```
%reading the audio file
[a fs]=audioread("C:\Users\pooja\Desktop\Cryptography\sig100.wav")
```

```
a = 650000×2
   -0.0283   -0.0127
   -0.0283   -0.0127
   -0.0283   -0.0127
   -0.0283   -0.0127
   -0.0283   -0.0127
   -0.0283   -0.0127
   -0.0283   -0.0127
   -0.0283   -0.0127
   -0.0234   -0.0156
   -0.0264   -0.0156
      ⋮
fs = 360
```

```
%extracting the first 10 seconds of the audio file
a_cut = a((fs * (10- 1)) + 1 : fs * ( 20- 1), :)
```

```
a_cut = 3600×2
   -0.0527   -0.0234
   -0.0537   -0.0293
   -0.0557   -0.0293
   -0.0586   -0.0303
   -0.0586   -0.0312
   -0.0615   -0.0283
   -0.0596   -0.0273
   -0.0586   -0.0283
   -0.0576   -0.0283
   -0.0586   -0.0312
      ⋮
```

```
%padding zeros to make a square matrix
%a_cut=a

%making the 2 channel file a single channel file
a_cut_mono=reshape(a_cut,[],1)
```

```
a_cut_mono = 7200×1
   -0.0527
   -0.0537
   -0.0557
   -0.0586
   -0.0586
   -0.0615
   -0.0596
   -0.0586
   -0.0576
   -0.0586
      ⋮
```

```
%finding the factors of the no of rows
n=(size(a_cut_mono))
```

```
n = 1×2
        7200           1
```

```
n=n(1)
```

```
n = 7200
```

```
factors=factorList(n);
size(factors)
```

```
ans = 1×2
     1    53
```

```
%creating ordered pairs of possible combinations
pairs=combinations(n,factors)
```

```
count = 1
pairs = 52×2
           2        3600
           3        2400
           4        1800
           5        1440
           6        1200
           8         900
           9         800
          10         720
          12         600
          15         480
      ⋮
```

```
optimal_pair =[pairs(1,:)];
minzero=0;
pairs
```

```
pairs = 52×2
           2        3600
           3        2400
           4        1800
           5        1440
           6        1200
           8         900
           9         800
          10         720
          12         600
          15         480
      ⋮
```

```
for i = 1:size(pairs,1)/2;
    temppair=[pairs(i,:)];
    temppair(1);
```

```
    temppair(2);
    zeroes = optimize(temppair(1), temppair(2));
    zeroes;
    if minzero == 0
        minzero = zeroes;
    else
       if zeroes < minzero
           minzero = zeroes;
           optimal_pair = temppair;
        end
    end
end
minzero
```

```
minzero = 900
```

```
temp=optimal_pair(1)
```

```
temp = 80
```

```
optimal_pair(1)=optimal_pair(2)
```

```
optimal_pair = 1×2
    90    90
```

```
optimal_pair(2)=temp
```

```
optimal_pair = 1×2
    90    80
```

```
a_reshaped=reshape(a_cut,optimal_pair(1),optimal_pair(2))
```

```
a_reshaped = 90×80
   -0.0527   -0.0654   -0.0537   -0.0479   -0.0762   -0.0557   -0.0547   -0.0820 ···
   -0.0537   -0.0674   -0.0527   -0.0420   -0.0771   -0.0527   -0.0537   -0.0742
   -0.0557   -0.0693   -0.0527   -0.0420   -0.0762   -0.0527   -0.0518   -0.0703
   -0.0586   -0.0693   -0.0547   -0.0479   -0.0791   -0.0547   -0.0537   -0.0713
   -0.0586   -0.0723   -0.0566   -0.0547   -0.0791   -0.0566   -0.0537   -0.0732
   -0.0615   -0.0693   -0.0547   -0.0537   -0.0781   -0.0557   -0.0508   -0.0742
   -0.0596   -0.0684   -0.0557   -0.0537   -0.0732   -0.0537   -0.0469   -0.0693
   -0.0586   -0.0674   -0.0537   -0.0576   -0.0742   -0.0537   -0.0469   -0.0693
   -0.0576   -0.0713   -0.0566   -0.0605   -0.0762   -0.0537   -0.0459   -0.0723
   -0.0586   -0.0713   -0.0547   -0.0635   -0.0771   -0.0566   -0.0469   -0.0732
     ⋮
```

```
size(a_reshaped)
```

```
ans = 1×2
    90    80
```

```
if optimal_pair(1)>optimal_pair(2)

    sq_wave = [a_reshaped, zeros(optimal_pair(1),optimal_pair(1)-optimal_pair(2))]

else
```

```
    a_reshaped=(a_reshaped)'
    size(a_reshaped)
    sq_wave = [a_reshaped, zeros(optimal_pair(2),optimal_pair(2)-optimal_pair(1))]

end
```

```
sq_wave = 90×90
   -0.0527   -0.0654   -0.0537   -0.0479   -0.0762   -0.0557   -0.0547   -0.0820 ···
   -0.0537   -0.0674   -0.0527   -0.0420   -0.0771   -0.0527   -0.0537   -0.0742
   -0.0557   -0.0693   -0.0527   -0.0420   -0.0762   -0.0527   -0.0518   -0.0703
   -0.0586   -0.0693   -0.0547   -0.0479   -0.0791   -0.0547   -0.0537   -0.0713
   -0.0586   -0.0723   -0.0566   -0.0547   -0.0791   -0.0566   -0.0537   -0.0732
   -0.0615   -0.0693   -0.0547   -0.0537   -0.0781   -0.0557   -0.0508   -0.0742
   -0.0596   -0.0684   -0.0557   -0.0537   -0.0732   -0.0537   -0.0469   -0.0693
   -0.0586   -0.0674   -0.0537   -0.0576   -0.0742   -0.0537   -0.0469   -0.0693
   -0.0576   -0.0713   -0.0566   -0.0605   -0.0762   -0.0537   -0.0459   -0.0723
   -0.0586   -0.0713   -0.0547   -0.0635   -0.0771   -0.0566   -0.0469   -0.0732
     ⋮
```

```
%generating a random key
key=rand(size(sq_wave))
```

```
key = 90×90
    0.6835    0.4055    0.4569    0.4101    0.2342    0.9136    0.1366    0.7189 ···
    0.8314    0.5595    0.2949    0.8572    0.7369    0.6054    0.0434    0.6850
    0.8550    0.7014    0.8377    0.9828    0.6667    0.1622    0.6728    0.1639
    0.6010    0.8269    0.3477    0.8162    0.6222    0.9201    0.1277    0.8468
    0.8032    0.4672    0.9702    0.1894    0.8555    0.1069    0.2193    0.4760
    0.7251    0.1810    0.4025    0.0397    0.5483    0.1435    0.6589    0.7090
    0.7012    0.9737    0.5244    0.6059    0.9051    0.6396    0.3226    0.2971
    0.9383    0.2527    0.5104    0.7305    0.0178    0.2650    0.5025    0.2269
    0.1889    0.4661    0.5726    0.0482    0.5859    0.0100    0.5344    0.9025
    0.9041    0.0353    0.8934    0.7922    0.2811    0.8526    0.4591    0.6201
     ⋮
```

```
%encryption
fprintf("Encryption")
```

```
Encryption
```

```
tic
enc=sq_wave*key
```

```
enc = 90×90
   -2.3499   -2.0660   -2.2396   -2.1970   -1.9697   -2.3619   -1.8916   -2.1067 ···
   -2.2845   -2.0759   -2.2221   -2.1846   -1.9225   -2.3250   -1.8774   -2.0773
   -2.2425   -2.0982   -2.2363   -2.1946   -1.8911   -2.3165   -1.8818   -2.0732
   -2.2788   -2.1689   -2.3047   -2.2523   -1.9372   -2.3614   -1.9400   -2.1338
   -2.3092   -2.1940   -2.3236   -2.2790   -1.9780   -2.3751   -1.9790   -2.1693
   -2.3046   -2.1469   -2.2863   -2.2299   -1.9827   -2.3301   -1.9647   -2.1566
   -2.2979   -2.0890   -2.2230   -2.1756   -1.9864   -2.2876   -1.9288   -2.1231
   -2.4073   -2.1192   -2.2719   -2.2188   -2.0869   -2.3542   -1.9750   -2.1955
   -2.5454   -2.1793   -2.3342   -2.2851   -2.1920   -2.4626   -2.0287   -2.2834
   -2.6528   -2.2192   -2.3809   -2.3471   -2.2742   -2.5492   -2.0689   -2.3548
```

```
toc
```

```
Elapsed time is 0.006485 seconds.
```

```
%decryption
fprintf("Decryption")
```

```
Decryption
```

```
tic
dec=enc*inv(key)
```

```
dec = 90×90
   -0.0527   -0.0654   -0.0537   -0.0479   -0.0762   -0.0557   -0.0547   -0.0820 ···
   -0.0537   -0.0674   -0.0527   -0.0420   -0.0771   -0.0527   -0.0537   -0.0742
   -0.0557   -0.0693   -0.0527   -0.0420   -0.0762   -0.0527   -0.0518   -0.0703
   -0.0586   -0.0693   -0.0547   -0.0479   -0.0791   -0.0547   -0.0537   -0.0713
   -0.0586   -0.0723   -0.0566   -0.0547   -0.0791   -0.0566   -0.0537   -0.0732
   -0.0615   -0.0693   -0.0547   -0.0537   -0.0781   -0.0557   -0.0508   -0.0742
   -0.0596   -0.0684   -0.0557   -0.0537   -0.0732   -0.0537   -0.0469   -0.0693
   -0.0586   -0.0674   -0.0537   -0.0576   -0.0742   -0.0537   -0.0469   -0.0693
   -0.0576   -0.0713   -0.0566   -0.0605   -0.0762   -0.0537   -0.0459   -0.0723
   -0.0586   -0.0713   -0.0547   -0.0635   -0.0771   -0.0566   -0.0469   -0.0732
     ⋮
```

```
toc
```

```
Elapsed time is 0.006050 seconds.
```

```
enc_col=enc(:,1)
```

```
enc_col = 90×1
   -2.3499
   -2.2845
   -2.2425
   -2.2788
   -2.3092
   -2.3046
   -2.2979
   -2.4073
   -2.5454
   -2.6528
     ⋮
```

```
fprintf("Average time to complete 50 encryptions")
```

```
Average time to complete 50 encryptions
```

```
average_enc_time(sq_wave,key)
```

```
Elapsed time is 0.000192 seconds.
Elapsed time is 0.000027 seconds.
Elapsed time is 0.000022 seconds.
```

```
Elapsed time is 0.000022 seconds.
Elapsed time is 0.000022 seconds.
Elapsed time is 0.000022 seconds.
Elapsed time is 0.000021 seconds.
Elapsed time is 0.000022 seconds.
Elapsed time is 0.000021 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000012 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000012 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000013 seconds.
Elapsed time is 0.000018 seconds.
Elapsed time is 0.000012 seconds.
Elapsed time is 0.000012 seconds.
Elapsed time is 0.000012 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000015 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000012 seconds.
Elapsed time is 0.000012 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000012 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000012 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000012 seconds.
Elapsed time is 0.000012 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000012 seconds.
Elapsed time is 0.000011 seconds.
Elapsed time is 0.000015 seconds.
Elapsed time is 0.000011 seconds.
ans = 4.6900e-05
```

```
fprintf("Average time to complete 50 decryptions")
```

```
Average time to complete 50 decryptions
```

```
average_dec_time(enc,key)
```

```
Elapsed time is 0.000371 seconds.
Elapsed time is 0.000158 seconds.
Elapsed time is 0.000155 seconds.
Elapsed time is 0.000140 seconds.
Elapsed time is 0.000134 seconds.
Elapsed time is 0.000153 seconds.
```

```
Elapsed time is 0.000150 seconds.
Elapsed time is 0.000144 seconds.
Elapsed time is 0.000141 seconds.
Elapsed time is 0.000130 seconds.
Elapsed time is 0.000131 seconds.
Elapsed time is 0.000158 seconds.
Elapsed time is 0.000134 seconds.
Elapsed time is 0.000136 seconds.
Elapsed time is 0.000159 seconds.
Elapsed time is 0.000289 seconds.
Elapsed time is 0.000192 seconds.
Elapsed time is 0.000176 seconds.
Elapsed time is 0.000184 seconds.
Elapsed time is 0.000131 seconds.
Elapsed time is 0.000168 seconds.
Elapsed time is 0.000143 seconds.
Elapsed time is 0.000123 seconds.
Elapsed time is 0.000123 seconds.
Elapsed time is 0.000118 seconds.
Elapsed time is 0.000109 seconds.
Elapsed time is 0.000116 seconds.
Elapsed time is 0.000146 seconds.
Elapsed time is 0.000155 seconds.
Elapsed time is 0.000131 seconds.
Elapsed time is 0.000179 seconds.
Elapsed time is 0.000236 seconds.
Elapsed time is 0.000179 seconds.
Elapsed time is 0.000180 seconds.
Elapsed time is 0.000154 seconds.
Elapsed time is 0.000207 seconds.
Elapsed time is 0.000148 seconds.
Elapsed time is 0.000134 seconds.
Elapsed time is 0.000138 seconds.
Elapsed time is 0.000131 seconds.
Elapsed time is 0.000136 seconds.
Elapsed time is 0.000129 seconds.
Elapsed time is 0.000129 seconds.
Elapsed time is 0.000134 seconds.
Elapsed time is 0.000128 seconds.
Elapsed time is 0.000135 seconds.
Elapsed time is 0.000127 seconds.
Elapsed time is 0.000136 seconds.
Elapsed time is 0.000127 seconds.
Elapsed time is 0.000127 seconds.
Elapsed time is 0.000133 seconds.
ans = 1.8650e-04
```

```
a_stripped=dec(1:90,1:80)
```

```
a_stripped = 90×80
   -0.0527   -0.0654   -0.0537   -0.0479   -0.0762   -0.0557   -0.0547   -0.0820 ···
   -0.0537   -0.0674   -0.0527   -0.0420   -0.0771   -0.0527   -0.0537   -0.0742
   -0.0557   -0.0693   -0.0527   -0.0420   -0.0762   -0.0527   -0.0518   -0.0703
   -0.0586   -0.0693   -0.0547   -0.0479   -0.0791   -0.0547   -0.0537   -0.0713
   -0.0586   -0.0723   -0.0566   -0.0547   -0.0791   -0.0566   -0.0537   -0.0732
   -0.0615   -0.0693   -0.0547   -0.0537   -0.0781   -0.0557   -0.0508   -0.0742
   -0.0596   -0.0684   -0.0557   -0.0537   -0.0732   -0.0537   -0.0469   -0.0693
   -0.0586   -0.0674   -0.0537   -0.0576   -0.0742   -0.0537   -0.0469   -0.0693
   -0.0576   -0.0713   -0.0566   -0.0605   -0.0762   -0.0537   -0.0459   -0.0723
   -0.0586   -0.0713   -0.0547   -0.0635   -0.0771   -0.0566   -0.0469   -0.0732
```

```
%a_stripped=a_stripped(:,1)

%converting it back into a 2 channel file

orig=reshape(a_stripped,[],2);

%comparison of original file and decrypted file
a_cut
```

```
a_cut = 3600×2
   -0.0527   -0.0234
   -0.0537   -0.0293
   -0.0557   -0.0293
   -0.0586   -0.0303
   -0.0586   -0.0312
   -0.0615   -0.0283
   -0.0596   -0.0273
   -0.0586   -0.0283
   -0.0576   -0.0283
   -0.0586   -0.0312
     ⋮
```

```
orig
```

```
orig = 3600×2
   -0.0527   -0.0234
   -0.0537   -0.0293
   -0.0557   -0.0293
   -0.0586   -0.0303
   -0.0586   -0.0312
   -0.0615   -0.0283
   -0.0596   -0.0273
   -0.0586   -0.0283
   -0.0576   -0.0283
   -0.0586   -0.0312
     ⋮
```

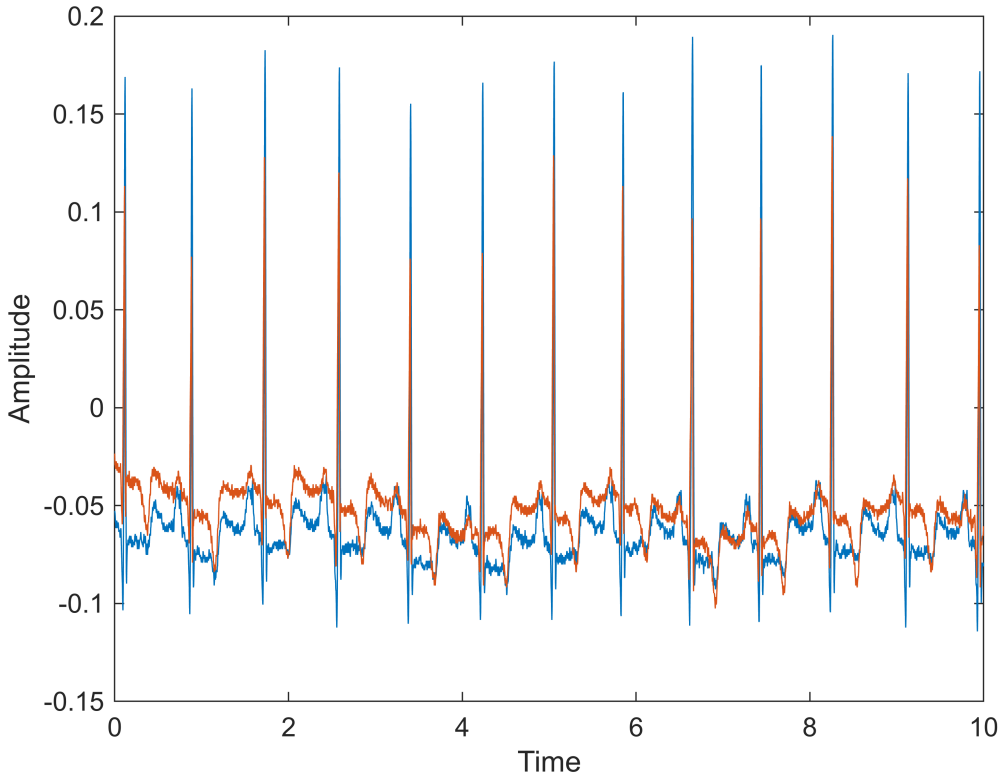
```
a_cut-orig
```

```
ans = 3600×2
10^-13 ×
    0.0819   -0.0554
    0.0993   -0.0651
    0.0924   -0.0489
    0.0793   -0.0819
    0.0754   -0.0557
    0.0720   -0.0647
    0.0974   -0.0515
    0.0597   -0.0438
    0.0754   -0.0381
    0.1072   -0.0846
     ⋮
```

```
%plotting the original, encrypted and decrypted waves

%og
t_og=(0:length(a_cut)-1)/fs
```

```
t_og = 1×3600
         0    0.0028    0.0056    0.0083    0.0111    0.0139    0.0167    0.0194 ···
```

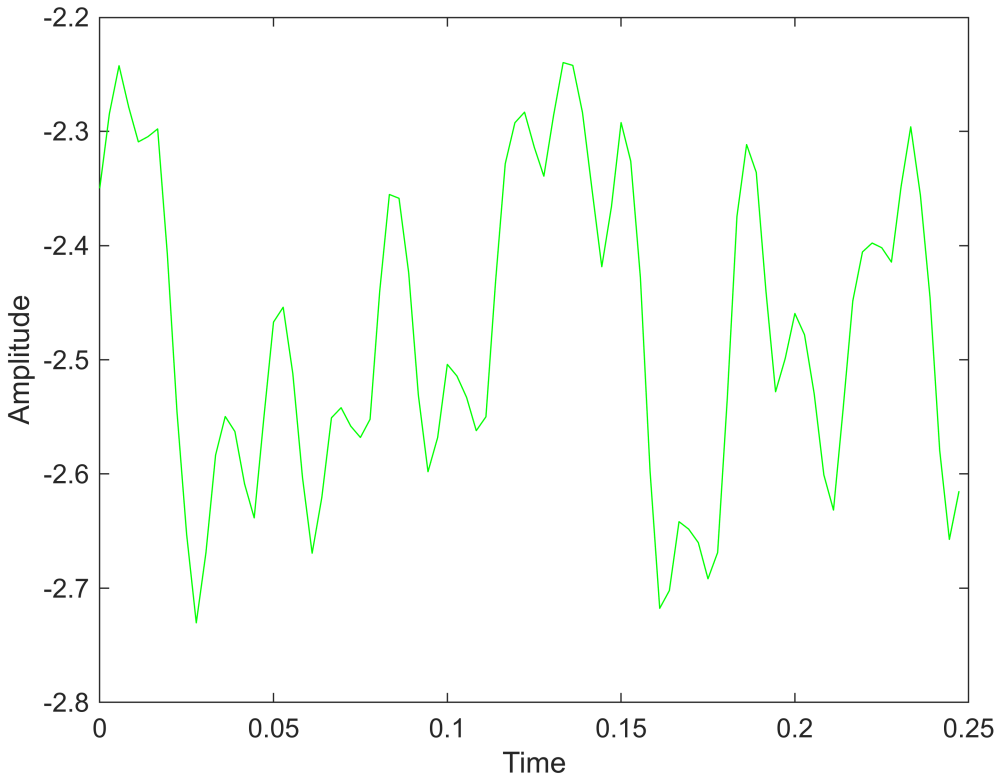
```
plot(t_og,a_cut)
xlabel("Time")
ylabel("Amplitude")
```




```
%encrypted mono channel waveform
t_enc=(0:length(enc_col)-1)/fs
```

```
t_enc = 1×90
         0    0.0028    0.0056    0.0083    0.0111    0.0139    0.0167    0.0194 ···
```

```
plot(t_enc,enc_col,'g')
xlabel("Time")
ylabel("Amplitude")
```



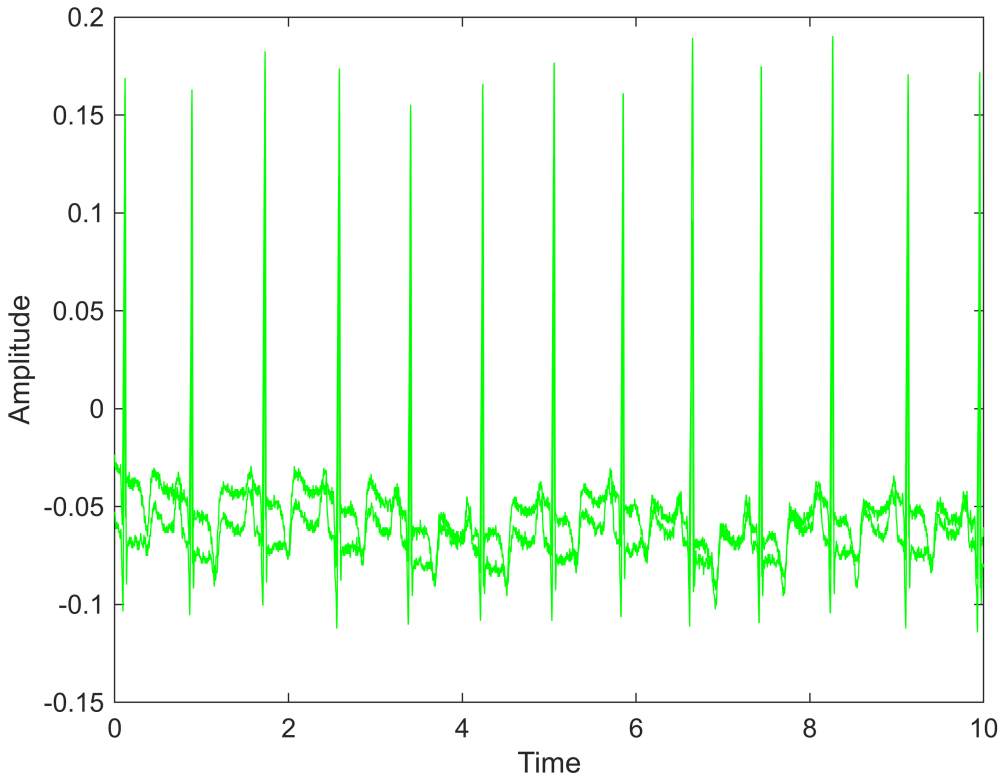

```
%original 2 channel waveform

t_og=(0:length(a_cut)-1)/fs
```

```
t_og = 1×3600
         0    0.0028    0.0056    0.0083    0.0111    0.0139    0.0167    0.0194 ···
```

```
plot(t_og,a_cut)
xlabel("Time")
ylabel("Amplitude")
hold on
%decrypted 2 channel waveform
t_dec=(0:length(orig)-1)/fs
```

```
t_dec = 1×3600
         0    0.0028    0.0056    0.0083    0.0111    0.0139    0.0167    0.0194 ···
```

```
plot(t_dec,orig, 'g')
xlabel("Time")
ylabel("Amplitude")
hold off
```


0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
Amplitude
0
2
4
6
8
10
Time