Experiment 3

Title: **Sampling & Aliasing**

Consider various human voice / speech (probably your voice both male and female) or music signals. Try different sampling rates and observe the effect of aliasing.

Learning Objectives

i) To understand basic concept of sampling
ii) To study effect of sampling on frequency and bandwidth
iii) To study magnitude and phase spectrum of signal
iv) To have hands on simulation using python language

Prerequisites

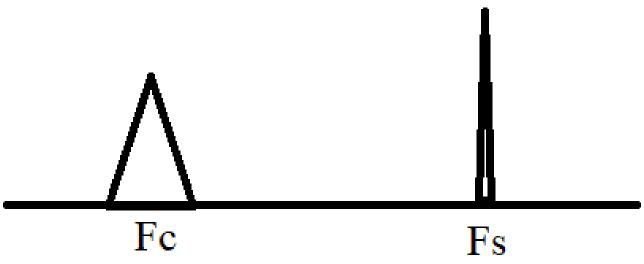
i) Basic understanding of mathematics
ii) Basic understanding of signal representation
iii) Basic understanding of Python language

Theory

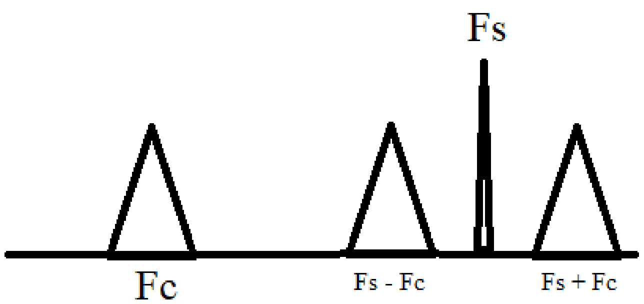
Sampling Theorem:

According to Nyquist principle of sampling, in order to remove alising effect signals are sampled with sampling frequency equals to twice of the frequency of signal to be sampled.

If F = frequency of signal to be sampled
Then, sampling frequency = Fs $\geq$ 2F

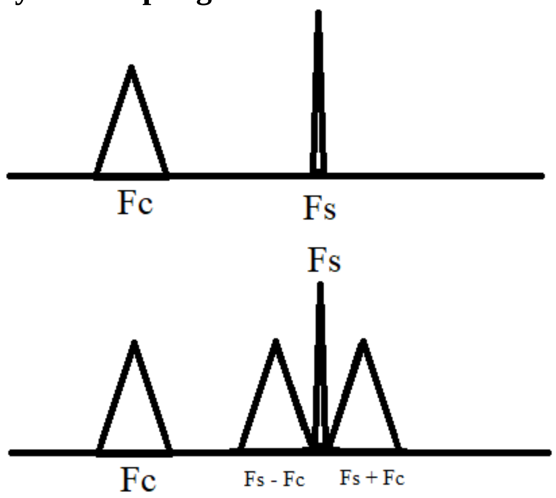


(a) Selecting Sampling frequency



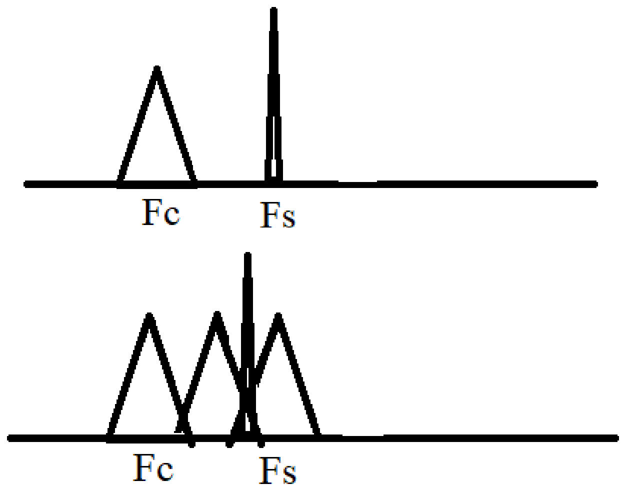
(b) Effect of sampling on frequency

Selecting closer frequency for sampling

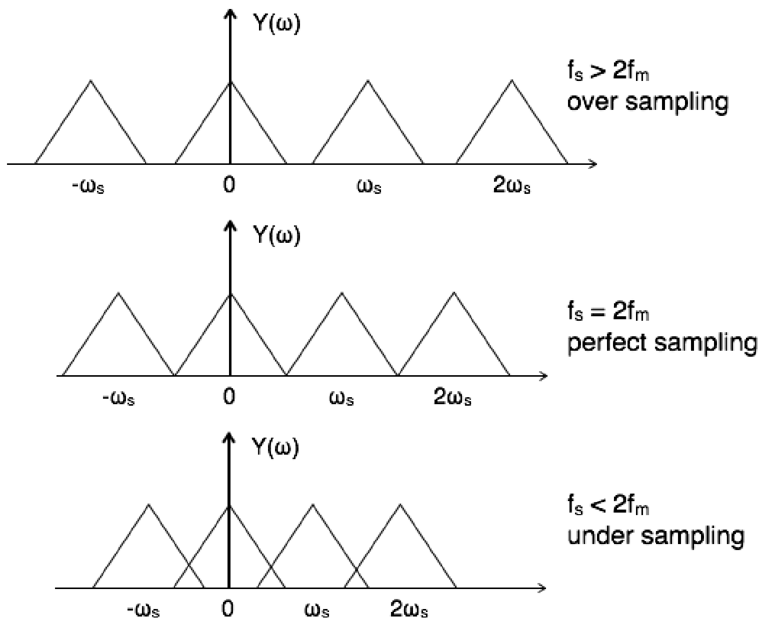


(c) Result of sampling after selecting closer frequency

Selecting more closer frequency for sampling



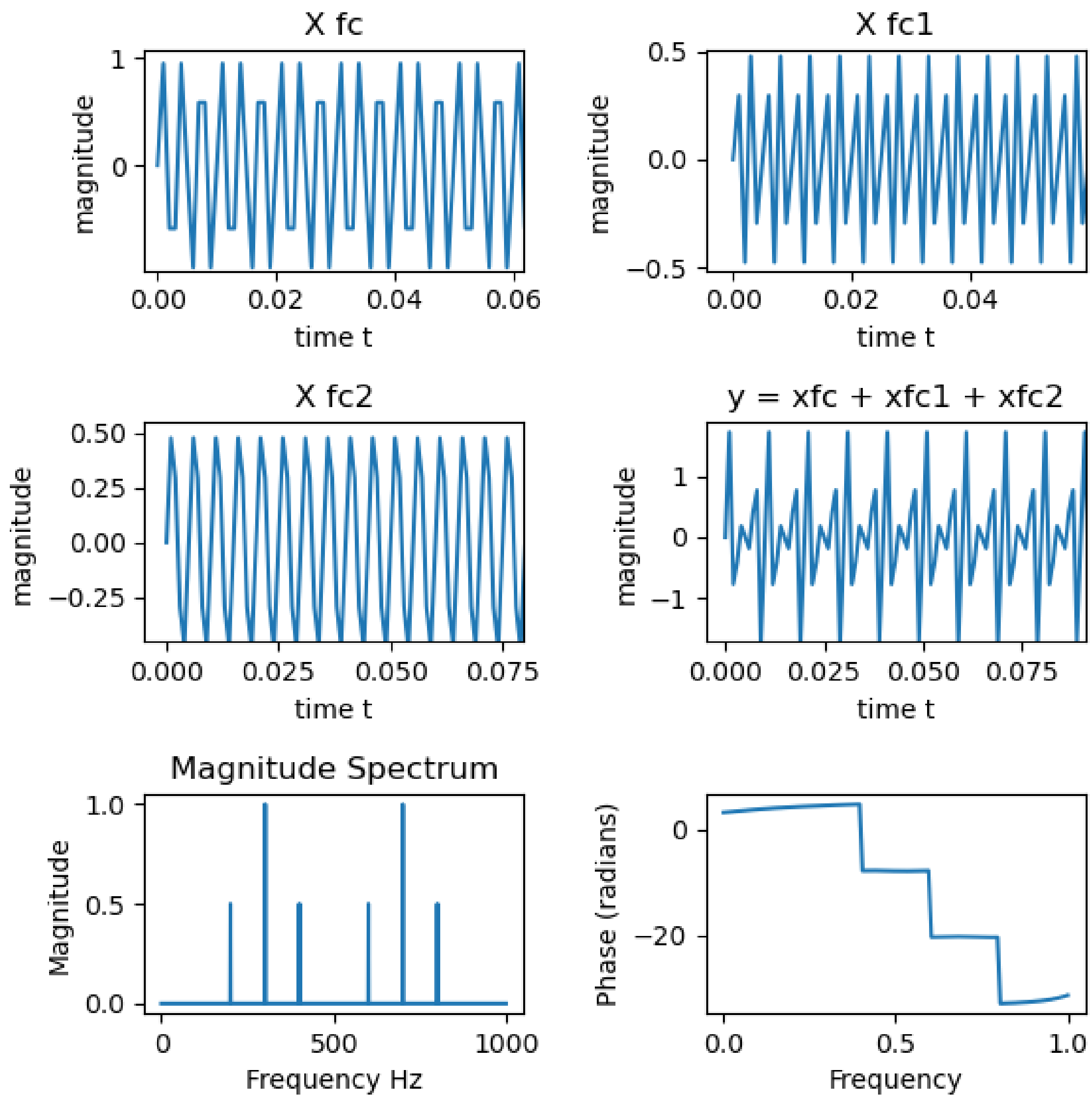
(d) Result of selecting more closer frequency for sampling



Simulation Code

```
import numpy as np
import matplotlib.pyplot as plt
from scipy.fftpack import fft

Fs = 1000
n = np.arange(Fs)
t = n/Fs

fc = 300
fc1 = fc + 100
fc2 = fc - 100

xc = np.sin(2*np.pi*fc*t)
xfc1 = 0.5*np.sin(2*np.pi*fc1*t)
xfc2 = 0.5*np.sin(2*np.pi*fc2*t)

y = xc + xfc1 + xfc2

Y = fft(y)    #taking FFT
Y_m = (2/Fs)*abs(Y)     #magnitude spectrum
Y_phase = (2/Fs)*np.angle(Y)     #phase spectrum

plt.subplot(3,2,1)
plt.plot(t, xc)
plt.title('X fc')
plt.xlabel('time t')
plt.ylabel('magnitude')

plt.subplot(3,2,2)
plt.plot(t, xfc1)
plt.title('X fc1')
plt.xlabel('time t')
plt.ylabel('magnitude')

plt.subplot(3,2,3)
plt.plot(t, xfc2)
plt.title('X fc2')
plt.xlabel('time t')
plt.ylabel('magnitude')

plt.subplot(3,2,4)
plt.plot(t, y)
plt.title('y = xfc + xfc1 + xfc2')
plt.xlabel('time t')
plt.ylabel('magnitude')

plt.subplot(3,2,5)
plt.plot(Y_m)
plt.title('Magnitude Spectrum')
plt.xlabel('Frequency Hz')
plt.ylabel('Magnitude')
```

```
plt.subplot(3,2,6)
plt.phase_spectrum(y)

plt.show()
```



Assignment

Task1: Write description for codes

Task2: Vary the parameters of the signals and observe the magnitude and phase spectrum

Conclusion