Discrete-Time Signal Development and Analysis in MATLAB
LAB-0
ECE161B

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Date Performed:	1/11/22 to 1/20/22
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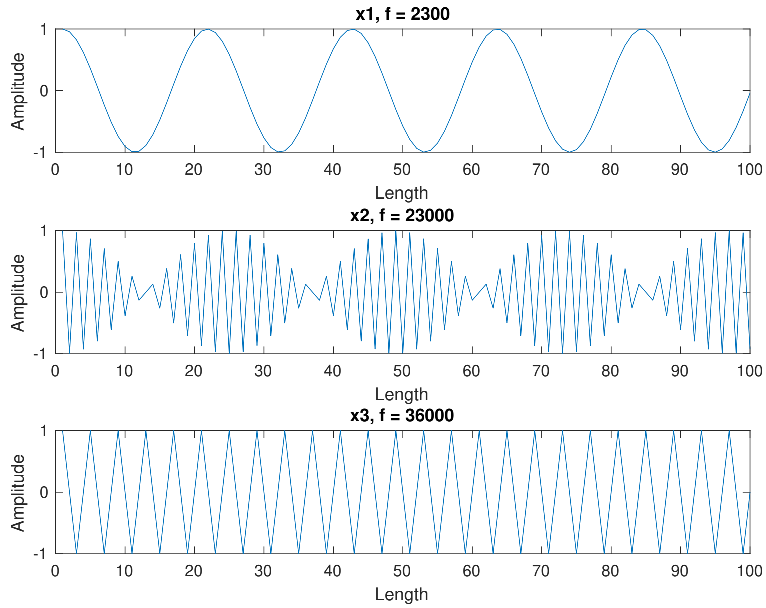
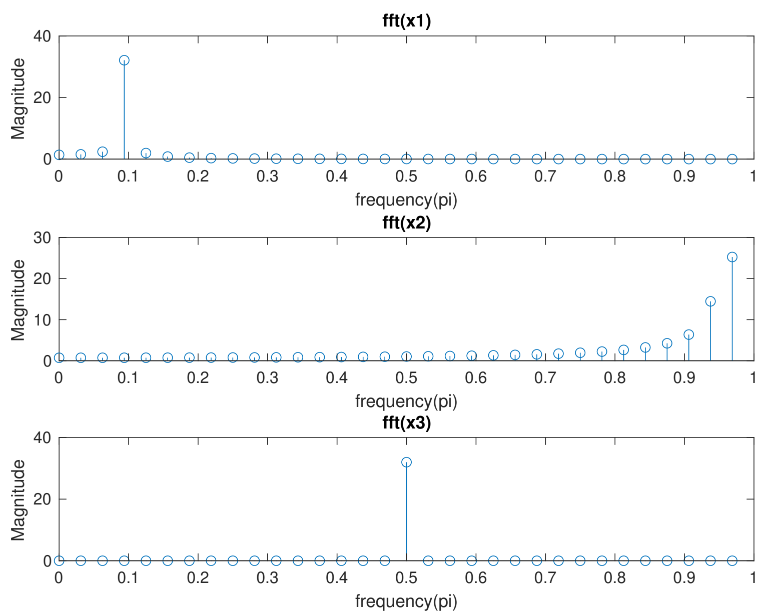
1 Introduction

The purpose of this lab is to generate three sinusoidal discrete-time domain signal in MATLAB, all with different frequencies. Fourier transform plots were developed using fft() function in MATLAB using the three sinusoidal discrete-time signals. The plots of the signals and fft's are rendered and observations can be made. The sinusoids are then converted into .WAV files and passed through a C program that uses Libsndfile software to alter the signals. The signals are then passed back into MATLAB where we can see that the amplitude has been altered.

2 Task 1



3 Task 2



4 Task 3

The magnitude plots of fft(x1) and fft(x2) are not perfect delta functions because they have values that are not all zero outside of the actual delta spike.The reason there are artifacts in these plots is because our signal is not infinite duration, which is effectively a sinusoidal signal multiplied by a square wave in the time domain. This result in delta functions convolved with a sinc function in the frequency domain. The artifacts are caused by parts of the sinc functions summing together and not equalling zero. fft(x3) is a perfect delta because the fft() grids align with the sink function nicely when we convole in the frequency domain.

5 Task 4

Sample Frequency in this experiment is Fs = 48kHz
Nyquist Sampling rate: (1/2)Fs=24kHz $\geq samplefrequency$

From Task 2 sinusoidal wave with f = 2300Hz:
There is no aliasing in this plot because the signal frequency is below the 24kHz. Artifacts can be observed from where elements of the sink functions adding up prevent points outside the delta form being exactly zero.

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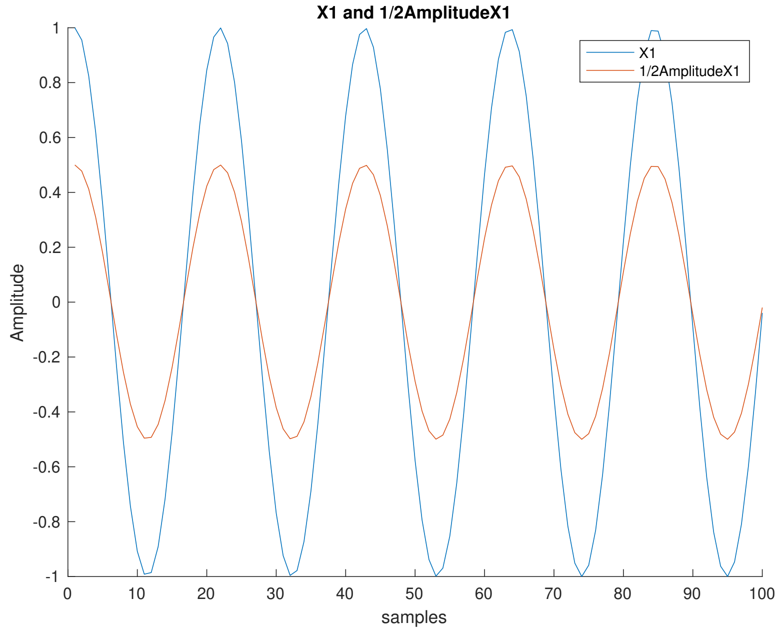
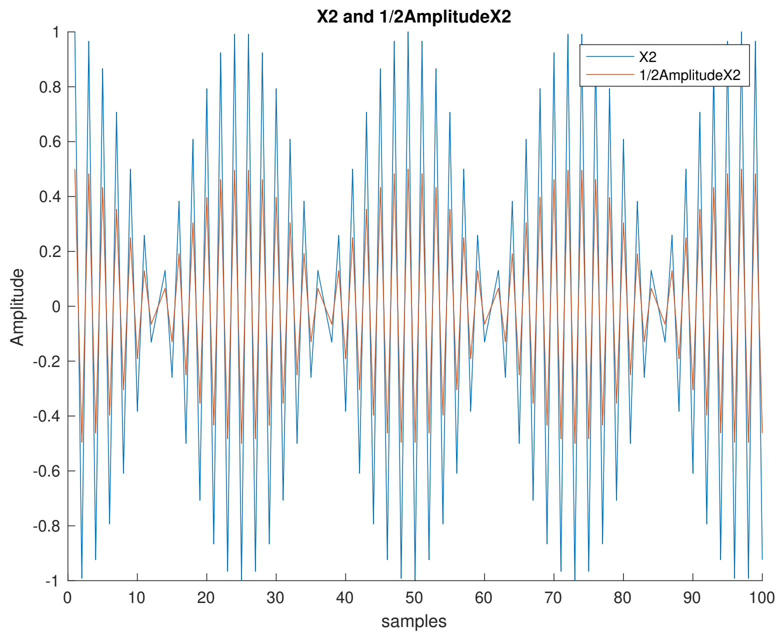
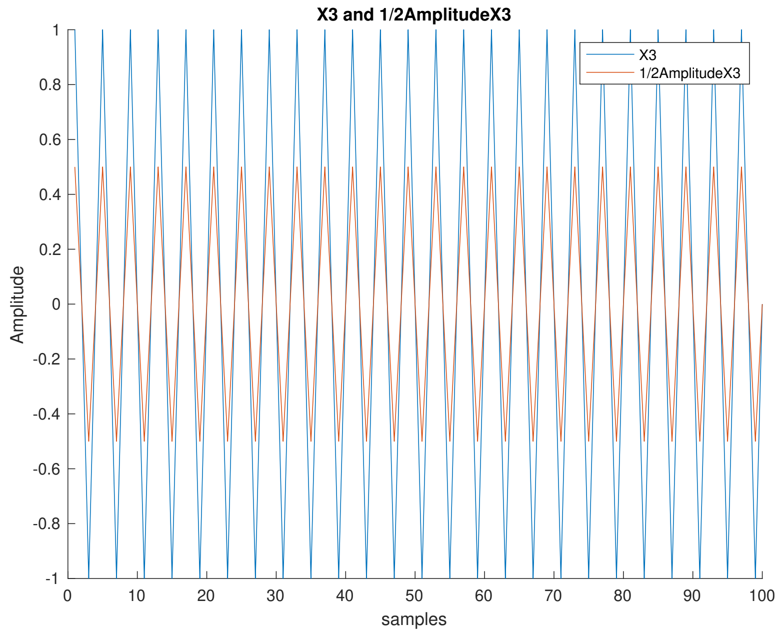
From Task 2 sinusoidal wave with f = 36000Hz:
There is aliasing in this plot becasue f=36000Hz is greater than 24kHz. We can see that the delta is located at 0.5 which is a shifted copy of the signal centered at 2π.

6 Task 5


X1 and 1/2AmplitudeX1
X1
1/2AmplitudeX1
Amplitude
samples
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
10
20
30
40
50
60
70
80
90
100


X2 and 1/2AmplitudeX2
X2
1/2AmplitudeX2
Amplitude
samples
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
10
20
30
40
50
60
70
80
90
100



7 Appendix

———————-Task 1 MATLAB Code———————-

```
L  = 100;
Fs = 48000;

f1 = 2300;
f2 = 23000;
f3 = 36000;

x1 = generate_sigs(f1,Fs,L);
x2 = generate_sigs(f2,Fs,L);
x3 = generate_sigs(f3,Fs,L);

figure();
subplot(3,1,1); %(how many rows, how many col, index)
plot(x1)
title("f = 2300")
xlabel("Length")
ylabel("Amplitude")

subplot(3,1,2);
plot(x2);
title("f = 23000")
```

```
xlabel("Length")
ylabel("Amplitude")

subplot(3,1,3);
plot(x3);
title("f = 36000")
xlabel("Length")
ylabel("Amplitude")

print -deps epsTask1

function x = generate_sigs(f,Fs,L)
    t = 0:1/Fs:L/Fs - 1/Fs ;
    x = cos(2*pi*f*t);
end
```

—————————-Task 2 MATLAB Code—————————-

```
x1fft = fft(x1,64);
x2fft = fft(x2,64);
x3fft = fft(x3,64);

xAxis = 0:1/32:1-1/32; % now we have 32 sampl with 1/32 gap

figure();
subplot(3,1,1);
stem(xAxis,abs(x1fft(1:32)))
title("fft(x1)")
xlabel("frequency(pi)")
ylabel("Magnitude")

subplot(3,1,2);
stem(xAxis,abs(x2fft(1:32)));
title("fft(x2)")
xlabel("frequency(pi)")
ylabel("Magnitude")

subplot(3,1,3);
stem(xAxis,abs(x3fft(1:32)));
title("fft(x3)")
xlabel("frequency(pi)")
ylabel("Magnitude")

print -deps epsTask2
```

—————————-Task 5 Modified C code—————————-

```
// Load data
```

```
for(ii=0; ii < sndInfo.frames; ii++)
{
sf_readf_float(sndFile, buffer, 1);

//Do something to the variable buffer here
        *buffer = (*buffer)*(0.5);

sf_writef_float(sndFileOut, buffer, 1);
}
```