EE2703 : Applied Programming Lab
Assignment 8
Digital Fourier Transform

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1 Aim

we observe different DFT functions using fft library in numpy.

2 The Sinusoid

Consider the sinusoids $\sin^3 t and cos^3 t$:

$\sin^3 t = 3sin(t) - sin(3t)/4$

$\cos^3 t = cos(3t) + 3cos(t)/4$

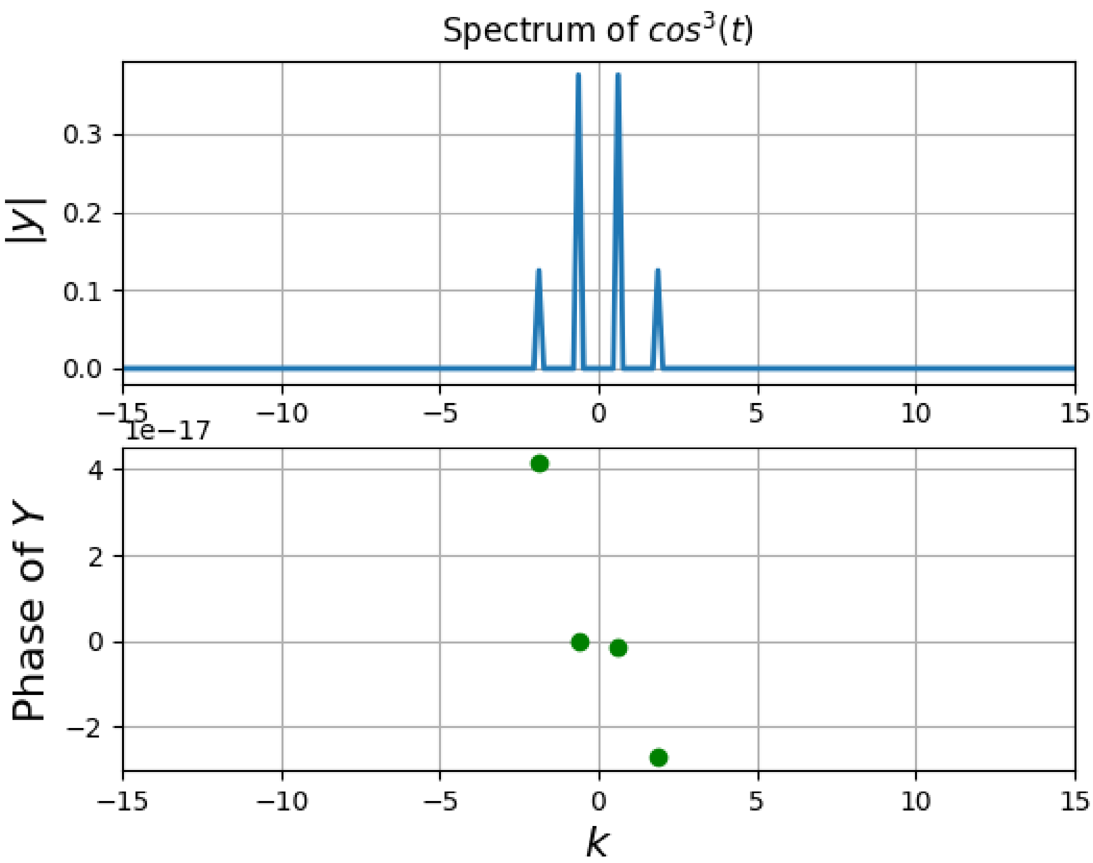

Figure 1.1: e^x DFT of $\cos^3 t$

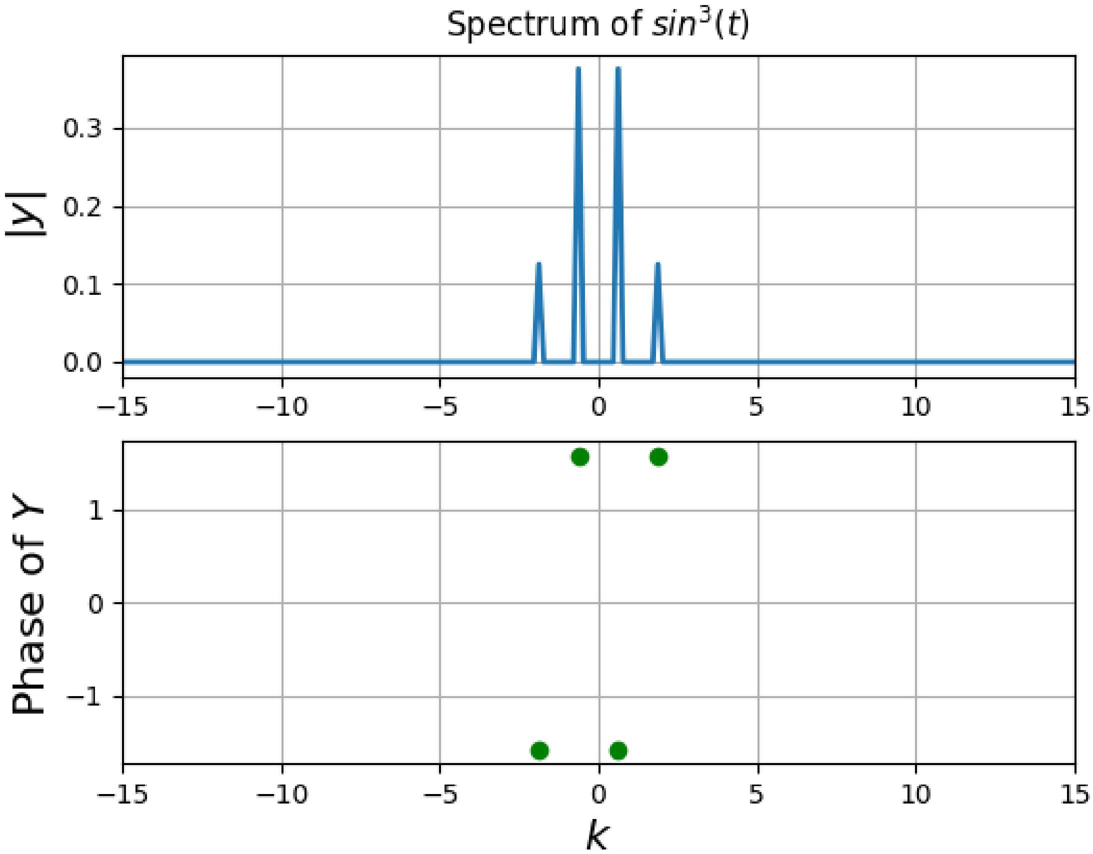

Figure 1.2: e^x DFT of $\sin^3 t$

3 Frequency Modulation:

Here, we consider the frequency modulated function cos(20t + 5cos(t))

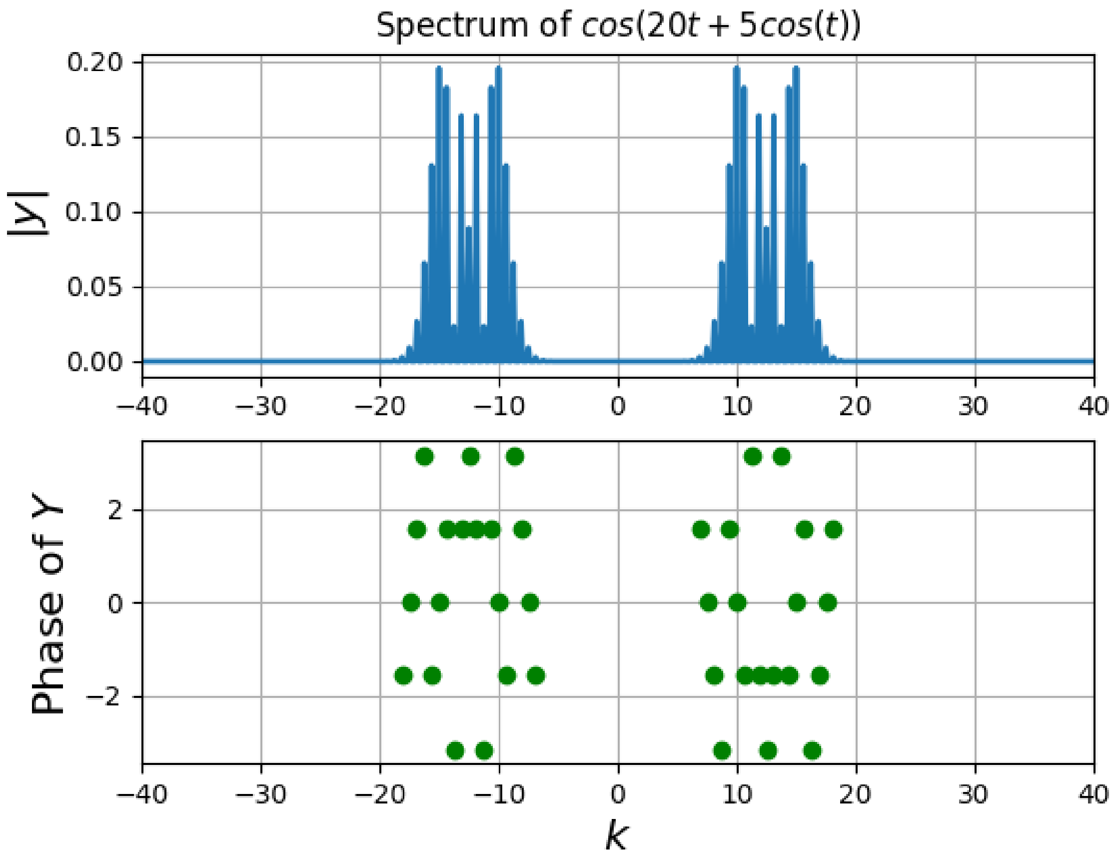

Figure 1.3: DFT of cos(20t + 5cos(t))

4 The Gaussian:

The frequency spectrum of the Gaussian function f(x) = $e^{-(}x^2/2)$

is non-zero even for very large frequencies, indicating that it is not band-limited.

The Continuous Time Fourier Transform for the Gaussian is given by

F(w) = root(2pi).$e^{-(}w^2/2)$

As a result, for any w, the phase is zero, and the magnitude is a Gaussian function. The DFT can be used to calculate the error after proper normalising. The error in the estimation for the DFT derived using the fftshift function varied for different time ranges(tlim). The value of error was also found to change with frequency domain resolution (wlim) and sampling rate. For the values,

N = 512, wlim = 32 rad s[1]

tlim = 8 *pi* s

the error was of the order 1015 ,which is well within the allowed error. For different sampling rates, we observe that the peak of the gaussian broadens.

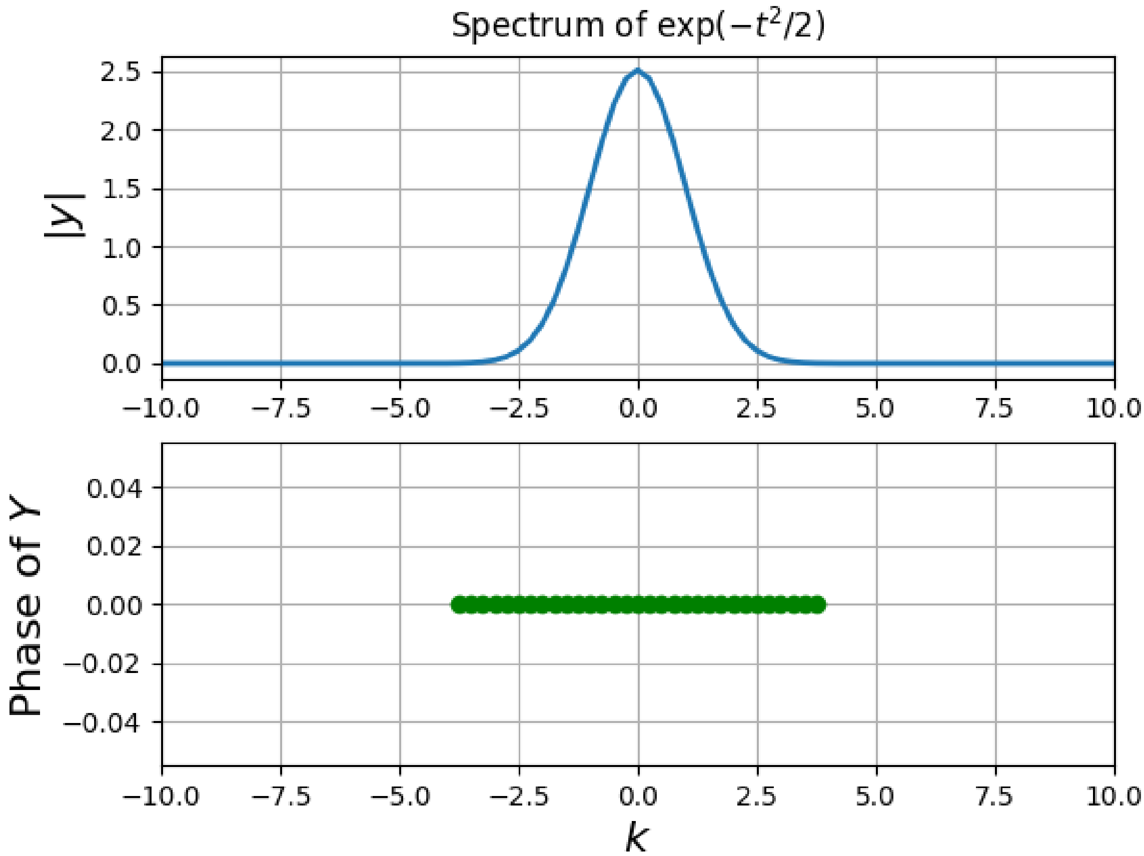

Figure 1.4: DFT of the Gaussian for tlim = 4pi

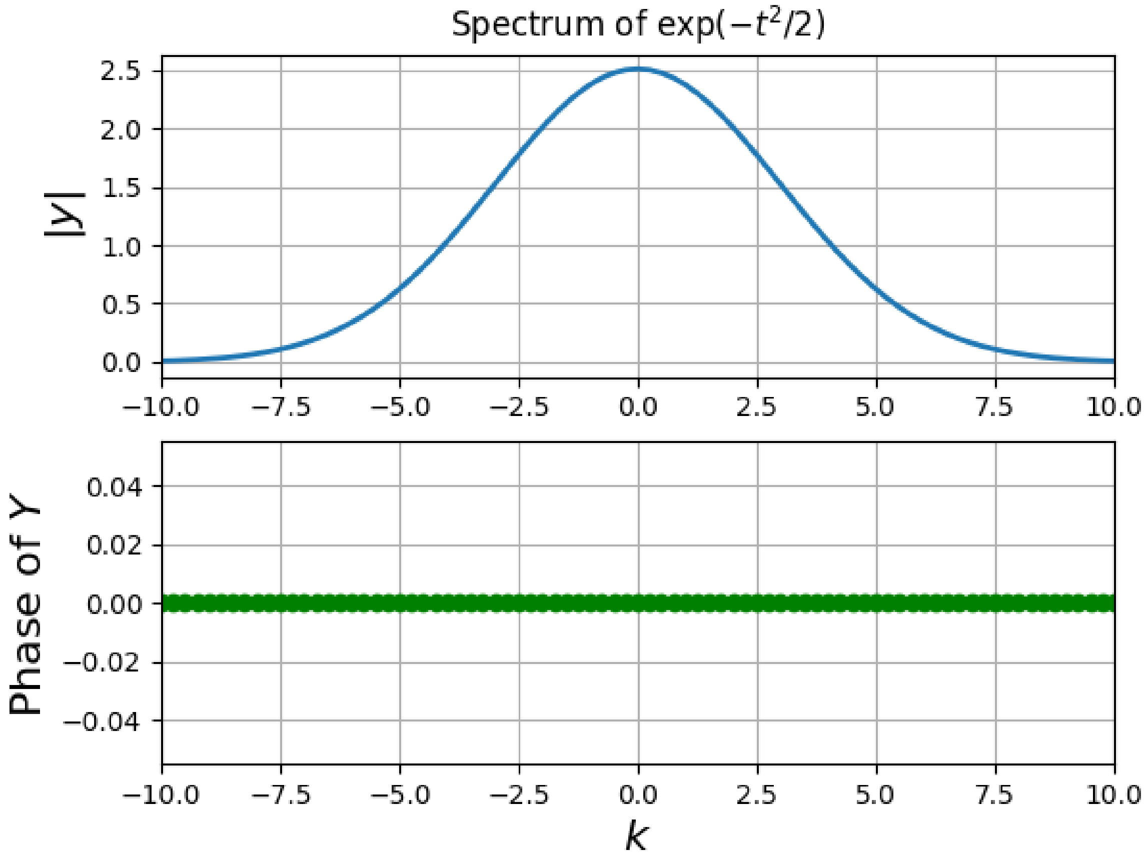

Figure 1.5: DFT of the Gaussian for tlim = 12pi

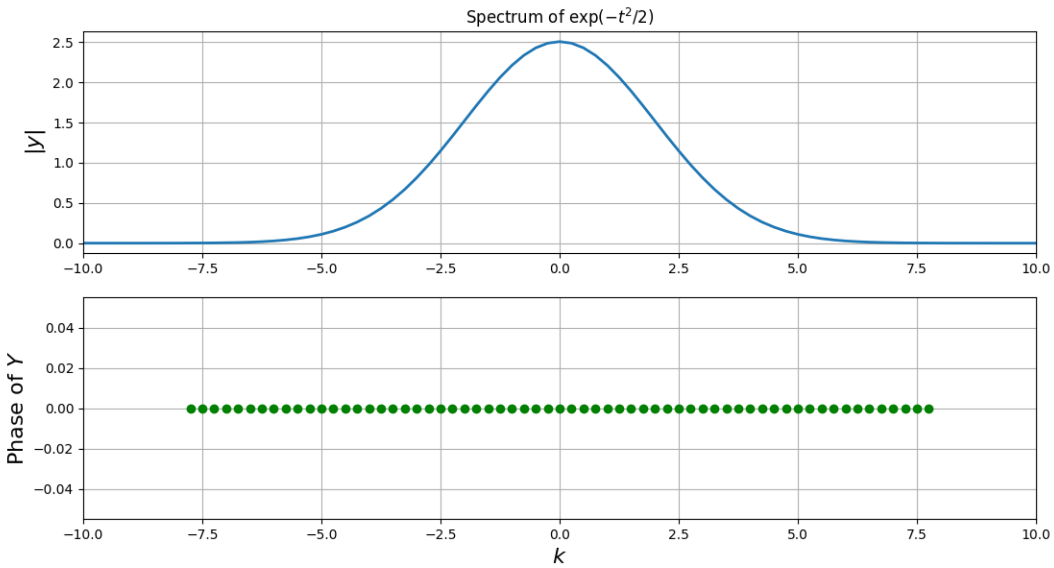

Figure 1.6: DFT of the Gaussian for N = 256

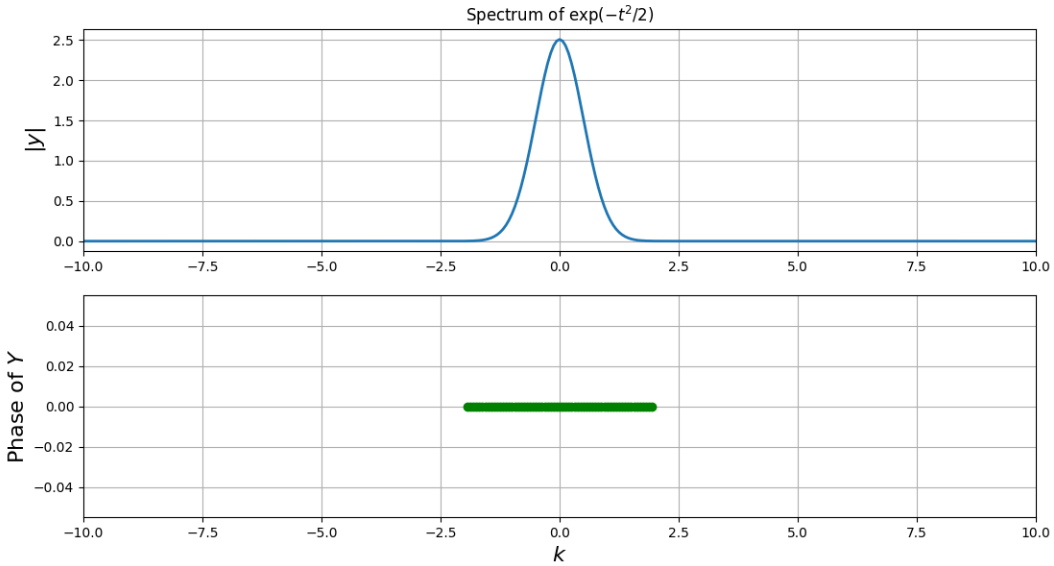

Figure 1.7: DFT of the Gaussian for N = 1024

5 Conclusion:

The fft module in Python is a valuable toolset for signal analysis using DFT. We looked at sinusoids' discrete Fourier Transforms, amplitude modulated signals, and frequency modulated signals. The DFT contained impulses at the sinusoid frequencies in the case of pure sinusoids. The frequency spectrum of the amplitude modulated wave included impulses at the carrier and side band frequencies. With an infinite number of side band frequencies, the frequency modulated wave produced a DFT with non zero values over a wider frequency range. The DFT of a gaussian is also a gaussian, with the spectrum sharpening for faster sampling rates and broadening for longer time spans.