Signals And Systems Project

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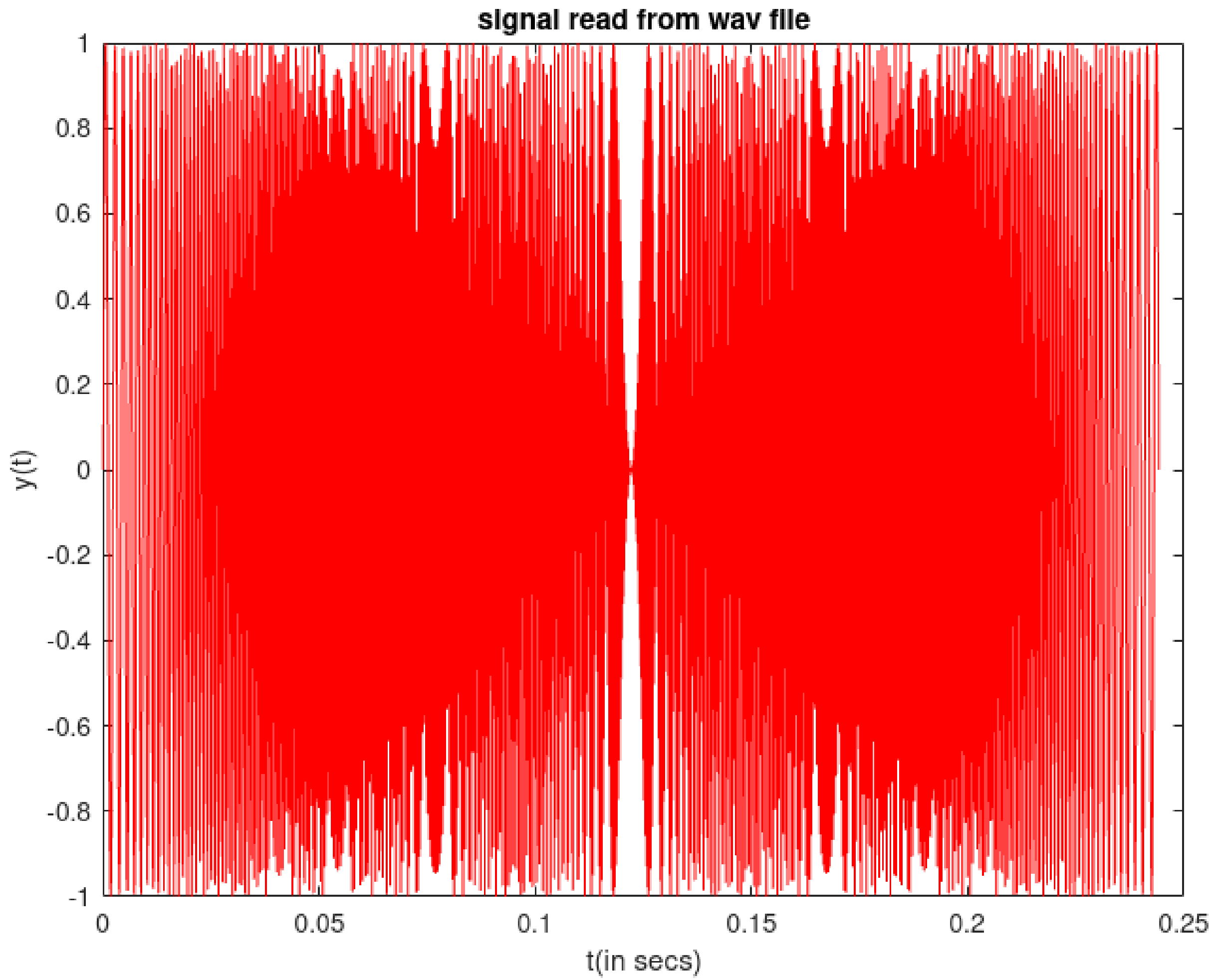
Task - 1

Part (b)

The code

```
filename = 'team15.wav';
[y, Fs] = audioread(filename);
l = length(y);
n = 1:l;

figure()
plot(n/Fs,y,'r');
ylabel('y(t)');
xlabel('t(in secs)');
title('signal read from wav file');
```

The Signal



Identification of the signal –

The signal that we read from the wav file is oscillating with both increasing and decreasing frequencies in certain time intervals as shown in the above image.

Properties of the signal –

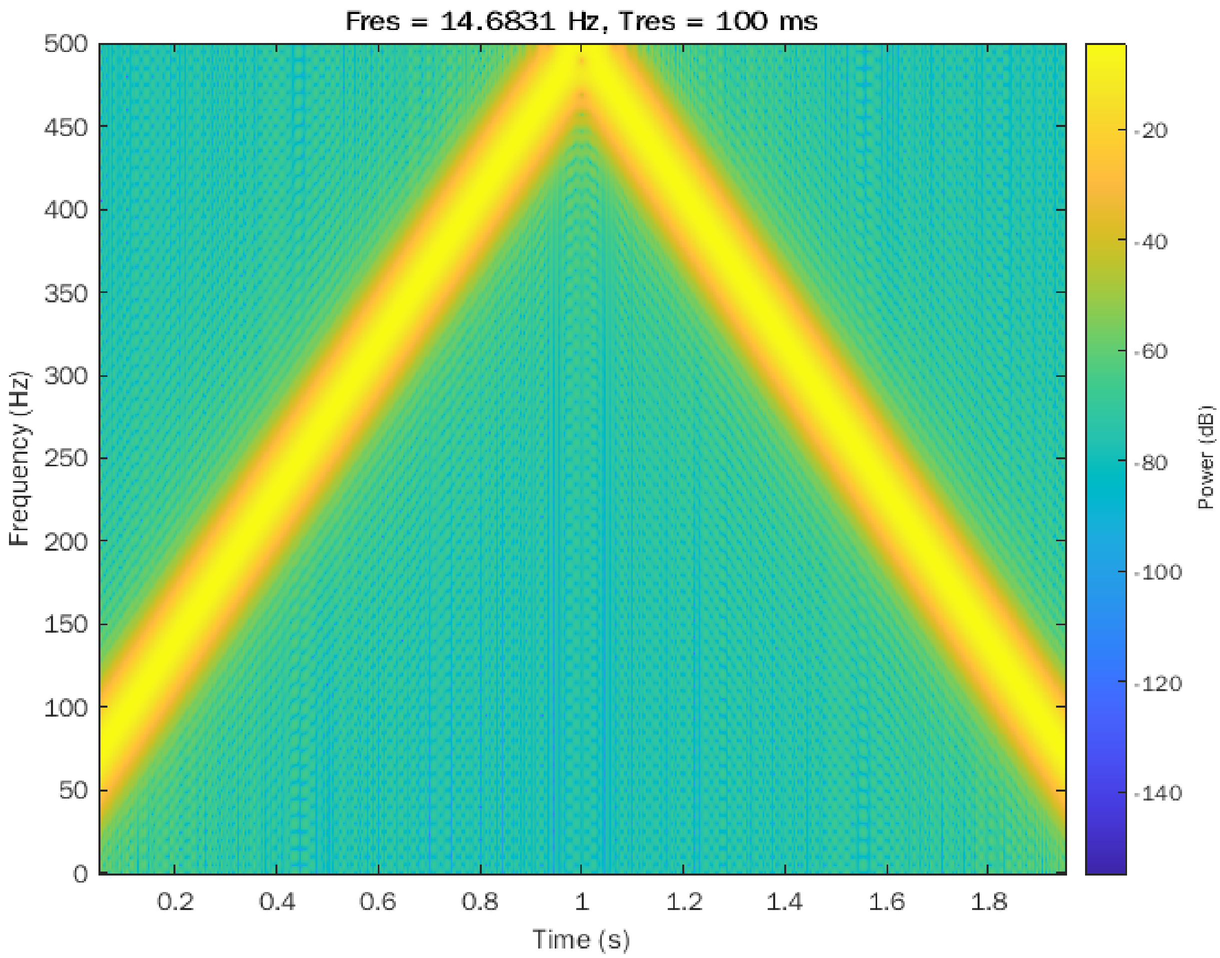
The signal oscillates between -1 to 1.

Its value at t=0 is 0.

Thus it's a sine wave in two different time intervals.

As we can observe from the above diagram, the frequency is increasing linearly till t=0.12s approximately and then decreases linearly. This can be proved by the spectrogram shown below.

Spectrogram



Properties of spectrogram

The frequency of the signal increases linearly and then decreases linearly too, as shown by the spectrogram.

Part ©

The code

```
y = zeros(2000,1);

for t = 0:1:2000
```

```
    if (t < 1000)
        w = 1450*(t/1000) + 50;
    else
        w = 2950 - 1450*(t/3000);
    end
    y(t+1) = sin(2*pi*w*(t/1000));
end

l = length(y);
n = 1:l;
Fs = 1000;

figure()
plot(n/Fs,y,'r');
ylabel('y(t)');
xlabel('t(in secs)');
title('constructed signal');
```

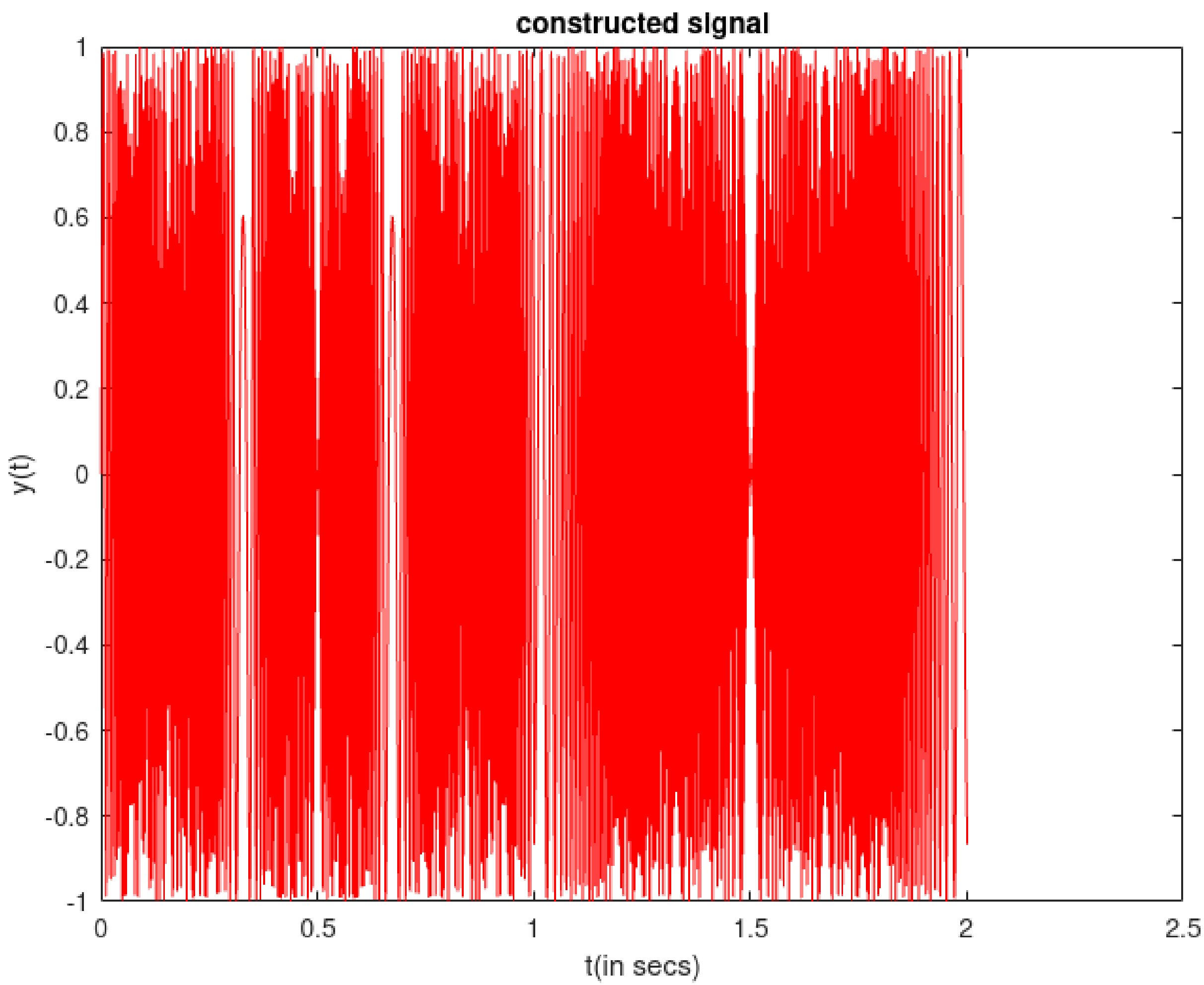
Frequencies

F0 = 50 Hz

F1 = 1500 Hz

F0 and F1 denote the range of our frequency for this part of the question.

Generated signals



Task - 2

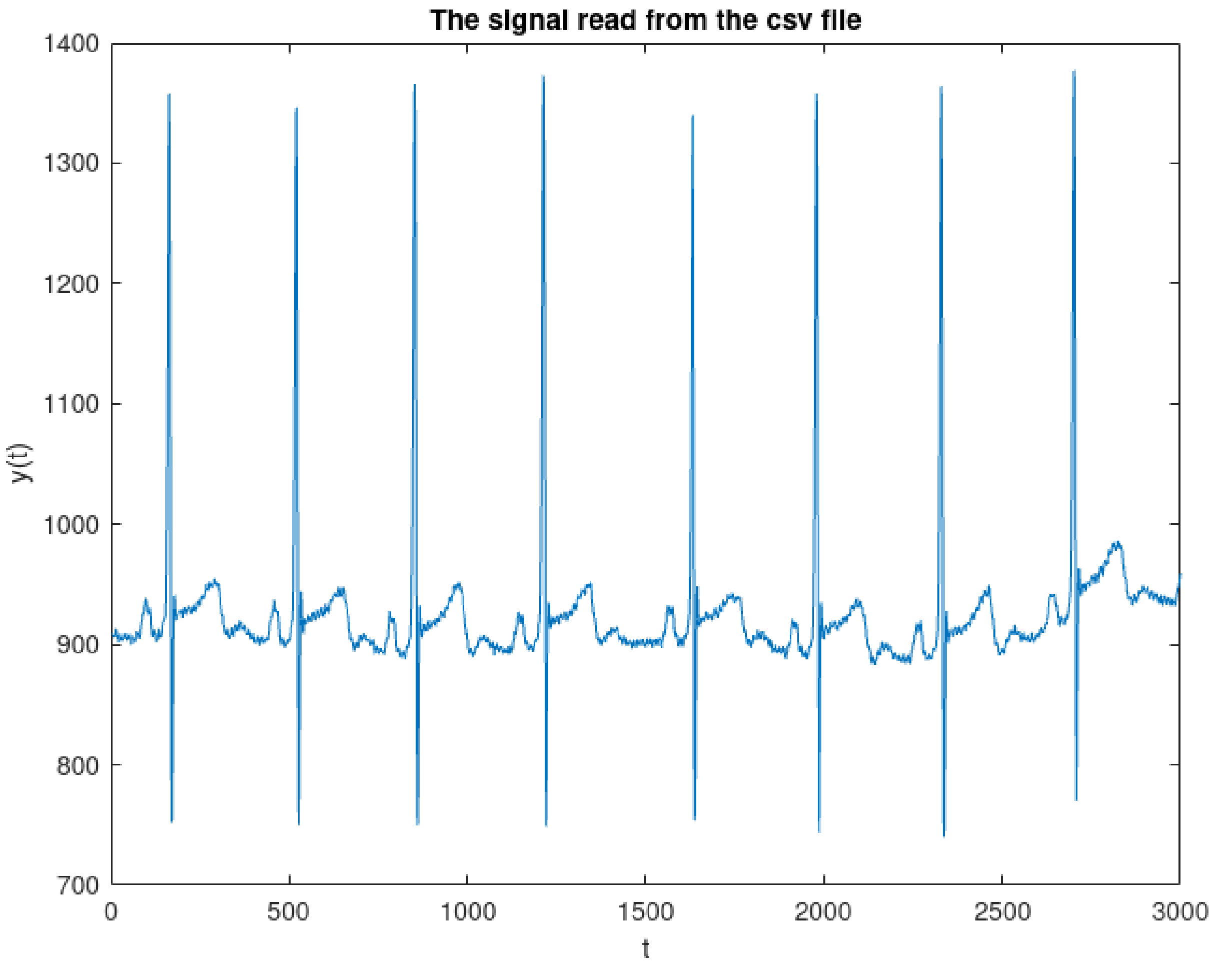
Part (b)

The code

```
filename = '115.csv';
Y = readmatrix(filename);
y = Y(:,2);
```

```
idx = 1:3000;
figure()
plot(y(1:3000,1));
ylabel('y(t)');
xlabel('t');
title('The signal read from the csv file');
%approximate period = 330 samples
%sampling rate = 44/0.122
%time period = 330*(1/sampling_rate) = 0.915
```

Plotting the ECG Signal



Quasi-Periodic and Sampling Rate

Quasi-periodic signal are signals that have a repetitive recognizable periodic pattern. They have variations in period and amplitude. They are signals that are almost periodic i.e. repetitive in nature.

Sampling rate is the no. of samples taken per second.

Calculation of Approximate Time period:

Time-Period = (1/Sampling Rate)*(No. Of samples per time period)

Our time period approximately came out to be 0.915s with sampling rate being 360.65

Part ©

The code

```
filename = '115.csv';

Y = readmatrix(filename);

y = Y(:,2);


m = zeros(3000,1);

for i = 1:3000

    m(i+1) = y(i+1) - y(i);

end


figure()

plot(m);

ylabel('m(t)');

xlabel('t');

title('Output signal when passed through an lti system');
```

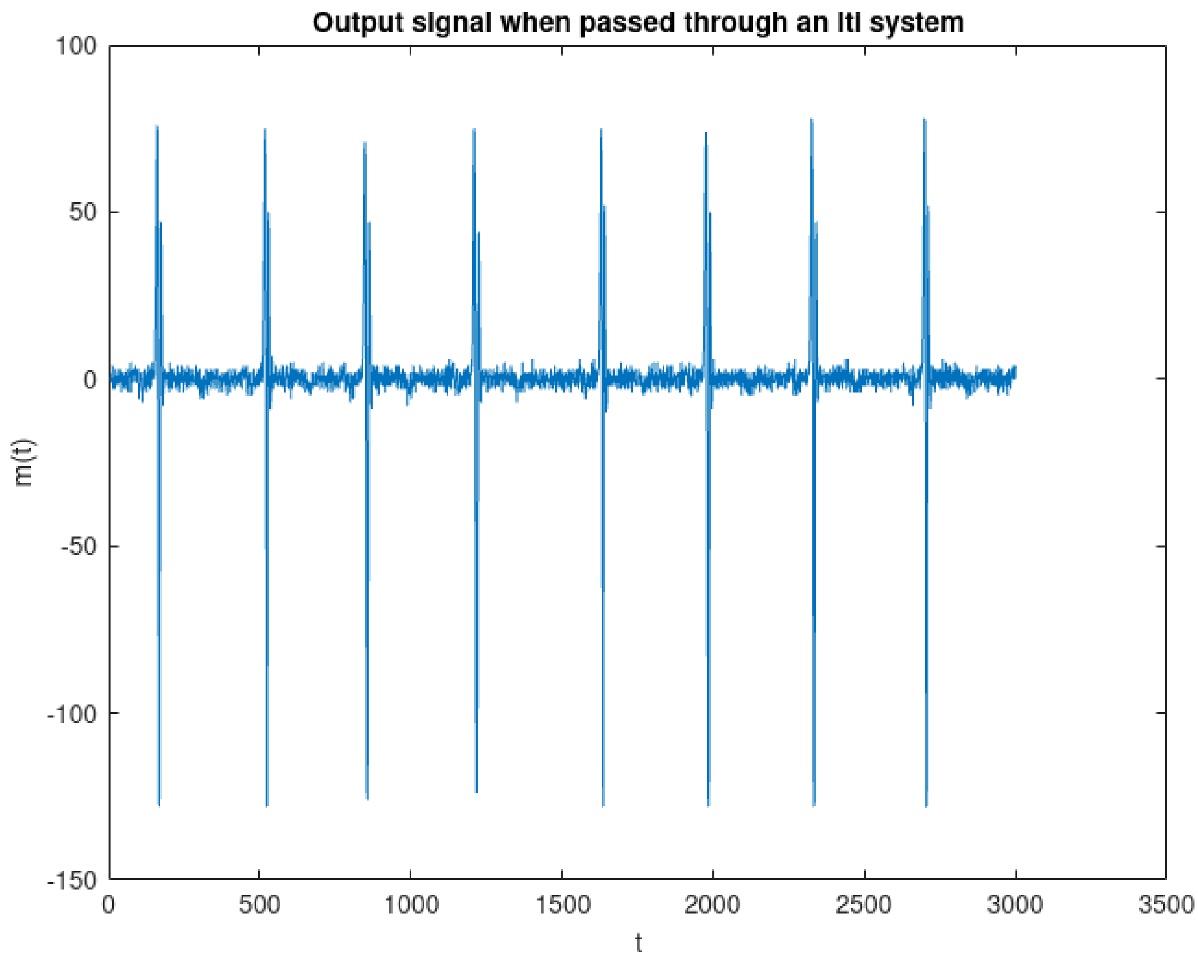
Design of LTI System

So here we need to output an ECG similar to the one we got.
So we can actually just get an LTI which gives the peak values as same as the input signal.
So if we just intialise our LTI to zero. And subtract the current value of peak from the previous one, we shall get the peak at almost the same point.

Therefore, our impulse response is.

$$h(t) = x(t)-x(t-1)$$

We can see that our output is getting peaks at almost the same points.



Part (d)

The code

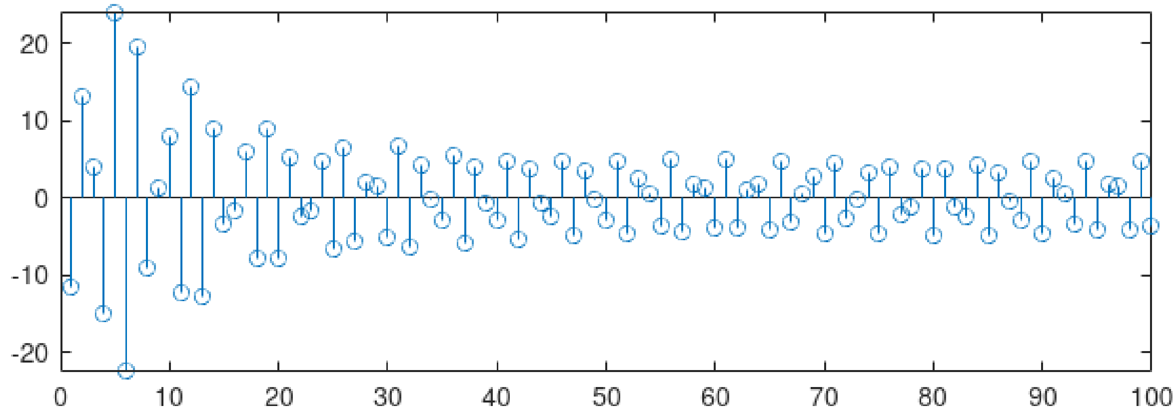
```
filename = '115.csv';

Y = readmatrix(filename);

y = Y(:,2);


T = 0.915;

w0 = 2*pi/T;
```

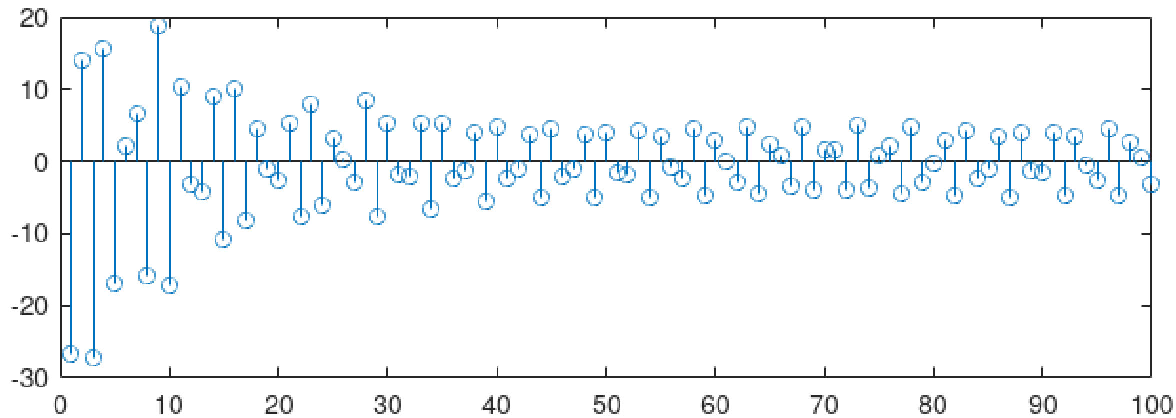
```
a = zeros(100,1);
b = zeros(100,1);
for k = 1:100
    for t = 530:1:860
        a(k) = a(k) + y(t)*cos(k*w0*(t*T/330))*(0.915/330);
        b(k) = b(k) + y(t)*sin(k*w0*(t*T/330))*(0.915/330);
    end
    a(k) = 2/T * a(k);
    b(k) = 2/T * b(k);
end

subplot(2,1,1)
subtitle('ak');
stem(1:100, a)
subplot(2,1,2)
subtitle('bk');
stem(1:100, b)
%plotted 100 fourier series coefficients
```

Fourier Series Analysis

Fourier transformation is used for periodic signal to expand them in terms of their harmonics which are sinusoidal and orthogonal in nature.

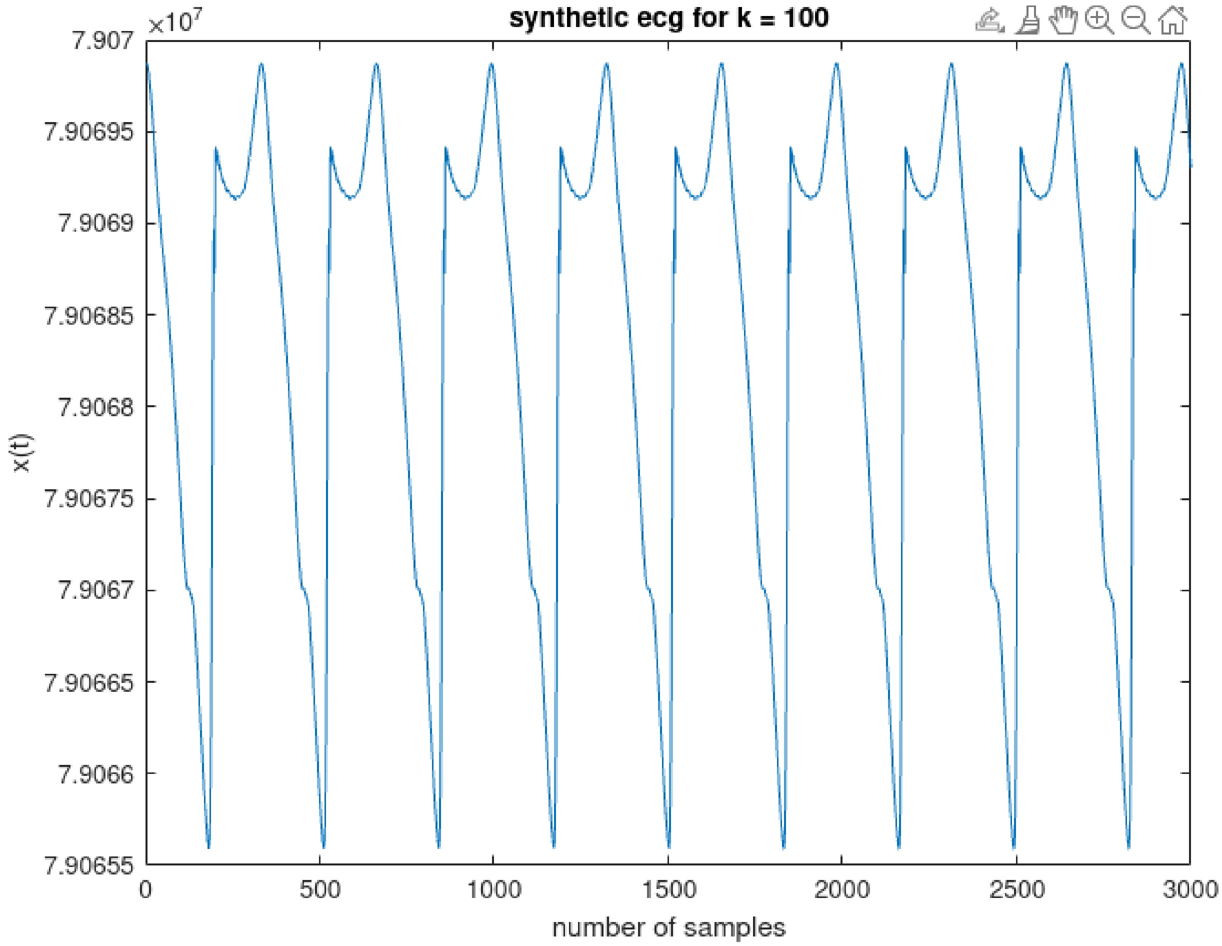
We have drawn the graph for the 2 coefficients ak(the upper graph) and bk(the lower graph) respectively.





Generating Synthetic ECG Signal

As we vary the value of k we get different synthetic ecg signals. One such is shown below.


synthetic ecg for k = 100
×10^7
7.907
7.90695
7.9069
7.90685
7.9068
7.90675
7.9067
7.90665
7.9066
7.90655
x(t)
0
500
1000
1500
2000
2500
3000
number of samples