EE386 Digital Signal Processing Lab **Jul-Dec 2021**

1: Introduction and Python

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The value of α = **3** in my case. The same value is used throughout the experiment.

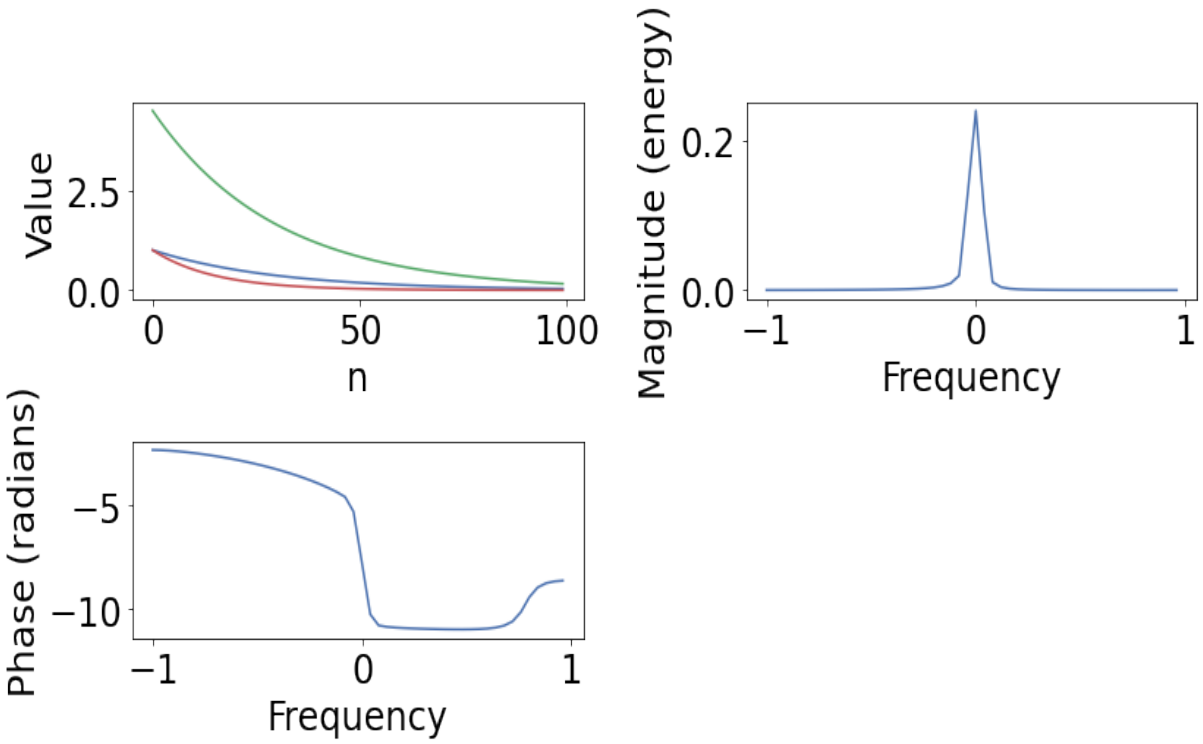
1 Problem 1

Generating Signals

(Plotting the signals, Properties of signals and Fourier Transform)

- `Introduction` :
  Generating a signal in python is basically generating a discrete signal with x-axis variable varying. Here its a decaying exponential with α as the time constant implies the function **x**=$e^{-t/\alpha}$.There are various properties that can be performed on this signal. These are Time shift and Time dilation to name a few.
- `Methods` :
  We need to use the 'linspace' to create an array of time with specific time resolution. Since its a computer we can not create a continuous signal.Every signal is basically a discrete signal which can be smoothened to look like continuous signal. After this create the desired equation.Use properties of signals to obtain results of the sub-problems.Fourier Transform can be calculated using hand and then plug in the equation. Use properties of Fourier Transform, namely shifting and scaling, to obtain further results.
- `Results` :
  From the graph 1. we can infer that on performing shifting operation on the original function(in Blue) the graph shifts to the right by the specified units(in Green). On performing scaling operation the graph starts to reduce rapidly(in Red). Graph 2 depicts the Magnitude spectrum of the original function. Graph 3 depicts the phase spectrum of the original function.

  Also Fourier transform of the original function comes out to be F(Ω)=α/(1+j$\alpha\Omega$). Then we can perform scaling and time shifting properties for the same to get our results.



The graphs above depict the following: 1. Plot of functions of $e^{-t/\alpha}$, $e^{-(t-1.5)\alpha)/\alpha}$, $e^{-2*t/\alpha}$. 2. Magnitude spectrum of $e^{-t/\alpha}$. 3. Phase spectrum of $e^{-t/\alpha}$

2 Problem 2

Generating Tones

(Sine Waves, Appending, Writing a .wav file)

- `Introduction`:

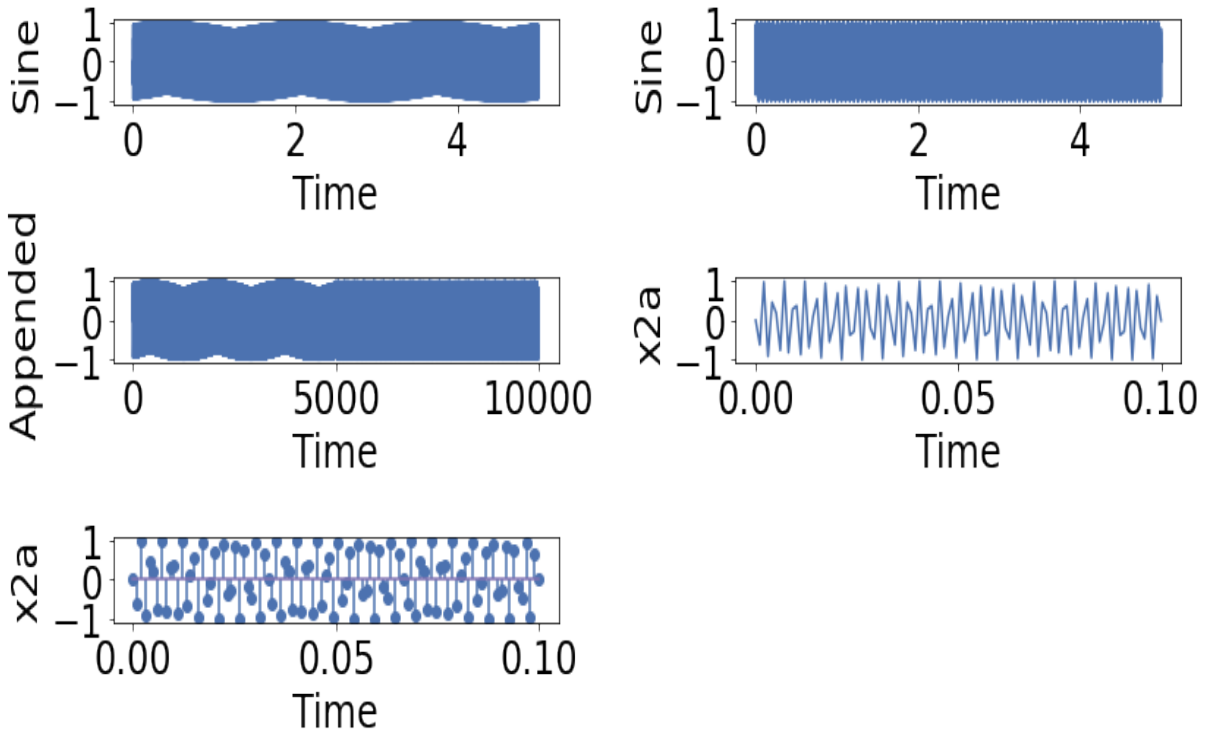
  Appending two signals refers to adding one signal behind the other. These signals can be of varying frequencies. Here we will be appending two sinusoids.

- `Methods`:

  It requires basic append function from the numpy library of python. This creates a signal with number of quantities equal to the sum of individual quantities. Used wavfile.write function to store the data into a wav file.

- `Results`:

  Graph 1 and graph 2 are sine waves of frequency 600Hz and 660Hz. Graph 3 is the Appended waveform. It is obtained by adding two signal one behind the other. Graph 4 and 5 represent the plot and stem-plot of first 100 samples of appended waveform.



There is a resultant audio which is combination of the first audio signal and the second audio signal.

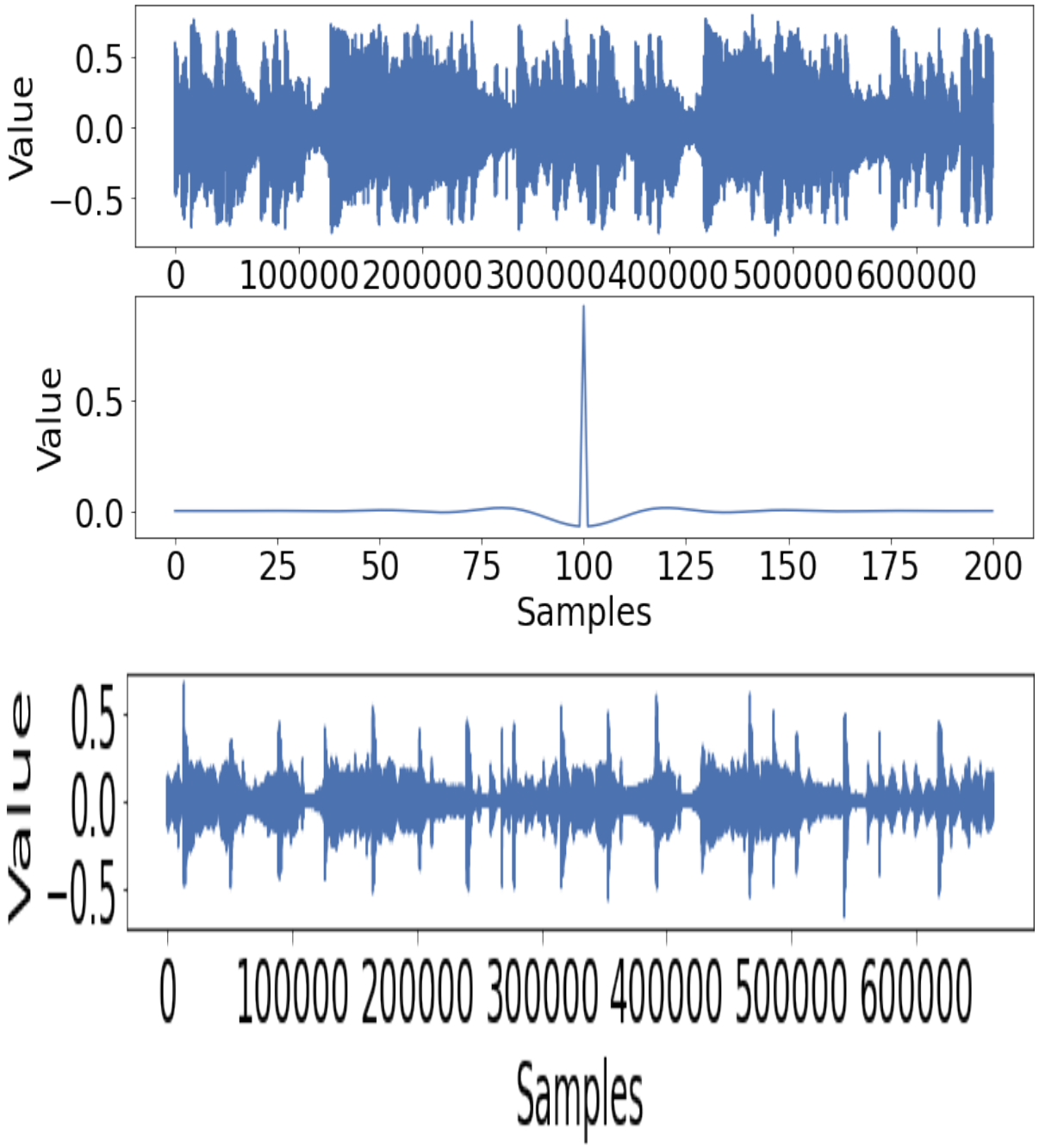
3 Problem 3

Convolution

(Convolve, Filter, Impulse)

- `Introduction`:
  Performing convolution refers to combining two signals such that a third signal is created which depicts the way one signal changes the shape of other signal. Its a multiplication of Fourier Transform of the two signals when calculated analytically.
- `Methods`:
  Use of convolution function from SciPy. On Paper it can be solved using multiplication of Fourier Transform of each signal.
- `Results`:
  Graphs 1 depicts the original wave which is to be convoluted with the impulse. It is a particular channel of the stereo provided to us. Graph 2 depicts the text file which is actually the impulse that needs to be applied to the signal. Graph 3 is the actual convoluted signal.Convolution refers to response of a signal to the impulse.

  We observe that the values have shrinked or shifted to particular frequency. The resultant signal is a signal that has passed through a Low Pass Filter i.e low frequency pass.



4 Problem 4

Amplitude Modulation

- `Introduction`:

  Amplitude Modulation means transmitting the message signal from one end to the other by modulating it with the carrier wave. When it comes to this specific signal given in this question, it is modulated to a sound similar to alien voice.It is because of overlapping the signal with a cosine wave,which acts as a carrier signal, that the original signal travels with the sound of alien voice.

- `Methods`:

  The only method involved is overlapping the given signal to the cosine wave of a particular frequency. That itself gives us the signal desired.

- `Results`:

  The amplitude of the message wave comes in sync with the carrier wave. The wave in Blue is the original signal from speech.wav file. The green signal represents aftermath of multiplication of cosine. The amplitude has been modulated to a smaller value.