MIDDLE EAST TECHNICAL UNIVERSITY

ELECTRICAL-ELECTRONICS ENGINEERING DEPARTMENT

EE-301 Term Project

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1.

```
x1 = audiorecorder(44100,16,1);
pause(2);
disp('Play!')
recordblocking(x1, 3);
disp('Stop!')
x1.play;
%%
x2 = audiorecorder(11025,16,1);
pause(2);
disp('Play!')
recordblocking(x2, 3);
disp('Stop!')
x2.play;
%%
x3 = audiorecorder(4900,16,1);
pause(2);
disp('Play!')
recordblocking(x3, 3);
disp('Stop!')
x3.play;
%%
x4 = audiorecorder(2756,16,1);
pause(2);
disp('Play!')
recordblocking(x4, 3);
disp('Stop!')
x4.play;
%%
x1.play; pause(3);
x2.play; pause(3);
x3.play; pause(3);
x4.play; pause(3);
```

Comment: It is quite obvious that, the audio whose sampling rate is higher, sounds better. So it can be said that, as the sampling rate increases the quality of the sound increases and vice versa.

2.

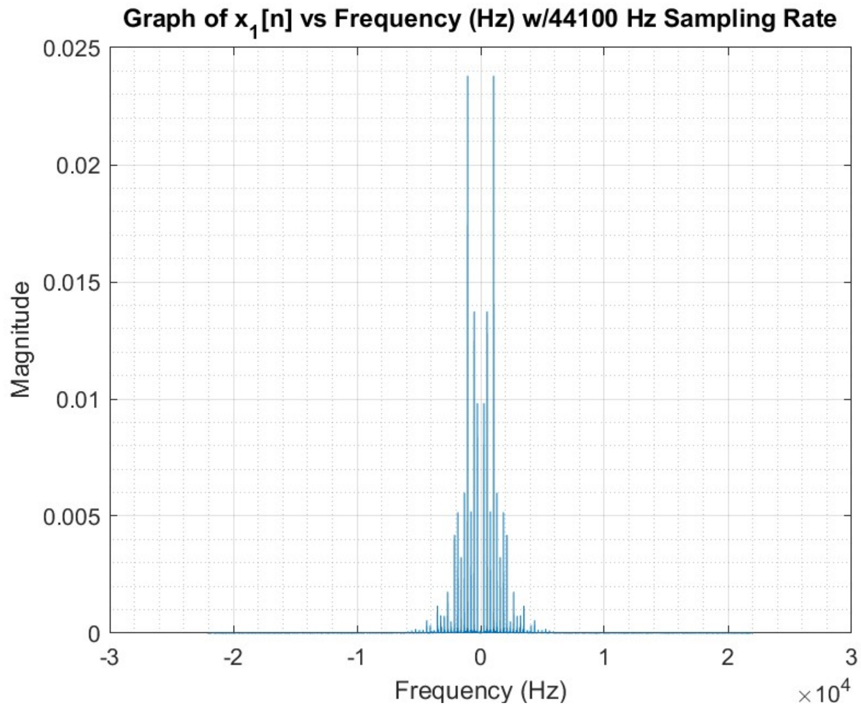

Figure1: Graph of $x_1[n]$ vs Frequency (Hz) w/44100 Hz Sampling Rate

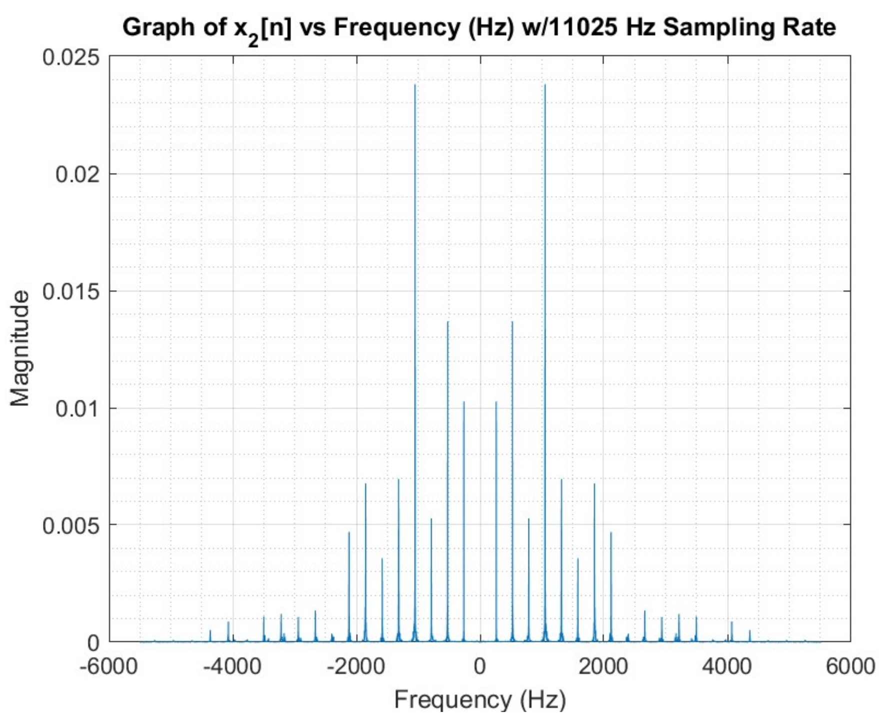

Figure2: Graph of $x_2[n]$ vs Frequency (Hz) w/11025 Hz Sampling Rate

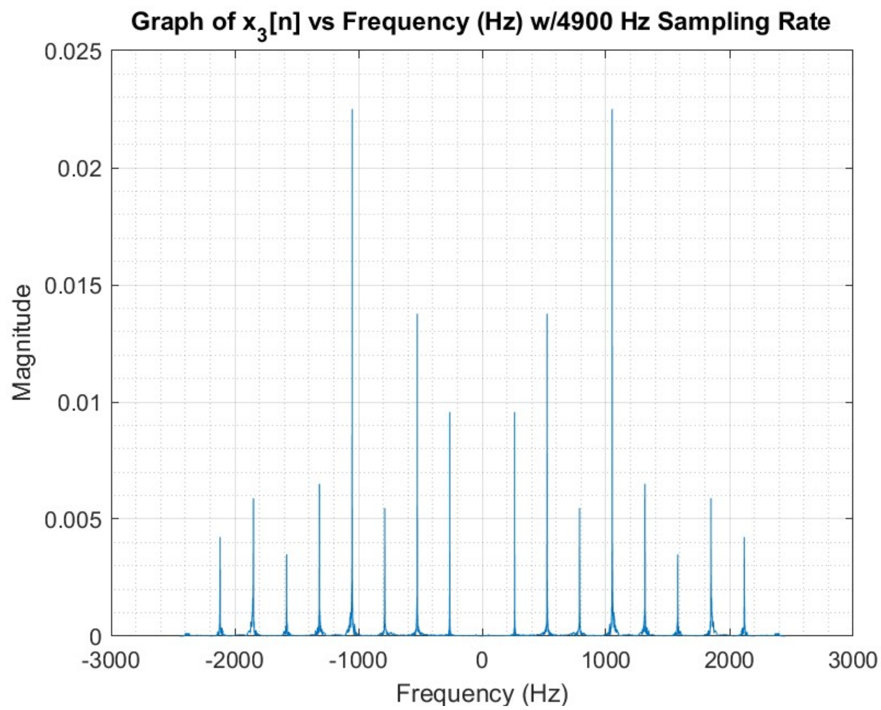

Figure3: Graph of $x_3[n]$ vs Frequency (Hz) w/4900 Hz Sampling Rate

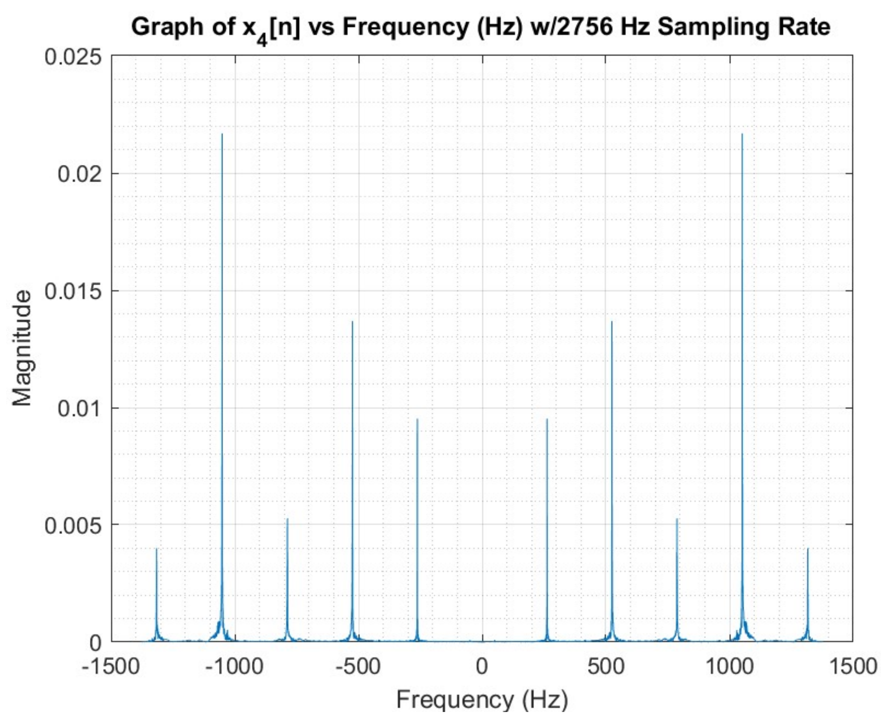

Figure4: Graph of $x_4[n]$ vs Frequency (Hz) w/2756 Hz Sampling Rate

```
x1_data = getaudiodata(x1);
x2_data = getaudiodata(x2);
x3_data = getaudiodata(x3);
x4_data = getaudiodata(x4);

x1_dft = fftshift(fft(x1_data));
x2_dft = fftshift(fft(x2_data));
x3_dft = fftshift(fft(x3_data));
x4_dft = fftshift(fft(x4_data));

x1_mag = abs(x1_dft)/length(abs(x1_dft));  %normalized
x2_mag = abs(x2_dft)/length(abs(x2_dft));  %normalized
x3_mag = abs(x3_dft)/length(abs(x3_dft));  %normalized
x4_mag = abs(x4_dft)/length(abs(x4_dft));  %normalized

f1 = linspace(-44100/2,44100/2, length(x1_data));
f2 = linspace(-11025/2,11025/2, length(x2_data));
f3 = linspace(-4900/2,4900/2, length(x3_data));
f4 = linspace(-2756/2,2756/2, length(x4_data));


plot(f1',x1_mag); grid minor; grid on;
xlabel('Frequency (Hz)'); ylabel('Magnitude'); title('Graph of x_1[n]...
vs Frequency (Hz) w/44100 Hz Sampling Rate')
saveas(gcf,'x1.png')
figure; plot(f2',x2_mag); grid minor; grid on;
xlabel('Frequency (Hz)'); ylabel('Magnitude'); title('Graph of x_2[n]...
vs Frequency (Hz) w/11025 Hz Sampling Rate')
saveas(gcf,'x2.png')
figure; plot(f3',x3_mag); grid minor; grid on;
xlabel('Frequency (Hz)'); ylabel('Magnitude'); title('Graph of x_3[n]...
vs Frequency (Hz) w/4900 Hz Sampling Rate')
saveas(gcf,'x3.png')
figure; plot(f4',x4_mag); grid minor; grid on;
xlabel('Frequency (Hz)'); ylabel('Magnitude'); title('Graph of x_4[n]...
vs Frequency (Hz) w/2756 Hz Sampling Rate')
saveas(gcf,'x4.png')

sound(x1_data,44100)
pause(3);
sound(x2_data,11025)
pause(3);
sound(x3_data,4900)
pause(3);
sound(x4_data,2756)
```

3.

Comment: The following values are more appropriate values for us to filter aliasing. Since when we convolve $x_1[n]$ with h[n] (designed from these values) and obtain $x_6[n]$, it sounds much clearer than $x_5[n]$ and is much more similar to $x_4[n]$.

$$w_{pass} = 0.064 \;\; \& \;\; w_{stop} = 0.08$$

4.

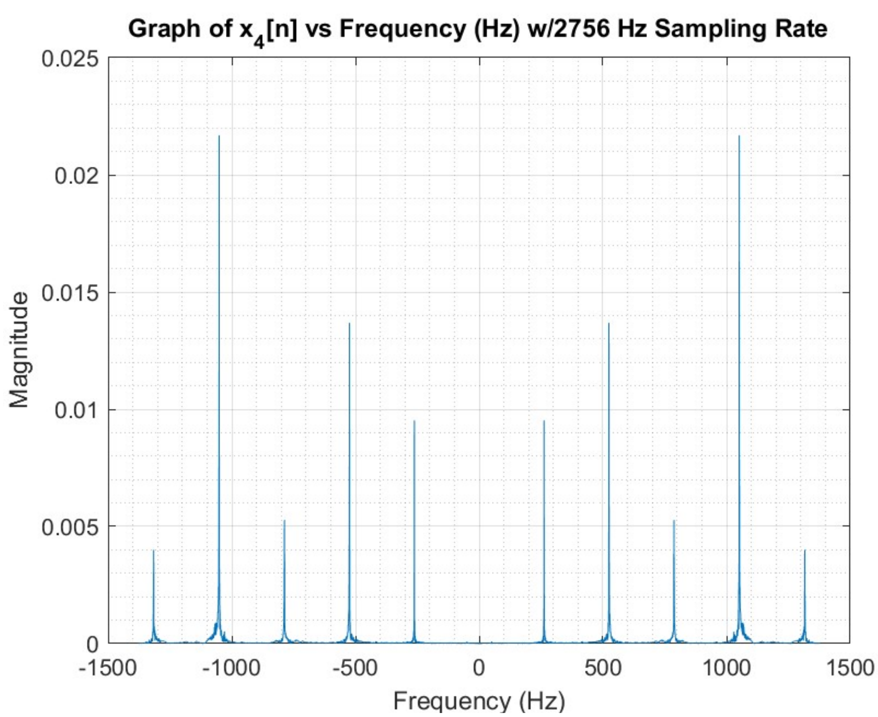

Figure5: Graph of $x_4[n]$ vs Frequency (Hz)

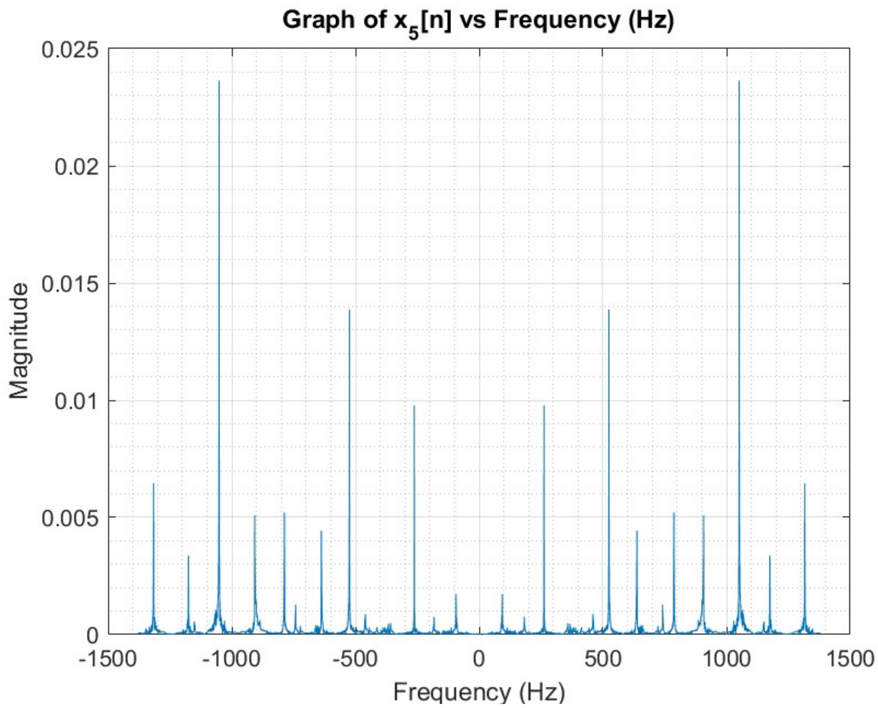

Figure6: Graph of $x_5[n]$ vs Frequency (Hz)

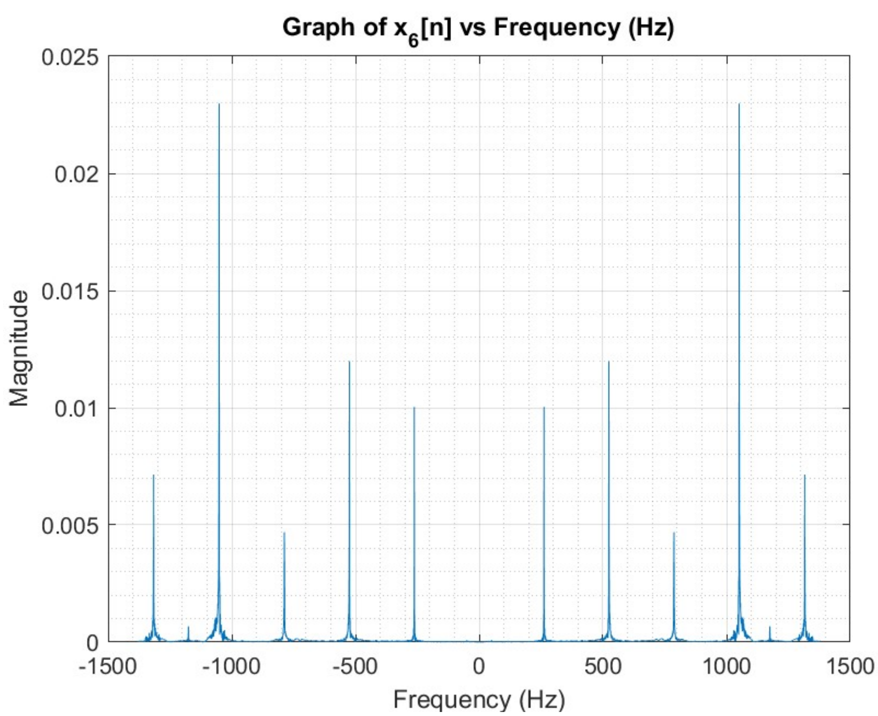

Figure7: Graph of $x_6[n]$ vs Frequency (Hz)

```
x1_data = getaudiodata(x1);
x4_data = getaudiodata(x4);

x5_data = downsample(x1_data,16);

%w_pass = 0.064 ; w_stop = 0.08
x6_data = downsample(conv(x1_data,h),16);

x1_dft = fftshift(fft(x1_data));
x4_dft = fftshift(fft(x4_data));
x5_dft = fftshift(fft(x5_data));
x6_dft = fftshift(fft(x6_data));

x1_mag = abs(x1_dft)/length(abs(x1_dft));   %normalized
x4_mag = abs(x4_dft)/length(abs(x4_dft));   %normalized
x5_mag = abs(x5_dft)/length(abs(x5_dft));   %normalized
x6_mag = abs(x6_dft)/length(abs(x6_dft));   %normalized

f4 = linspace(-2756/2,2756/2, length(x4_mag));
f5 = linspace(-2756/2,2756/2, length(x5_mag));
f6 = linspace(-2756/2,2756/2, length(x6_mag));


plot(f4',x4_mag); grid minor; grid on;
xlabel('Frequency (Hz)'); ylabel('Magnitude'); title('Graph of x_4[n]...
vs Frequency (Hz)')
saveas(gcf,'3-x4.png')
figure; plot(f5',x5_mag); grid minor; grid on;
xlabel('Frequency (Hz)'); ylabel('Magnitude'); title('Graph of x_5[n] ...
vs Frequency (Hz)')
saveas(gcf,'3-x5.png')
figure; plot(f6',x6_mag); grid minor; grid on;
xlabel('Frequency (Hz)'); ylabel('Magnitude'); title('Graph of x_6[n] ...
vs Frequency (Hz)')
saveas(gcf,'3-x6.png')

sound(x4_data,2756);
pause(3);
sound(x5_data,2756);
pause(3);
sound(x6_data,2756);
```

Comment: It is obvious that $x_6[n]$ is much more similar to $x_4[n]$ than $x_5[n]$ both from graphs and as sound, since we choose w_{pass} and w_{stop} properly.