BME 306 Lab 2 - Introduction to Audio in Matlab

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Alexander Ross 10/7/19

Question 1

```
% The reason is because in principle, the more electrodes one uses,
 the
% finer the place resolution for coding frequencies
```

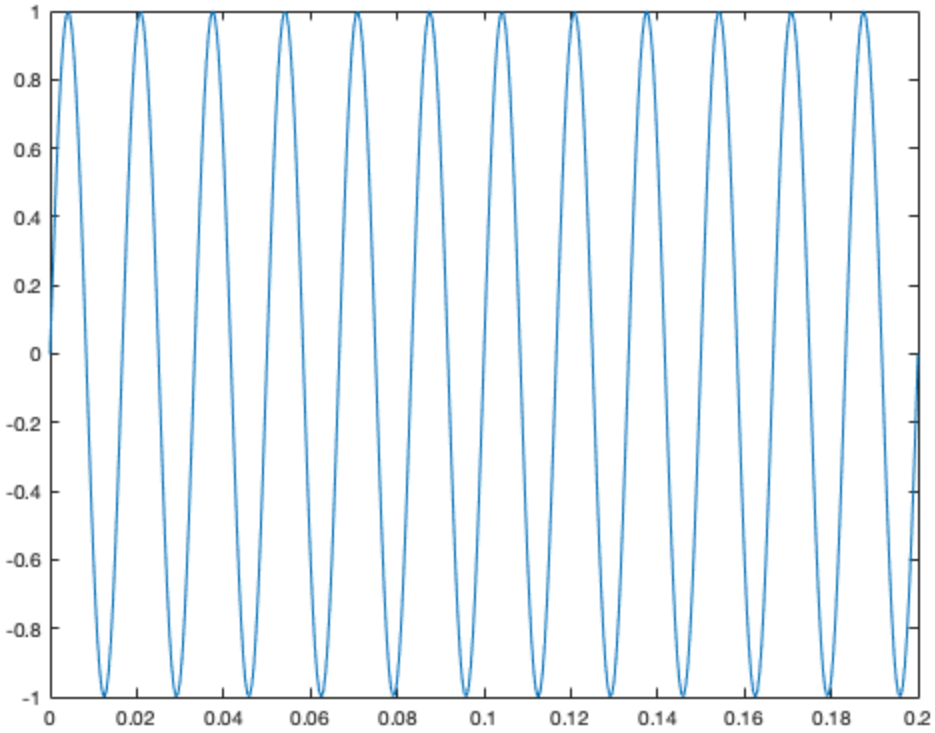
Question 2

```
% The CIS approach is advantagous because it addresses the channel
% interactions issues by using nonsimulatanious, interleaved pulses.
 This
% means that only one electrode is stimulated at a time, so that
 pulses are
% delivered in a nonoverlapping (nonsimulatanious) fasion.
```

Question 3

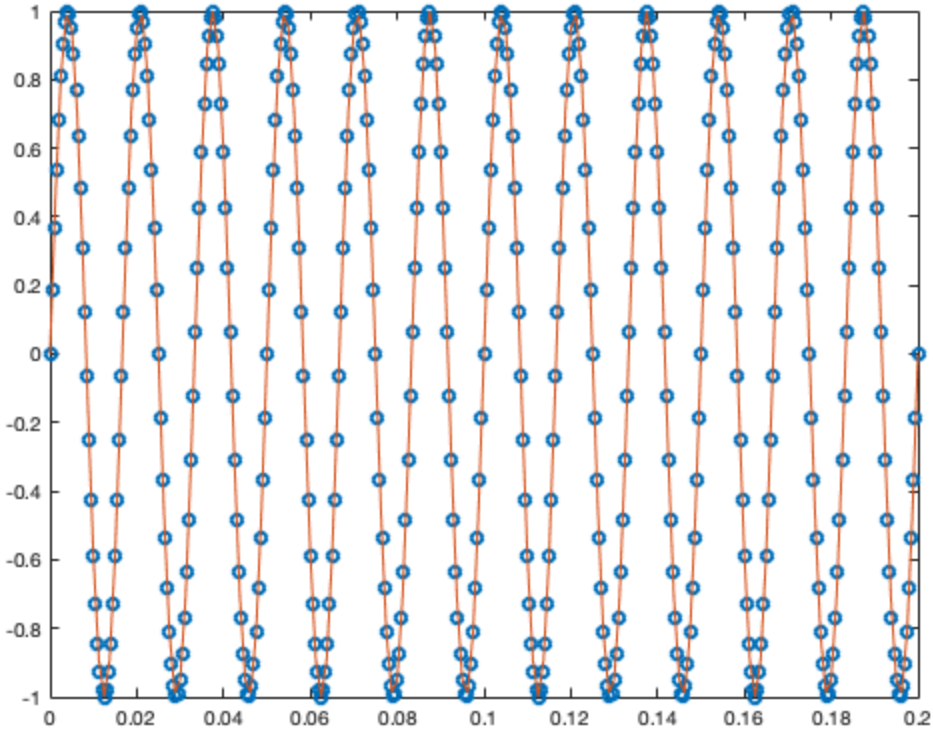
```
t = 0:0.2/400:0.2;
fc = 60;
s = sin(2*pi*fc*t);
plot(t,s);

% Step size of the time vector: 0.2/400 Seconds
% Sampling frequency: 2000 Hertz
```



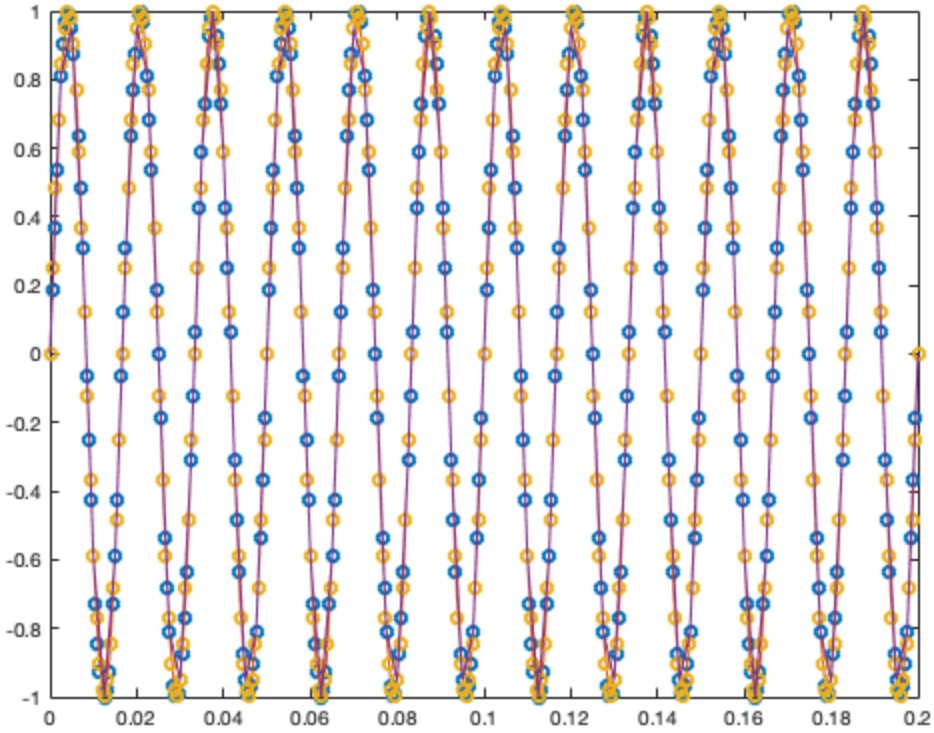
Question 4

```
t2 = 0:1/800:0.2;
s2 = sin(2*pi*fc*t2);
plot(t,s,'o');
hold on
plot(t2,s2);
```



Question 5

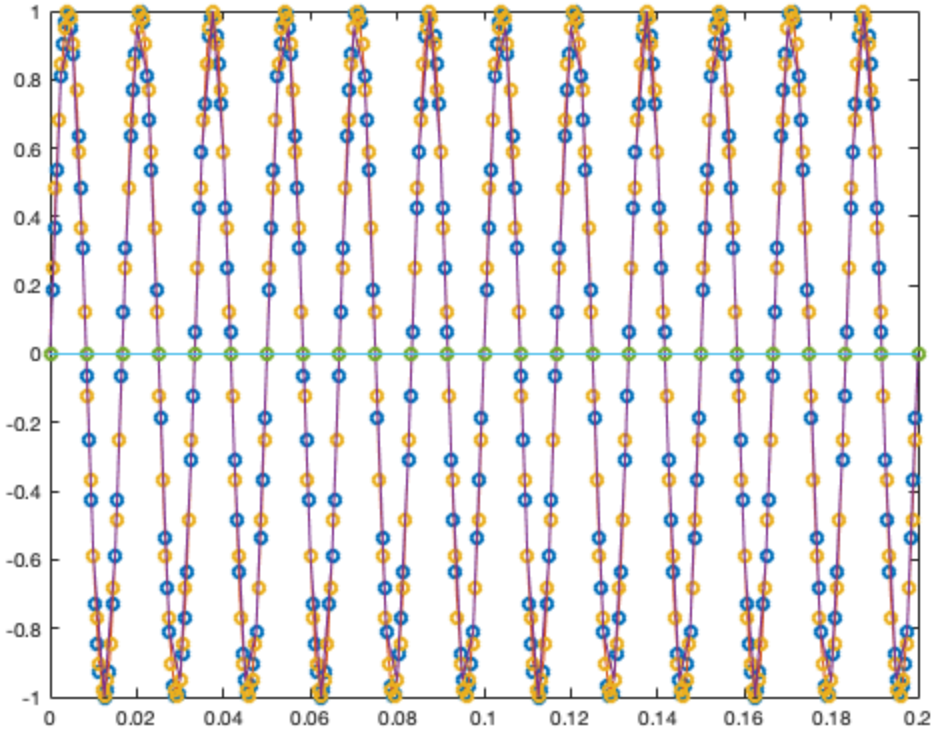
```
fc = 60;
t3 = 0:0.2/300:0.2;
s3 = sin(2*pi*fc*t3);
t4 = 0:1/400:0.2;
s4 = sin(2*pi*fc*t4);
plot(t3,s3,'o');
hold on
plot(t4,s4);
```



Question 6

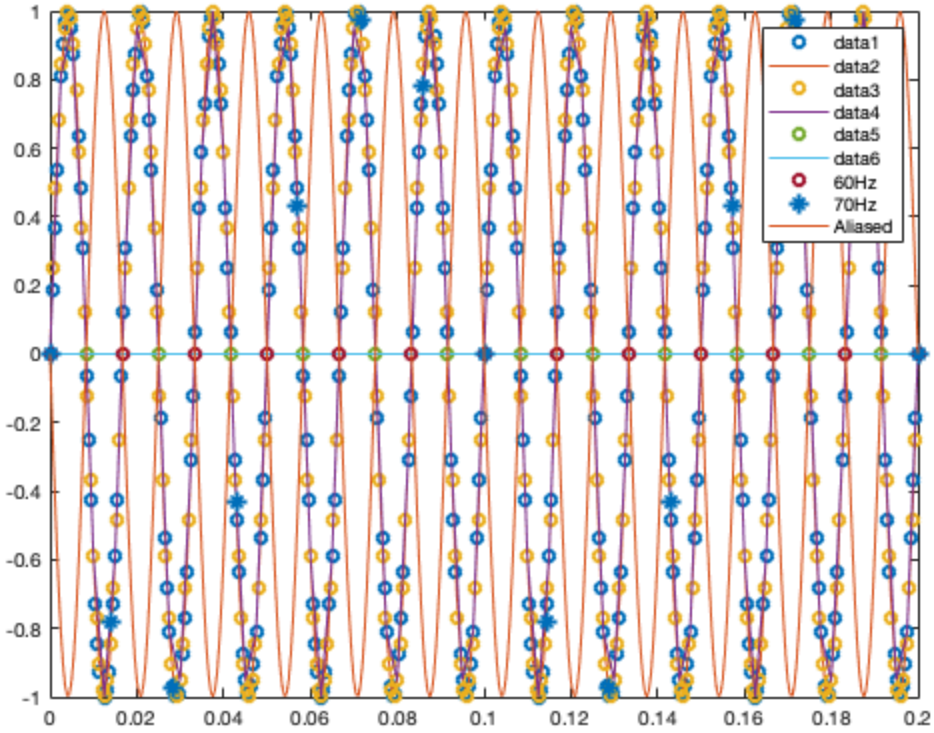
```
fc = 60;
t3 = 0:0.2/24:0.2;
s3 = sin(2*pi*fc*t3);
t4 = 0:1/120:0.2;
s4 = sin(2*pi*fc*t4);
plot(t3,s3,'o');
hold on
plot(t4,s4);

tlim = ([-1 1]);
```



Question 7

```
fc = 60;
t3 = 0:1/60:0.2;
s3 = sin(2*pi*fc*t3);
t4 = 0:1/70:0.2;
s4 = sin(2*pi*fc*t4);
t5 = 0:0.2/400:0.2;
s5 = -sin(2*pi*fc*t5);
hold on
legend();
plot(t3,s3,'o','DisplayName','60Hz');
plot(t4,s4,'*','DisplayName','70Hz');
plot(t5,s5,'DisplayName','Aliased')
hold off
```



Question 8

```
% See attached voicetosignal.m
% See attached plot
```

Question 9

```
% Sampling frequency = 8000Hz
% Bits per sample = 8
% The function records in mono (one channel)
```

Question 10

```
% See attached voicetosignal.m
% See attached plot
```

Question 11

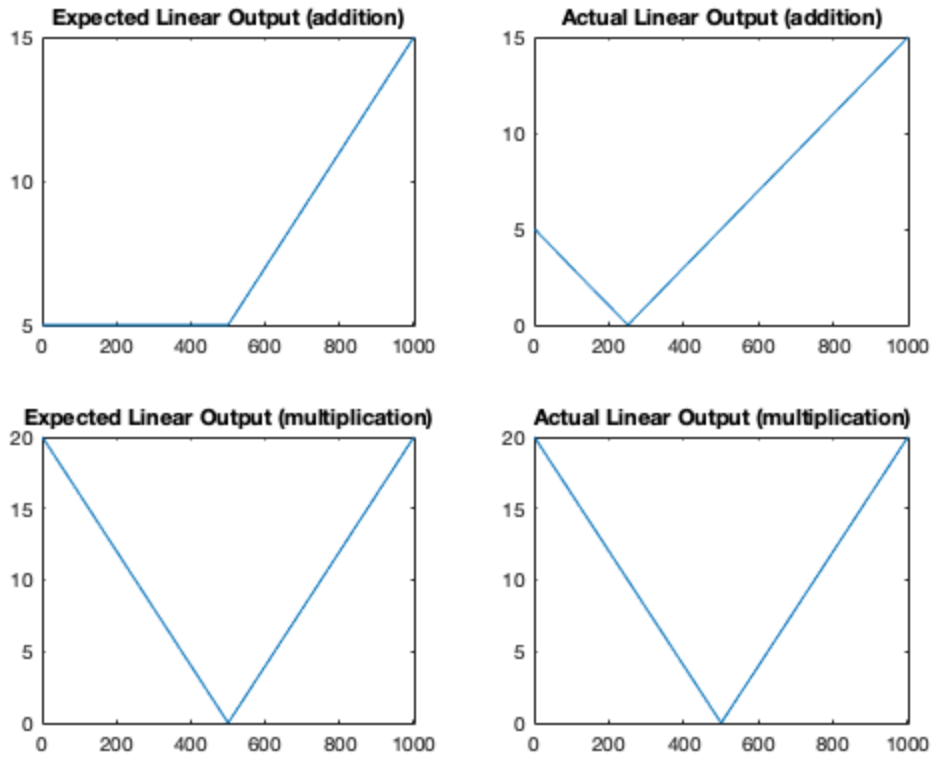
```
% See attached voicetosignal.m
% See output function
% See attached plot
```

Question 12

```
x1 = -5:0.01:5;
x2 = 0:0.01:10;
s1 = abs(x1)+abs(x2);
s2 = abs(x1+x2);
s3 = abs(x1)*4;
s4 = abs(x1*4);

figure();
subplot(2,2,1);
plot(s1);
title('Expected Linear Output (addition)')
subplot(2,2,2);
plot(s2);
axis ([0 1000 0 15]);
title('Actual Linear Output (addition)')
subplot(2,2,3);
plot(s3);
title('Expected Linear Output (multiplication)')
subplot(2,2,4);
plot(s4);
title('Actual Linear Output (multiplication)')

% Explanation: The Expected Linear Output graphs should match the
 Actual
% Linear Output graphs for both the multiplication and addition
 properties.
% This is because the functions that are depicted in the plots are the
 tests
% for linearity.  As can be seen, the mulitiplicitive property holds,
% however the additive property does not. Since they don't all match,
 the
% system is not linear
```



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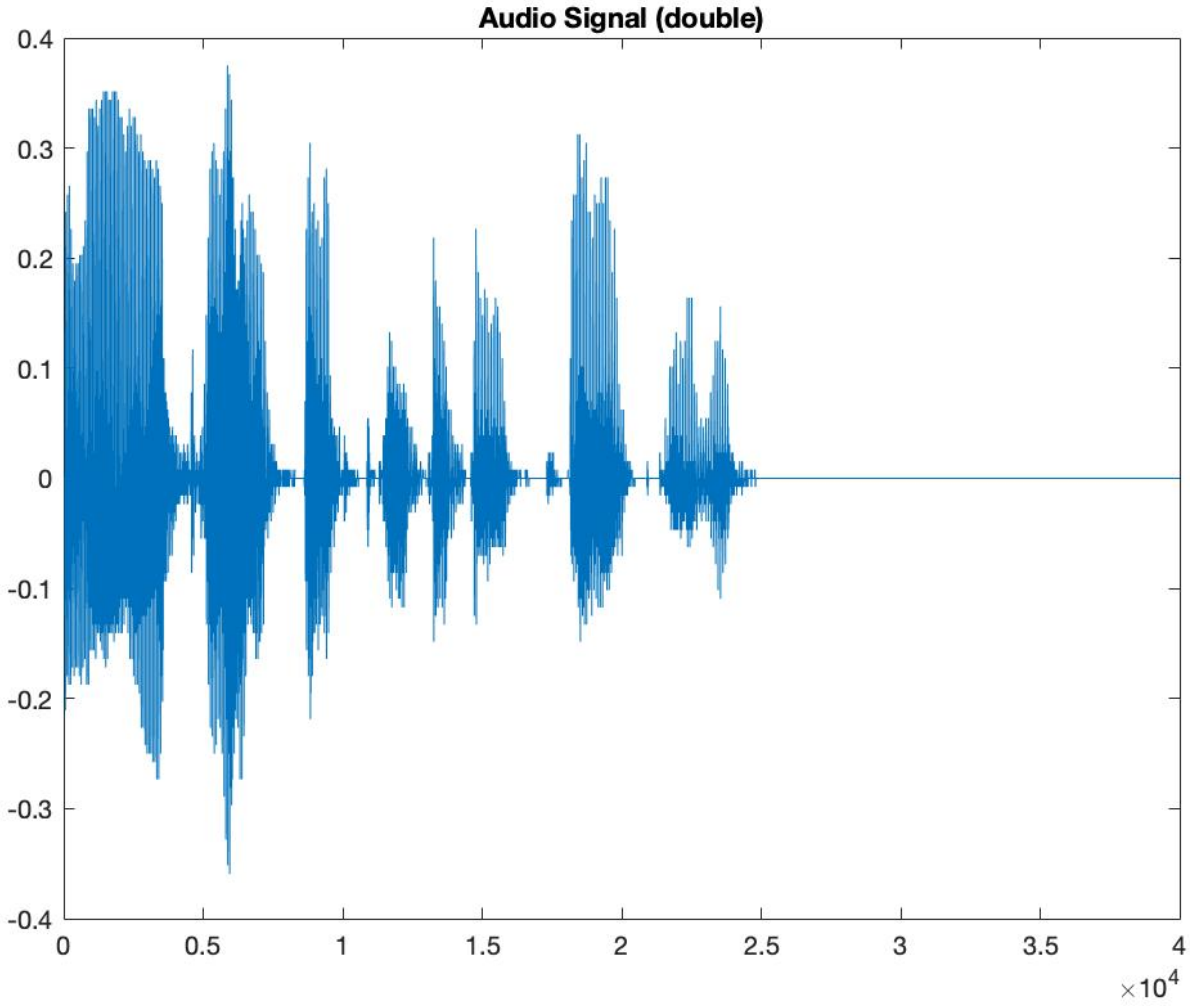
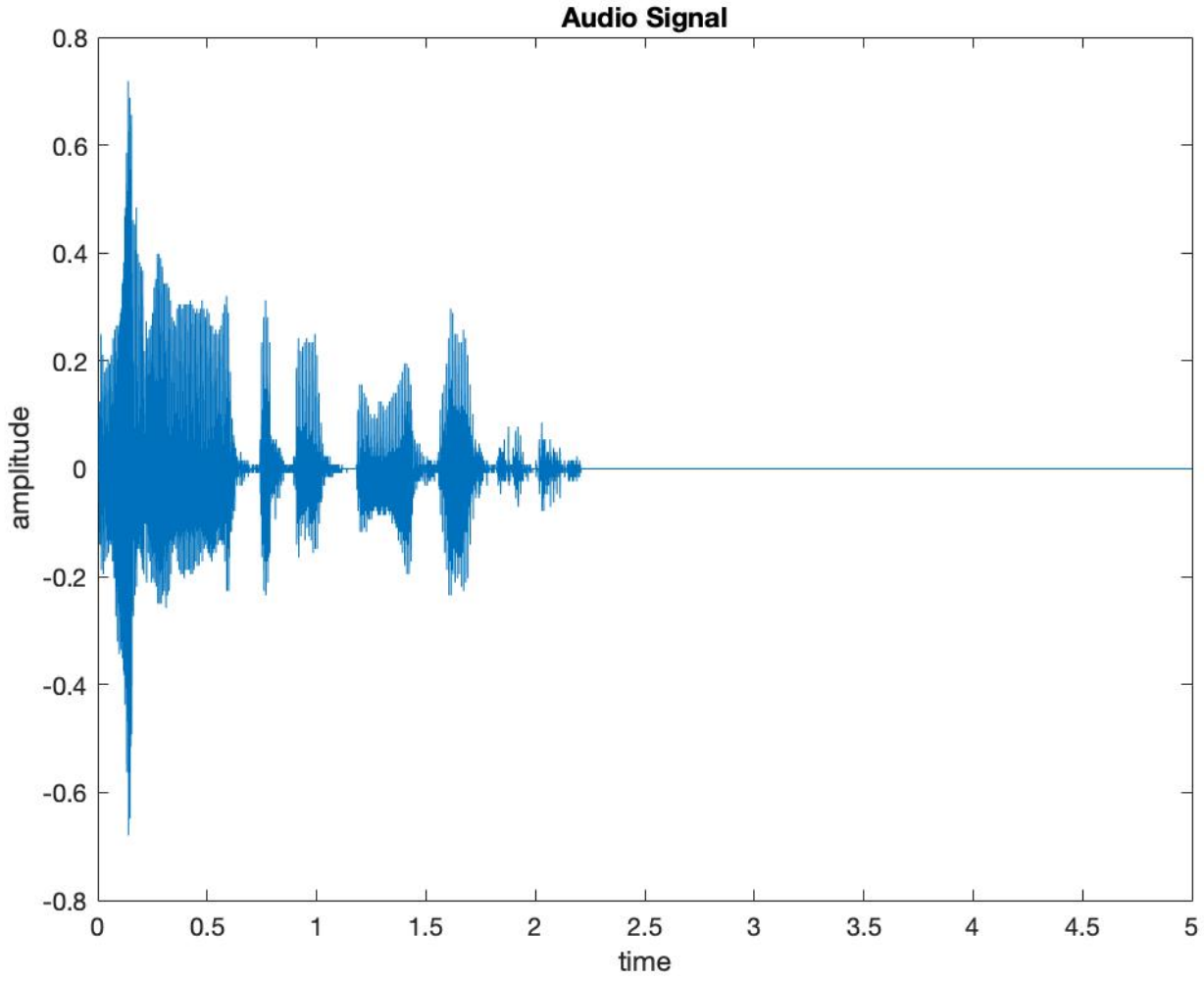
```
function [signal] = voicetosignal(t,question)

myVoice = audiorecorder;

pause(2);

% Define callbacks to show when
% recording starts and completes.
myVoice.StartFcn = 'disp(''Start speaking.'')';
recordblocking(myVoice,t);
myVoice.StopFcn = 'disp(''End of recording.'')';

doubleArray = getaudiodata(myVoice);

Fs = 8000;
time = 0:1/Fs:(Fs*t)/Fs-1/Fs;

plot(time,doubleArray);
xlabel('time'); % supply a x-axis label
ylabel('amplitude'); % supply a y-axis label
title('Audio Signal');

signal = (doubleArray)';

fprintf('The sampling frequency is %d\n', Fs);

%question = input('Would you like to hear what you just said? Please type "1"
for yes or "2" for no\n');
  if question == 1
      play(myVoice);
      pause(t);
  else
      return
  end


end
```

```
function [output] = EnvelopeDetector()

myVoice = audiorecorder;

pause(2);

% Define callbacks to show when
% recording starts and completes.
myVoice.StartFcn = 'disp(''Start speaking.'')';
recordblocking(myVoice,5);
myVoice.StopFcn = 'disp(''End of recording.'')';

doubleArray = getaudiodata(myVoice);
subplot(2,1,2);
plot(abs(doubleArray));
title('Audio Signal (rectified)');
subplot(2,1,1)
plot(doubleArray)
title('Audio Signal (double)');

end
```

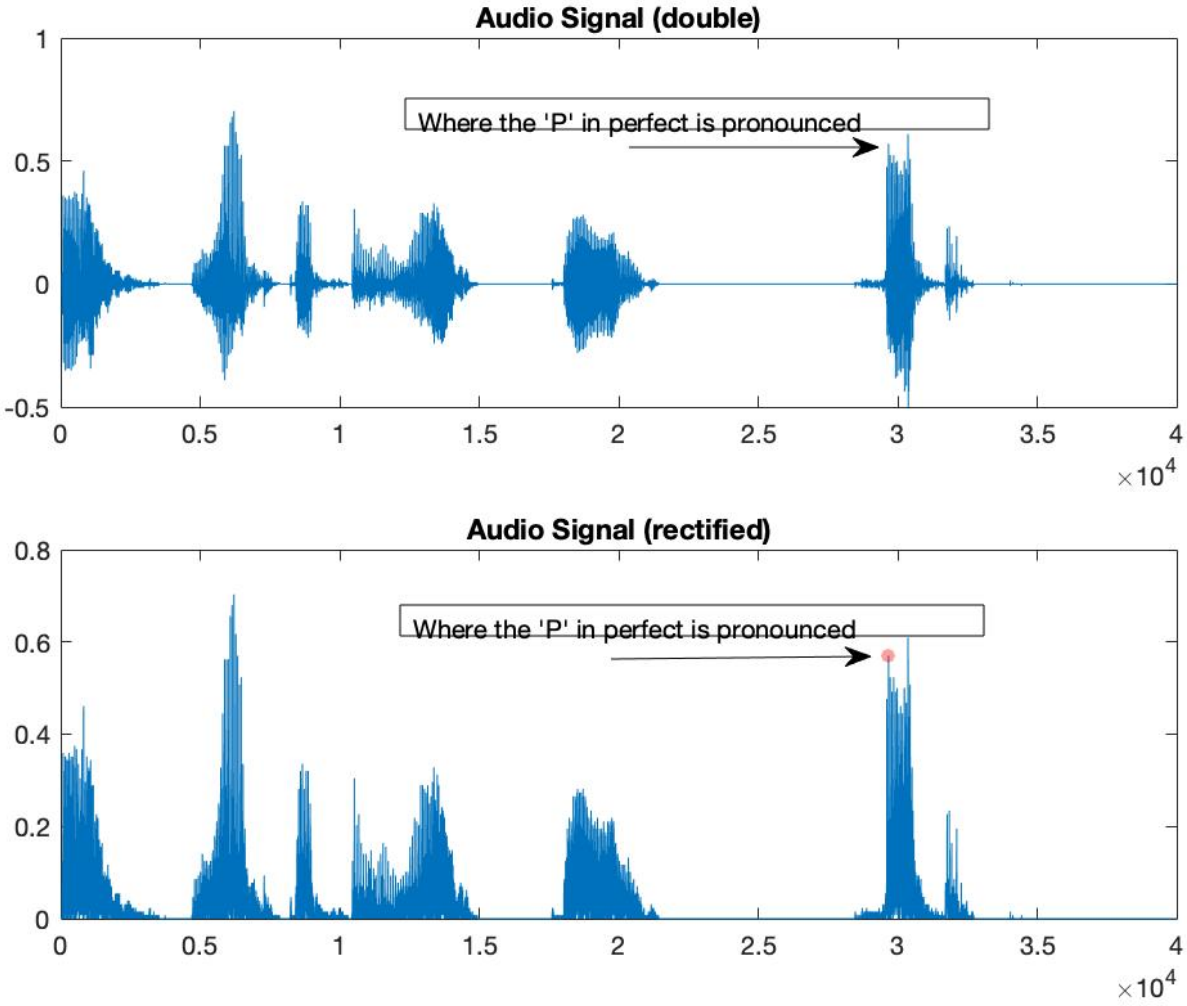
Question 8


Audio Signal (double)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
0
0.5
1
1.5
2
2.5
3
3.5
4
×10^4

Question 10


Audio Signal
amplitude
time
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Question 11


Audio Signal (double)
Where the 'P' in perfect is pronounced
1
0.5
0
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
×10^4
Audio Signal (rectified)
Where the 'P' in perfect is pronounced
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5
2
2.5
3
3.5
4
×10^4