

BLG354E

Homework-0

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Even teenagers know about audible portion of audio signals having a bandwidth of about 20 kHz(...)

B. P. Lathi, Linear Systems and Signals

In this homework, we will get familiar with Python libraries like **numpy**, **scipy**, **matplotlib** and **vispy** in terms of their possible applications on signal processing and analysis field. This homework will not be graded, but it is necessary to obtain an understanding of Python usage for signal processing and foreshadow the structure of next homeworks.

1 Plotting Signals

SciPy is an scientific calculation and visualization library which is widely used in engineering fields. Libraries like Numpy (N-dimensional scientific computing) and Matplotlib (Graph visualization) are generally used with SciPy. For example, the following example may be used to create and plot the sine wave;

$$x(t) = \sin(2t + \pi/2) \quad (0.1)$$

```
1 import numpy as np
import matplotlib.pyplot as plt
3
time = np.arange(-10*np.pi,10*np.pi,0.1)
5 x = np.sin(2*time+np.pi/2)
7 plt.plot(time, x)
plt.show()
```

Obtain the same graph using:

- Eulerian representation of the sine wave.
- Taylor series approximation of the sine wave

Take a look at Matplotlib documentation to give x and y labels to the graph.

2 Reading/Writing Audio Files

Create nine more sine or cosine signals (e.g. x_2 , x_3 , ... x_9) having different frequencies and sum all the signals. Use **scipy.io.wavfile.write** to save the summed signal as a WAV file. The function takes the sampling rate as the second parameter. In most of the systems 44100 samples/sec is used. But you can change the sampling rate to obtain different outputs.

Save the obtained signal using sampling rates: 44100, 22050 and 11025.

- They all sound different. Why?
- Read the files using **scipy.io.wavfile.read** function. Is there a difference between the graphs? Why?

3 Spectrogram

VisPy is a scientific visualization and animation library. From many features of it, we will only use spectrogram for this homework. Read the **spec.wav** file and plot a spectrogram of it.

- What are the meanings of x and y axes? Interpret the graph.
- Who is that guy?