Robert Valencia

EE 3TP4 Lab 4

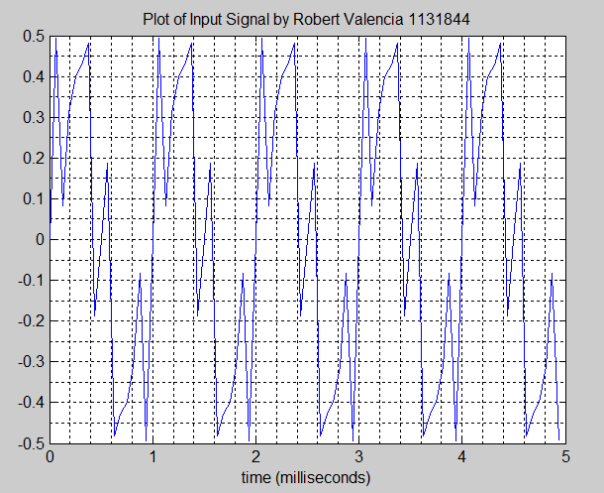
Part 1

Describe what you hear from tones2014.wav

A high-frequency signal can be heard

MATLAB code and output that plots the first 5 milliseconds of the audio file

```
% 1.3
% read audio file
[signal, Fs, bits_per_sample] =
wavread('tones2014.wav');
% get length
L = length(signal);
% get period
T = 1/Fs;
% get time elements
t = [0:L-1]*T;
% time range in milliseconds
t_plot = 5;
%milliseconds in a seconds
msec_per_sec = 1000;
% number of samples
numSamples = t_plot*Fs/msec_per_sec;
% plot of the first 5 milliseconds of the
tones2014.wav file
figure(1);
plot(msec_per_sec*t(1:numSamples),
signal(1:numSamples))
% title
title('Plot of Input Signal by Robert
Valencia 1131844')
% axes labels
xlabel('time (milliseconds)')
% displat gridlines
grid('minor');
```

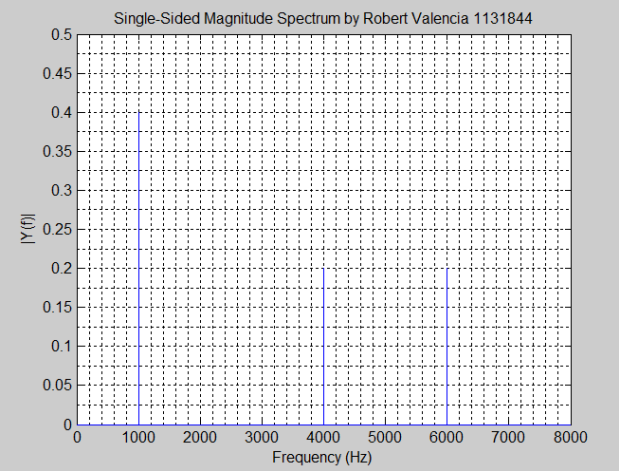


Estimate the number of sinusoids and their frequencies

From the plot, using the naked eye, it can be seen that there are three sinusoids in the signal just by looking at waveforms and their peaks inside or containing other waveforms and their peaks and seeing how much time it takes for a certain cycle pattern to repeat itself. The lower frequency signal completes a cycle (start-to-end) within 1 millisecond, so it has a frequency of around [1 cycle]/[(1/1000) seconds] = 1kHz. Within it, the next, higher frequency signal completes a cycle (start-to-end) within around 1/4 of a millisecond, so it has a frequency of around [1 cycle]/[(0.25/1000) seconds] = 4kHz. Finally, within the previous signals, the highest frequency signal completes a cycle (start-to-end) within around 1/5 of a millisecond, so it has a frequency of around [1 cycle]/[(0.20/1000) seconds] = 5kHz. Due to the limitations of the human eye, these estimations could be inaccurate.

MATLAB code and output that finds and plots the DFT of the audio file

```
% 1.5
% get discrete fourier transform
Y = fft(signal)/L;
f = Fs/2*linspace(0,1,L/2+1);
% Plot the single-sided magnitude spectrum.
figure(2);
plot(f,2*abs(Y(1:L/2+1)));
% title
title('Single-Sided Magnitude Spectrum by
Robert Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 .5]);
% displat gridlines
grid('minor');
```

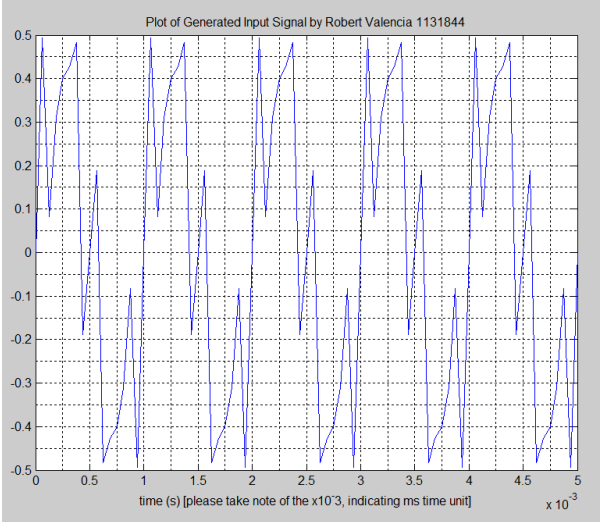


Determine the frequencies and magnitudes of the sinusoids that make up the audio signal

The lowest frequency signal has a frequency of 1kHz and has a magnitude of 0.4. The next, higher frequency signal has a frequency of 4kHz and has a magnitude of 0.2. Finally, the highest frequency signal has a frequency of 6kHz and has a magnitude of 0.2, just like 4kHz signal. From here, it can be clearly seen that the 2 highest frequency signals have the same magnitude, and that the lowest frequency signal has a magnitude 2 times that of the magnitudes of the 2 highest frequency signals.

MATLAB code and output that generates the signal that creates the audio file

```
% 1.7
% magnitudes of each signal component
A1=0.4;
A2=0.2;
A3=0.2;
% frequencies of each signal component
f1=1000;
f2=4000;
f3=6000;
%sampling rate 10*highest frequency for
correct shape and frequency
%characteristics
fs=Fs;
%milliseconds in a seconds
msecs_per_second=1000;
% time elements
t=0:(1/fs):(5/msecs_per_second);
% audio signal function that creates the
tones2014.wav signal
signal =
A1.*sin(2.*pi.*f1.*t)+A2.*sin(2.*pi.*f2.*t)+A
3.*sin(2.*pi.*f3.*t);
% plot the first 5 msec of the signal
figure(3);
plot(t, signal);
% axes limits
axis([0 5/1000 -0.5 0.5])
% title
title('Plot of Generated Input Signal by
Robert Valencia 1131844')
% axes labels
xlabel('time (s) [please take note of the
x10^-3, indicating ms time unit]');
% displat gridlines
grid('minor');
```



Compare it to what you found in Part 3.

Comparing the generated and the original signal, the shape and frequency characteristics of the signals are very similar with no noticeable difference. However, increasing the sampling frequency of the generated signal makes the peaks look blunt and the highest frequency signal more evident (magnitude-wise). Otherwise, with the same sampling frequency, the signals are practically identical.

Part 2

Describe what you hear from SecretMessage2014.wav

Distinct high-frequency "beep" signals, masked by noise, can be heard

MATLAB code and output for determining all of the signal's frequencies and decoding the secret message

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Part 2
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% 2.3
% read audio file
[signal, Fs, bits_per_sample] =
wavread('SecretMessage2014.wav');
% get length
L = length(signal);
% get period
T = 1/Fs;
% get time elements
t = [0:L-1]*T;
% time elements in milliseconds
t_plot = 28;
% number of samples
numSamples = t_plot*Fs;
% plot of the first 5 milliseconds of the
tones2014.wav file
figure();
plot(t(1:numSamples), signal(1:numSamples))
% title
title('Plot of Input Signal by Robert
Valencia 1131844')
% axes labels
xlabel('time (s)')
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 1
% starting signal element
startElement=1;
endElement=(L/28);
% get discrete fourier transform of character
1
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 1 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 2
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
2
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 2 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 3
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
3
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 3 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 4
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
4
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 4 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 5
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
5
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 5 Frequencies by Robert
Valencia 1131844')
```

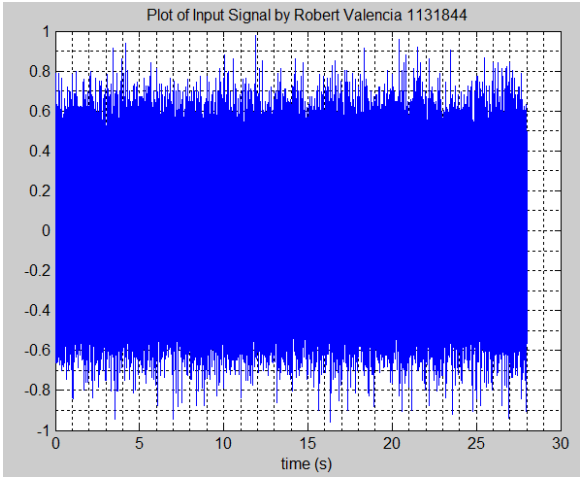
```
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 6
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
6
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 6 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 7
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
7
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 7 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 8
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
8
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 8 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 9
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
9
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 9 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 10
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
10
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 10 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 11
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
11
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 11 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
```

```
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 12
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
12
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 12 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 13
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
13
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 13 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 14
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
14
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 14 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 15
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
15
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 15 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 16
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
16
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 16 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 17
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
17
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 17 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

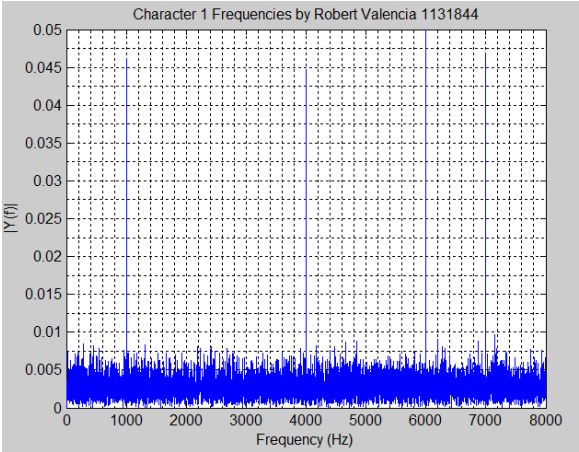
```
% character 18
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
18
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 18 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 19
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
19
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 19 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 20
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
20
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 20 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 21
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
21
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 21 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 22
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
22
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 22 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 23
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
23
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 23 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 24
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
```

```
% get discrete fourier transform of character
24
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 24 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 25
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
25
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 25 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 26
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
26
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 26 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 27
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
27
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 27 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% character 28
% starting signal element
startElement=startElement+(L/28);
endElement=endElement+(L/28);
% get discrete fourier transform of character
28
symbol1=signal(startElement:endElement);
Y = fft(symbol1)/(L/28);
f = Fs/2*linspace(0,1,(L/28)/2+1);
% plot the single-sided magnitude spectrum.
figure();
plot(f,2*abs(Y(1:(L/28)/2+1)));
% title
title('Character 28 Frequencies by Robert
Valencia 1131844')
% axes labels
xlabel('Frequency (Hz)')
ylabel('|Y(f)|')
% axes limits
axis([0 Fs/2 0 0.05]);
% displat gridlines
grid('minor');
```

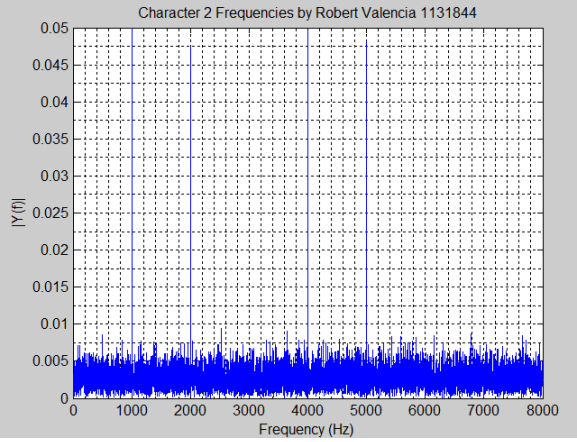
Input signal plot



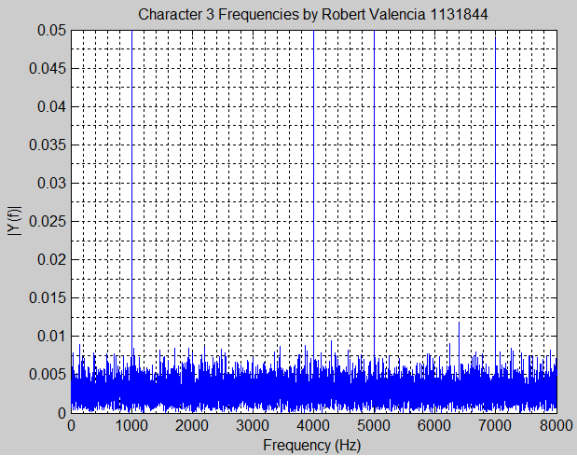
Frequency content plots and corresponding characters (based on the codebook)



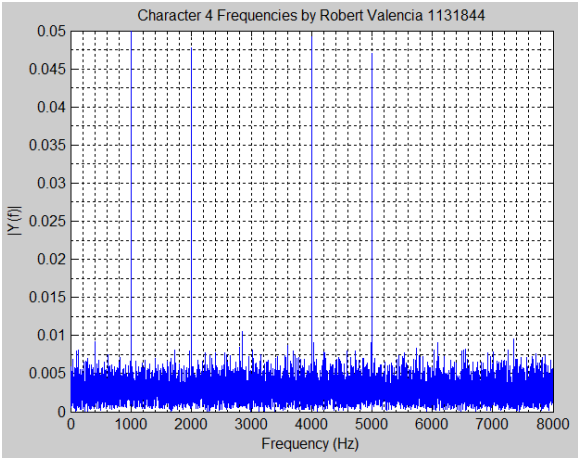
S



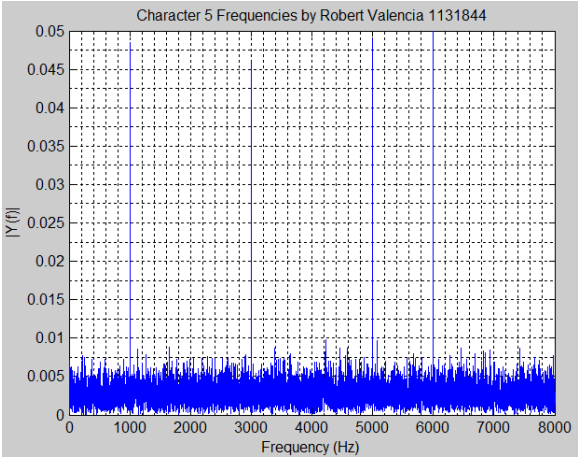
E



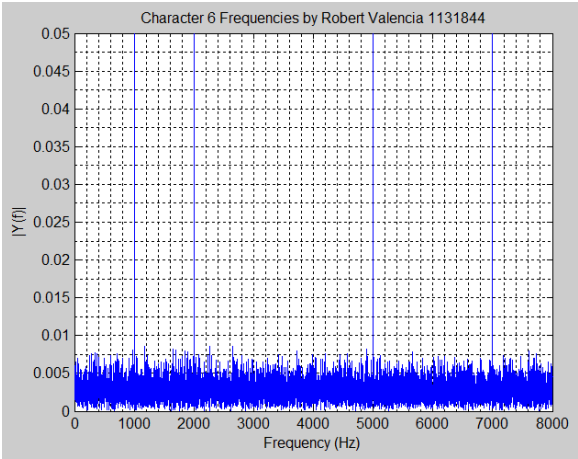
R



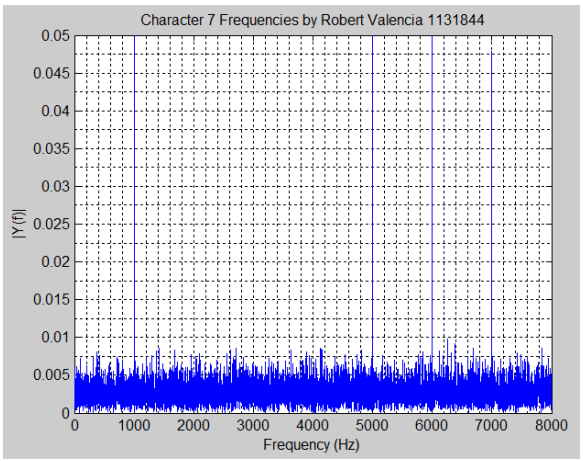
E



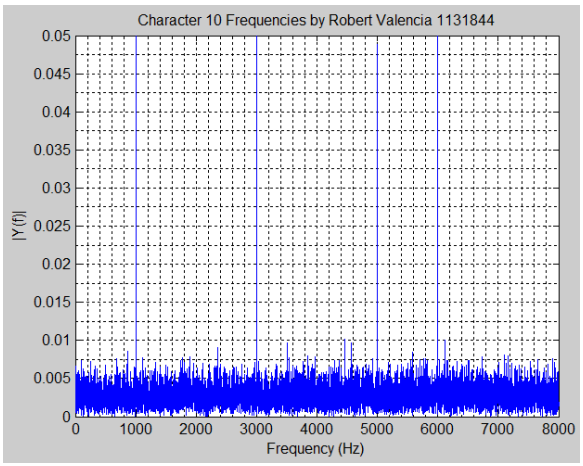
N



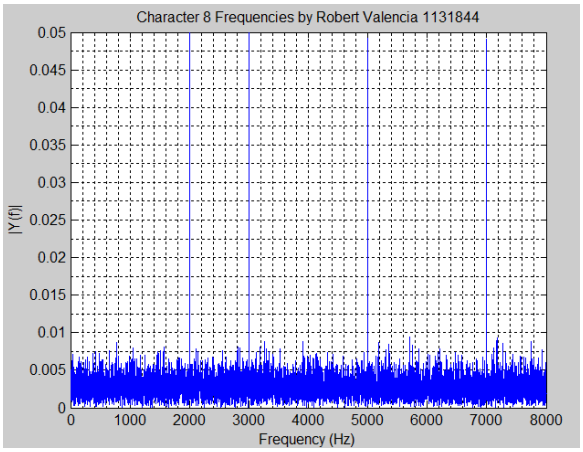
I


Character 7 Frequencies by Robert Valencia 1131844
|Y(f)|
Frequency (Hz)

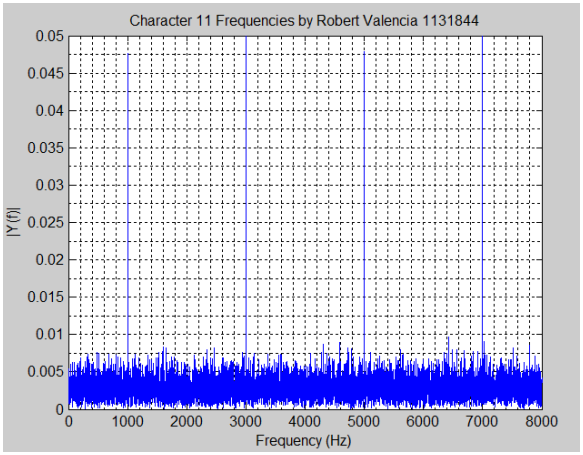
T


Character 10 Frequencies by Robert Valencia 1131844
|Y(f)|
Frequency (Hz)

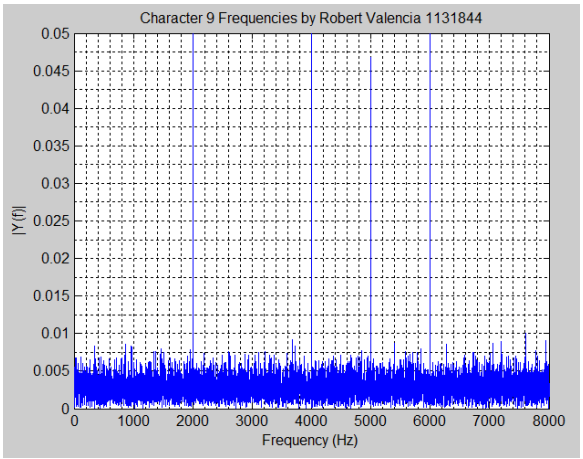
N


Character 8 Frequencies by Robert Valencia 1131844
|Y(f)|
Frequency (Hz)

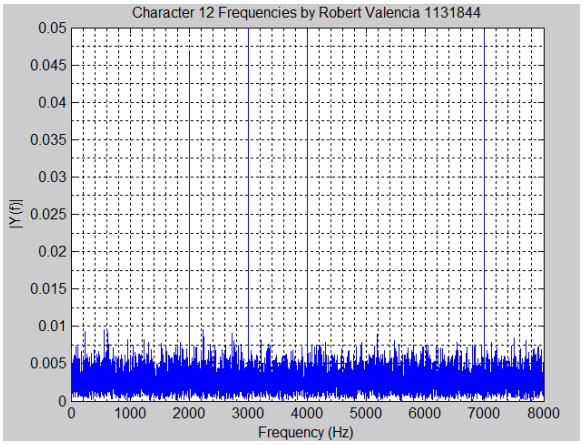
Y


Character 11 Frequencies by Robert Valencia 1131844
|Y(f)|
Frequency (Hz)

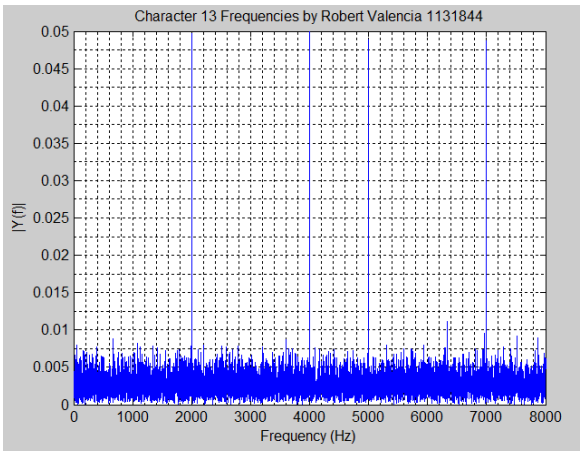
O


Character 9 Frequencies by Robert Valencia 1131844
|Y(f)|
Frequency (Hz)

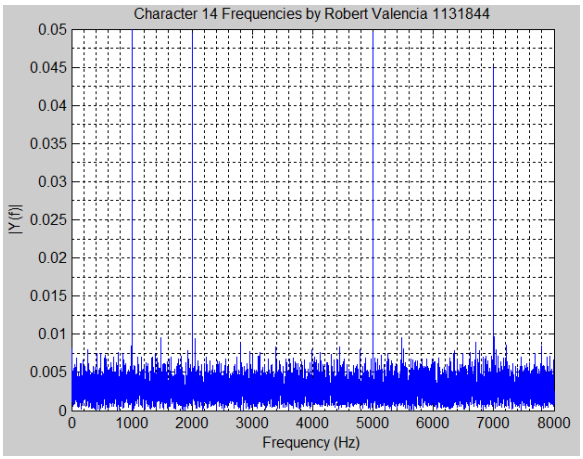
SPACE


Character 12 Frequencies by Robert Valencia 1131844
|Y(f)|
Frequency (Hz)

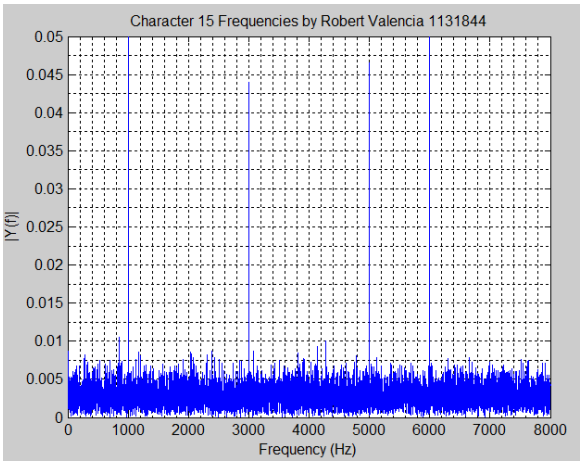
W



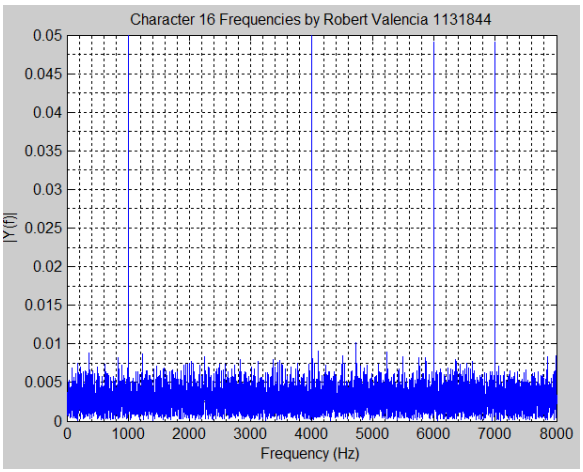
PERIOD



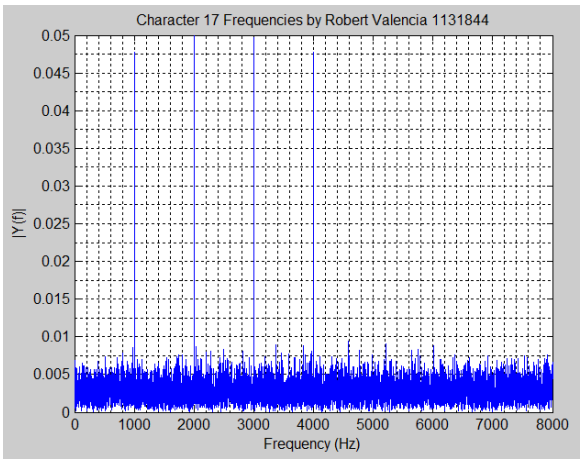
I



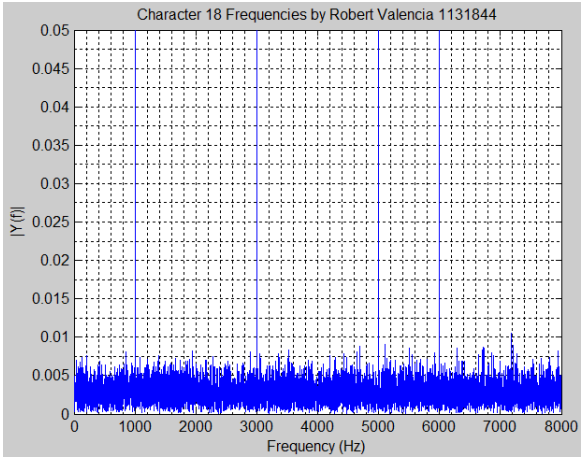
N



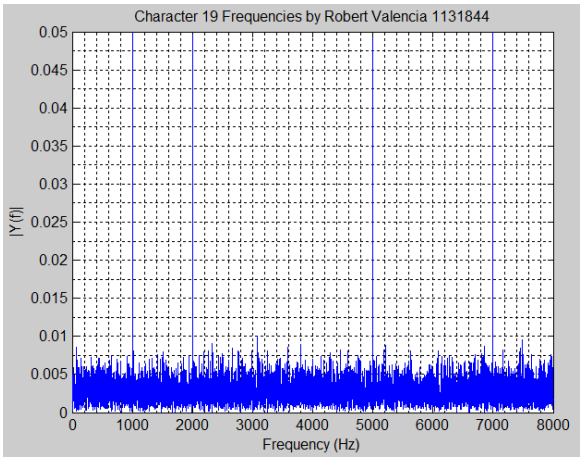
S



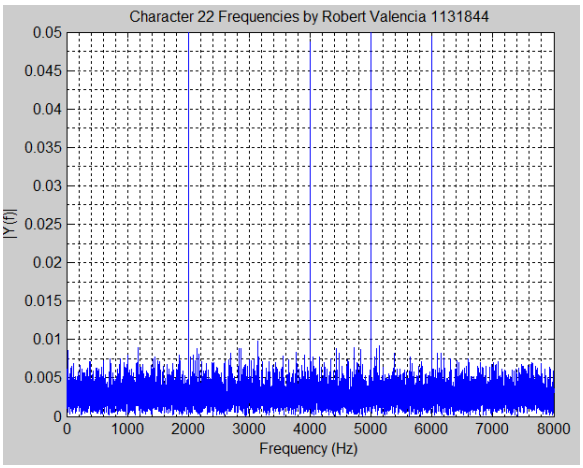
A



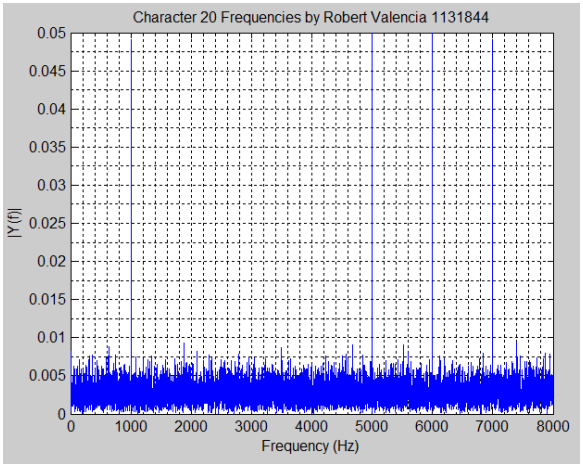
N


Character 19 Frequencies by Robert Valencia 1131844
|Y(f)|
Frequency (Hz)

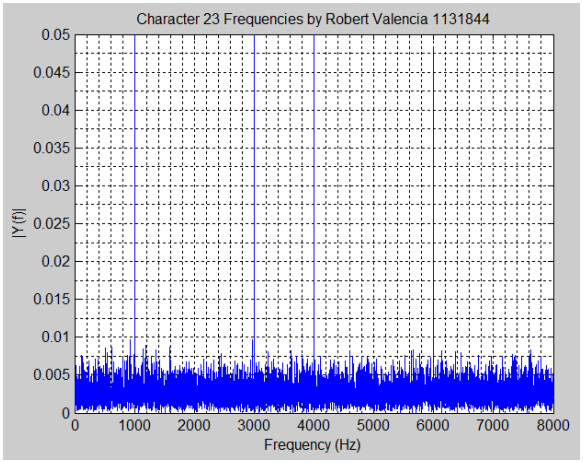
I


Character 22 Frequencies by Robert Valencia 1131844
|Y(f)|
Frequency (Hz)

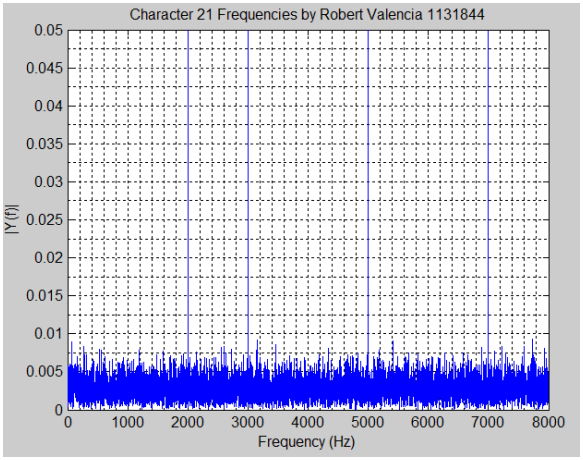
SPACE


Character 20 Frequencies by Robert Valencia 1131844
|Y(f)|
Frequency (Hz)

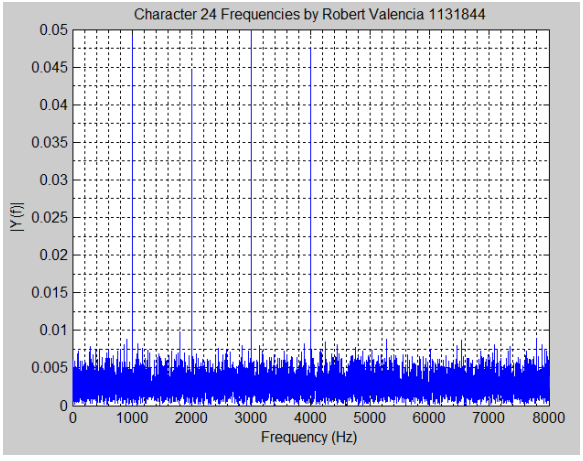
T


Character 23 Frequencies by Robert Valencia 1131844
|Y(f)|
Frequency (Hz)

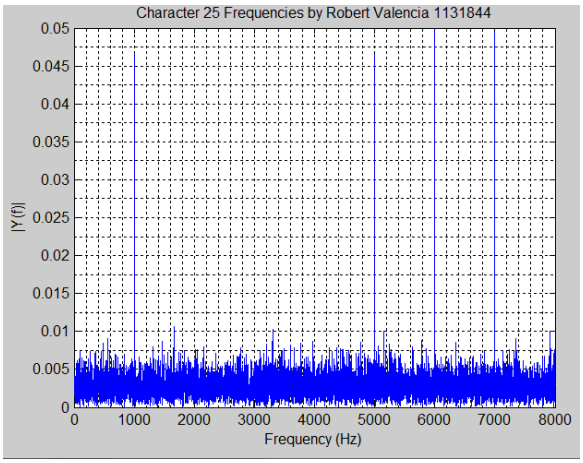
L


Character 21 Frequencies by Robert Valencia 1131844
|Y(f)|
Frequency (Hz)

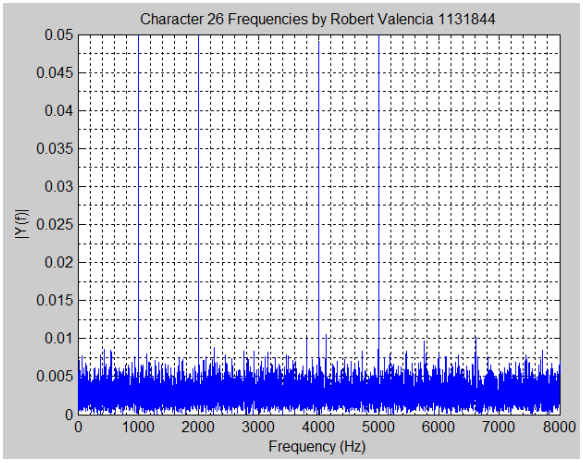
Y


Character 24 Frequencies by Robert Valencia 1131844
|Y(f)|
Frequency (Hz)

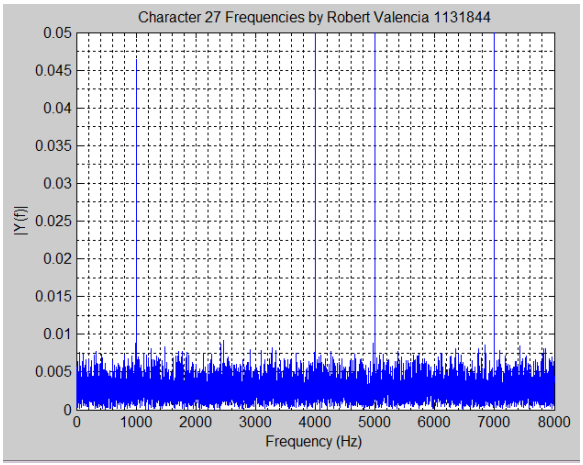
A



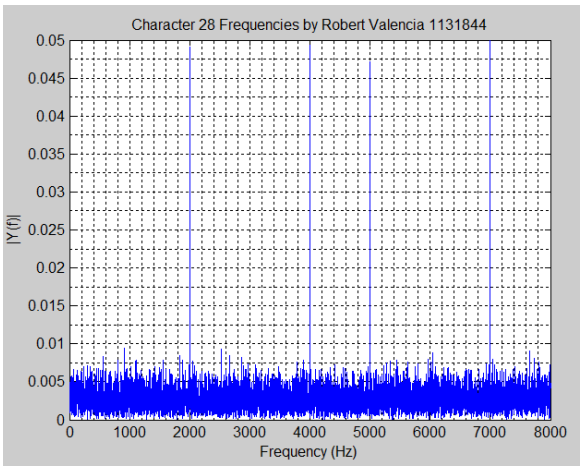
T



E



R



PERIOD

Decoded Message

SERENITY NOW.INSANITY LATER.