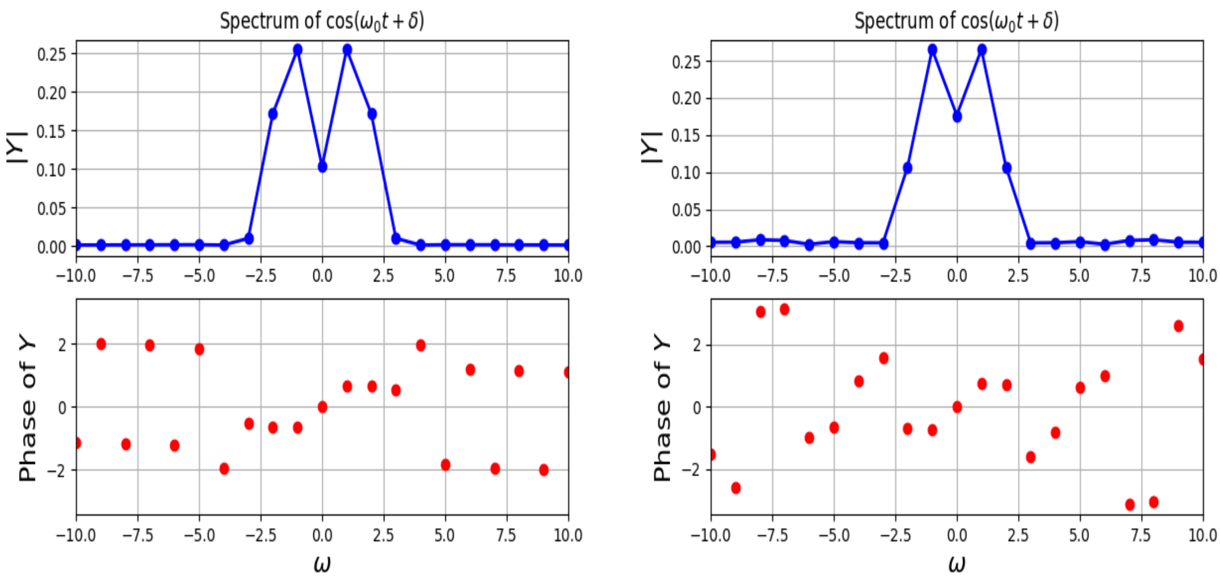
Figure 2: Spectrum of $cos^3(\omega_0 t)$ without hamming window for $\omega_0 = 0.86$



3 Spectrum of $cos(\omega_0 t + \delta)$for arbitary $\omega_0$and δ.

- The arbitary values of $\omega_0, \delta$are chosen using rand function.The spectrum of resulting has two peaks .
- The addition of guassian noise is done to the function using randn(sizeof(samples)).The resulting spectrum has two peaks at $\pm\omega_0$.
- When plot are taken for various values of ω_0, δwe can make conclusion on how hamming function helps us supress gibbs phenomena.

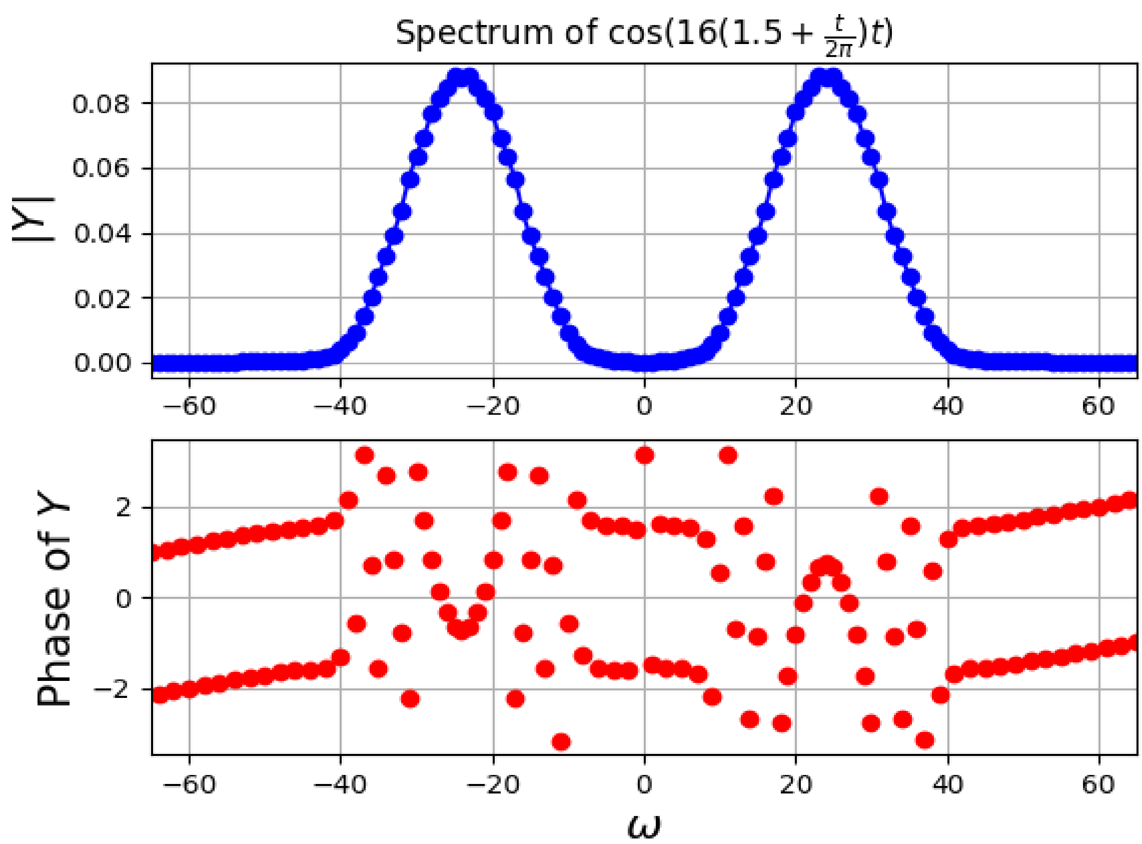
Figure 3: Spectrum of $cos(\omega_0 t + \delta)$ with and without noise for arbitary ω_0, δ



4 Dft of $cos(16(1.5 + \frac{t}{2\pi})t)$

- The time is sampled from $-\pi$ to π in 1024 steps. It results in the chirped signal whose frequency continuosly changes from 16 to 32 rad/s . The dft of the signal is done with above time step.

Figure 4: Dft of $cos(16(1.5 + \frac{t}{2\pi})t)$



- The 1024 samples of $cos(16(1.5 + \frac{t}{2\pi})t)$ are broken into 16 samples which are 64 samples wide.
- The Dft of each sample is extracted and stored in array Y.

- This plot shows how signal frequency varies with time.

Figure 5: Surface plot of $cos(16(1.5 + \frac{t}{2\pi})t)$ showing how frequency varies continuosly with time