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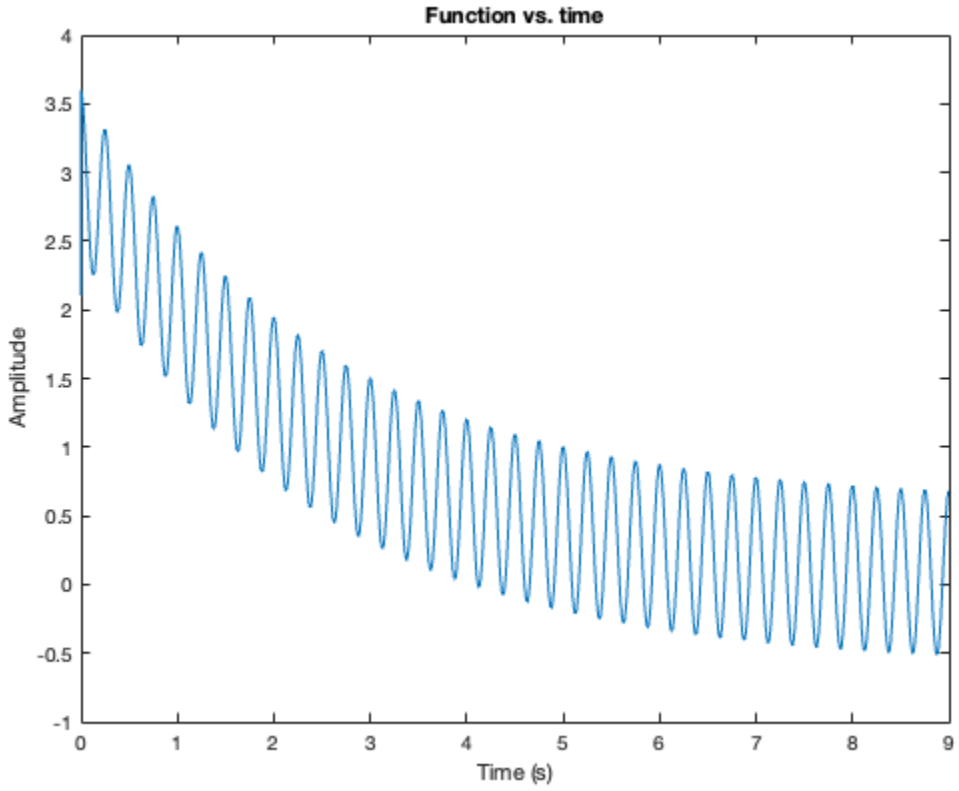
Lab 6: Sampling, FFTs, IFFTs, & Spectral Analysis

```
%scl84 & ckj16
%Shreeya Lingam & Cole Judson
%November 8,2023
```

PART 1: CONTINUOUS AND DISCRETE FOURIER TRANSFORMS

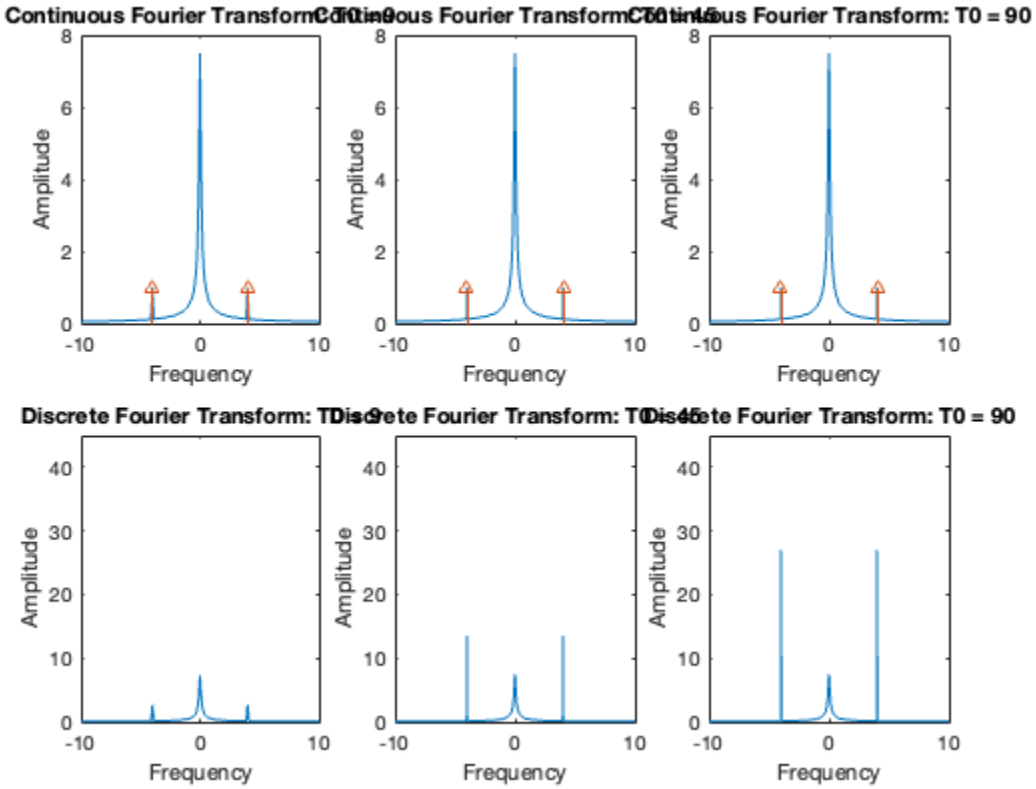
```
syms f(t);
syms w;

f(t) = 3*exp(-0.4*t)*heaviside(t) + 0.6*cos(8*pi*t);
SR = 2000; %defining the Sampling rate
dt = 1/SR;
t = 0:dt:9;% creating an initial time vector
sig = eval(f);

figure(1);
plot(t,sig);% plotting the ft over 9 seconds
ylabel('Amplitude');
xlabel('Time (s)');
title('Function vs. time');
```



PART 1 Figure 2

```
figure(2);

Tnot = [9 45 90];% T0 vector defined

for i = 1:3% using for loop for creation of sub plots later on
    t = 0:dt:Tnot(i);
    sig = eval(f);
    frequency = -1000:1/Tnot(i):1000;% frequency vector for graphing
    syms t
    cont(w) = fourier(f,t,w);% the fourier transform for ft
    conttrans = abs(eval(cont(frequency*2*pi)));% the absolte value of ft and
conversion to w
    disctrans = abs(fftshift(fft(sig*dt)));%  discrete transform, the absolte
value of ft and conversion to w

    %Continuous Fourier Transform Plotted
    subplot(2,3,i);

    infind = find(isinf(conttrans));
    conttrans(infind) = 1;

    plot(frequency,conttrans);
    drawnow;
```

```
    hold on;
    stem(frequency(infind),conttrans(infind),'^');
    xlabel('Frequency');
    ylabel('Amplitude');
    titleplot = sprintf('Continuous Fourier Transform: T0 = %d', Tnot(i)); %
indexing the Tnot variable for the subplot
    title(titleplot);
    xlim([-10 10]);

    %Discrete Fourier Transform
    subplot(2,3,i + 3);

    plot(frequency,disctrans);% plotting
    drawnow;
    xlabel('Frequency');
    ylabel('Amplitude');
    titleplot = sprintf('Discrete Fourier Transform: T0 = %d', Tnot(i));
    title(titleplot);
    xlim([-10 10]);
    ylim([0 45]);% using this to show all of the values and different
amplitudes of the graphs
end
```



PART 2: PRACTICAL APPLICATION:EEG PROCESSING

```
%Question 1
figure(3)
load('ArtificialEEG.mat');
SR = 1000;
dt = 1/SR;
Tnot = length(EEG)*dt;
t = 0:dt:Tnot-dt;
plot(t/60, EEG)
xlabel('time (min)')
ylabel('amplitude')

figure(4)

hold on

for i=1:15

    frequency = -500:1/Tnot*15:500;
    disctrans = abs(fftshift(fft(EEG(1 + ((i-1)*60000) : 1 + (i*60000)))));

    [row, col] = find(disctrans>500);
    frequency(col)

    %Discrete Fourier Transform

    subplot(5,3,i)

    plot(frequency,disctrans,'b-');
    xlabel('Frequency');
    ylabel('Amplitude');
    titleplot = sprintf('Discrete Fourier Transform for Minute %d to %d',
i-1, i);
    title(titleplot);
    xlim([0 100]);
end

hold off

f = 0:0.01:SR/2;

figure(5)
colormap jet
spectrogram(EEG,500,20,f,SR,'yaxis')
xlim([0 15])
ylim([0 100])
colorbar off


ans =
```

```
  Columns 1 through 7

  -60.0005   -8.3339   -8.2839   -8.2505   -8.2339   -8.2172   -8.2005

  Columns 8 through 14

   -8.1839   -8.1672   -8.1505   -8.1339   -8.1172   -8.1005   -8.0839

  Columns 15 through 21

   -8.0505   -8.0339    8.0328    8.0494    8.0828    8.0994    8.1161

  Columns 22 through 28

    8.1328    8.1494    8.1661    8.1828    8.1994    8.2161    8.2328

  Columns 29 through 32

    8.2494    8.2828    8.3328   59.9994

ans =

  -60.0172  -60.0005   59.9994   60.0160

ans =

  Columns 1 through 7

  -60.0005   -1.8006   -1.7839   -1.7339   -1.7172   -1.7006   -1.6839

  Columns 8 through 14

   -1.6672   -1.6506   -1.6339   -1.6172   -1.5839   -1.5672   -1.5506

  Columns 15 through 21

   -1.5006    1.4994    1.5494    1.5661    1.5828    1.6161    1.6328

  Columns 22 through 28

    1.6494    1.6661    1.6828    1.6994    1.7161    1.7328    1.7828

  Columns 29 through 30

    1.7994   59.9994

ans =

  Columns 1 through 7
```

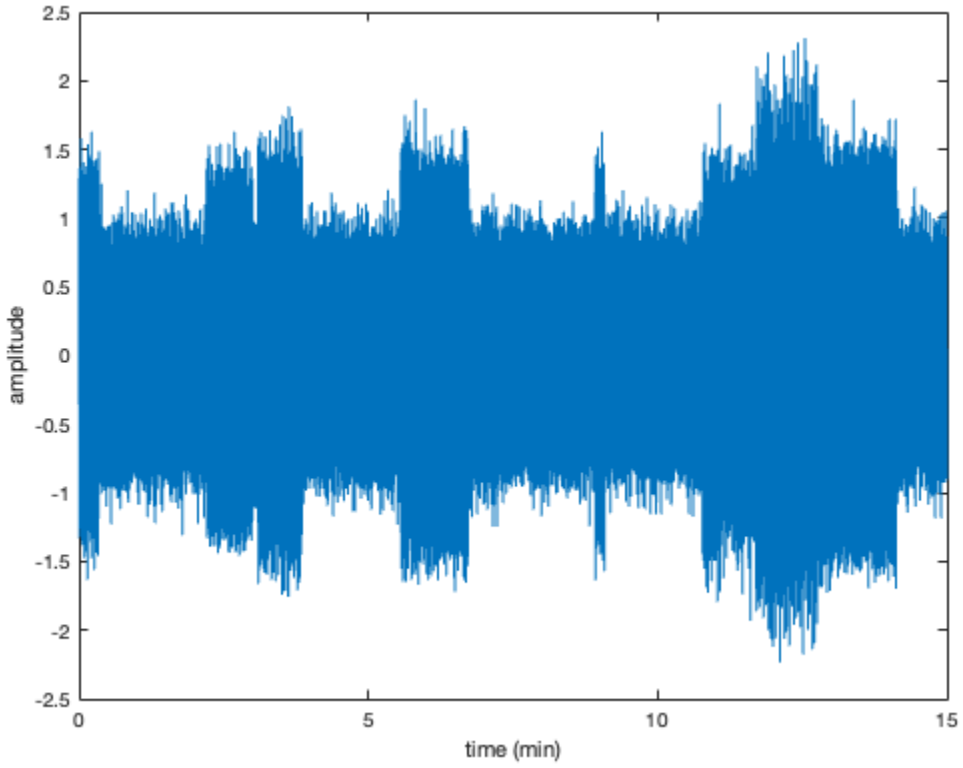
```
  -86.9171  -86.9005  -86.8505  -86.8338  -86.8005  -86.7838  -86.7671
  Columns 8 through 14
  -86.7505  -86.7338  -86.7171  -86.7005  -86.6838  -86.6671  -86.6505
  Columns 15 through 21
  -86.6338  -86.6005  -86.5838  -86.5171  -60.0172  -60.0005   59.9994
  Columns 22 through 28
   60.0160   86.5160   86.5827   86.5993   86.6327   86.6493   86.6660
  Columns 29 through 35
   86.6827   86.6993   86.7160   86.7327   86.7493   86.7660   86.7827
  Columns 36 through 40
   86.7993   86.8327   86.8493   86.8993   86.9160

ans =
  -60.0005   59.9994

ans =
  Columns 1 through 7
  -60.0005   -4.7006   -4.6506   -4.6172   -4.5839   -4.5672   -4.5506
  Columns 8 through 14
   -4.5339   -4.5172   -4.5006   -4.4839   -4.4672   -4.4506   -4.4339
  Columns 15 through 21
   -4.4172   -4.3839   -4.3506   -4.3339   -4.3006    4.2994    4.3328
  Columns 22 through 28
    4.3494    4.3828    4.4161    4.4328    4.4494    4.4661    4.4828
  Columns 29 through 35
    4.4994    4.5161    4.5328    4.5494    4.5661    4.5828    4.6161
  Columns 36 through 38
    4.6494    4.6994   59.9994
```

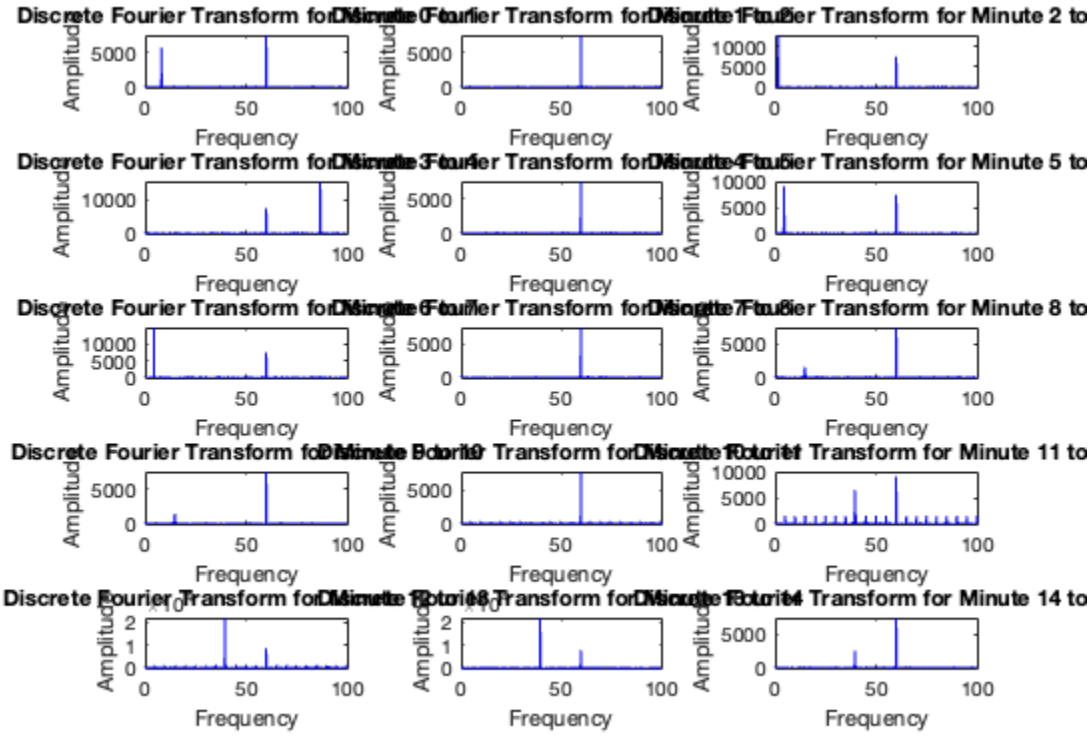
```
ans =

  Columns 1 through 7

  -60.0005   -4.6506   -4.6339   -4.5839   -4.5672   -4.5339   -4.5172

  Columns 8 through 14

   -4.5006   -4.4839   -4.4672   -4.4506   -4.4172   -4.4006   -4.3839

  Columns 15 through 21

   -4.3506   -4.3339   -4.2839   -4.2339    4.2328    4.2828    4.3328

  Columns 22 through 28

    4.3494    4.3828    4.3994    4.4161    4.4494    4.4661    4.4828

  Columns 29 through 35

    4.4994    4.5161    4.5328    4.5661    4.5828    4.6328    4.6494

  Column 36

   59.9994

ans =

  -60.0005   59.9994

ans =

  Columns 1 through 7

  -60.0005  -14.9172  -14.9005  -14.8839  -14.8672  -14.8505  -14.8339

  Columns 8 through 14

  -14.8172  -14.8005  -14.7839  -14.7672  -14.7505  -14.7339  -14.7172

  Columns 15 through 21

  -14.7005  -14.6839  -14.6672  -14.6505  -14.6339  -14.6172  -14.5839

  Columns 22 through 28

   14.5828   14.6161   14.6328   14.6494   14.6661   14.6828   14.6994

  Columns 29 through 35

   14.7161   14.7328   14.7494   14.7661   14.7828   14.7994   14.8161
```

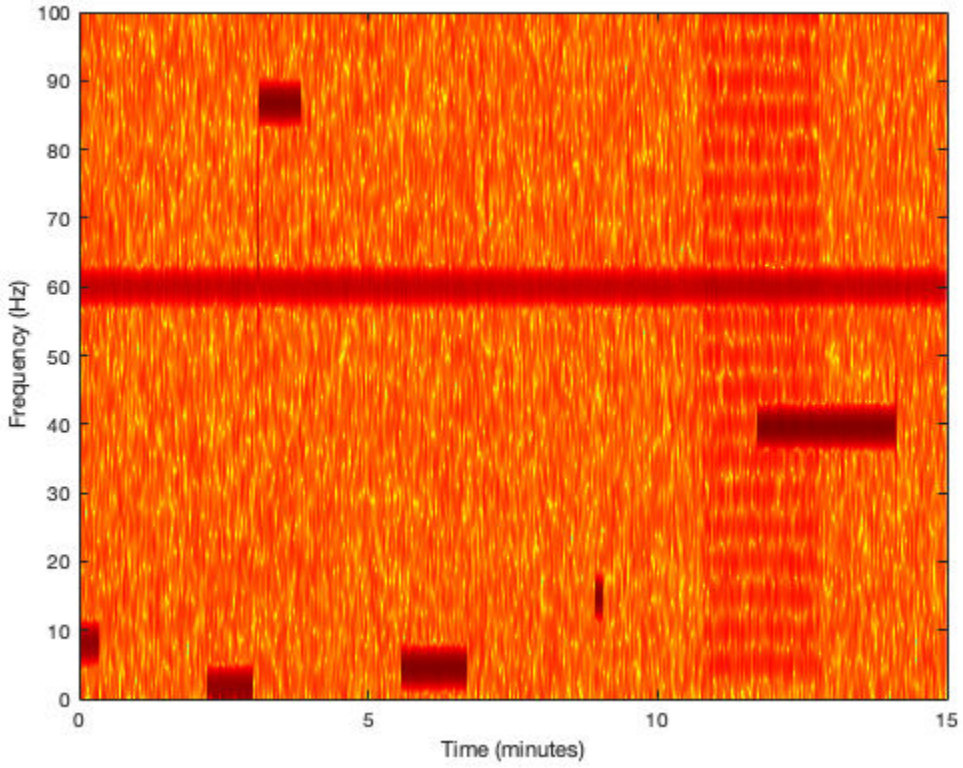
```
  Columns 36 through 42

   14.8328   14.8494   14.8661   14.8828   14.8994   14.9161   59.9994

ans =

  Columns 1 through 7

  -60.0005  -14.9172  -14.9005  -14.8839  -14.8672  -14.8505  -14.8339

  Columns 8 through 14

  -14.8172  -14.8005  -14.7839  -14.7672  -14.7505  -14.7339  -14.7172

  Columns 15 through 21

  -14.7005  -14.6839  -14.6672  -14.6505  -14.6339  -14.6172  -14.6005

  Columns 22 through 28

   14.5994   14.6161   14.6328   14.6494   14.6661   14.6828   14.6994

  Columns 29 through 35

   14.7161   14.7328   14.7494   14.7661   14.7828   14.7994   14.8161

  Columns 36 through 42

   14.8328   14.8494   14.8661   14.8828   14.8994   14.9161   59.9994

ans =

  -60.0005  -59.9838   59.9827   59.9994

ans =

  Columns 1 through 7

 -100.0004  -95.0004  -90.0005  -85.0005  -80.0005  -75.0005  -70.0005

  Columns 8 through 14

  -65.0005  -60.0172  -60.0005  -59.9838  -55.0005  -50.0005  -45.0005

  Columns 15 through 21

  -40.0005  -39.7838  -39.7338  -39.7172  -39.6838  -39.6672  -39.6505

  Columns 22 through 28
```

```
  -39.6338  -39.6172  -39.6005  -39.5838  -39.5672  -39.5505  -39.5338

  Columns 29 through 35

  -39.5172  -39.5005  -39.4838  -39.4505  -39.4338  -39.3838  -35.0005

  Columns 36 through 42

  -30.0005  -25.0005  -20.0005  -15.0005  -10.0005   -5.0005    4.9994

  Columns 43 through 49

    9.9994   14.9994   19.9994   24.9994   29.9994   34.9994   39.3827

  Columns 50 through 56

   39.4327   39.4494   39.4827   39.4994   39.5161   39.5327   39.5494

  Columns 57 through 63

   39.5661   39.5827   39.5994   39.6161   39.6327   39.6494   39.6661

  Columns 64 through 70

   39.6827   39.7161   39.7327   39.7827   39.9994   44.9994   49.9994

  Columns 71 through 77

   54.9994   59.9827   59.9994   60.0160   64.9994   69.9994   74.9994

  Columns 78 through 82

   79.9994   84.9994   89.9993   94.9993   99.9993

ans =

  Columns 1 through 7

 -100.0004  -95.0004  -90.0005  -85.0005  -80.0005  -75.0005  -70.0005

  Columns 8 through 14

  -65.0005  -60.0172  -60.0005  -55.0005  -50.0005  -45.0005  -40.0005

  Columns 15 through 21

  -39.6005  -39.5838  -35.0005  -30.0005  -25.0005  -20.0005  -15.0005

  Columns 22 through 28

  -10.0005   -5.0005    4.9994    9.9994   14.9994   19.9994   24.9994

  Columns 29 through 35
```

```
   29.9994   34.9994   39.5827   39.5994   39.9994   44.9994   49.9994
  Columns 36 through 42
   54.9994   59.9994   60.0160   64.9994   69.9994   74.9994   79.9994
  Columns 43 through 46
   84.9994   89.9993   94.9993   99.9993

ans =

  -60.0005  -39.5838   39.5827   59.9994

ans =

  Columns 1 through 7
  -60.0172  -60.0005  -39.8005  -39.7005  -39.6838  -39.6672  -39.6505
  Columns 8 through 14
  -39.6338  -39.6172  -39.6005  -39.5838  -39.5672  -39.5505  -39.5338
  Columns 15 through 21
  -39.5172  -39.5005  -39.4838  -39.4672  -39.3838  -39.3672  -39.3505
  Columns 22 through 28
   39.3494   39.3661   39.3827   39.4661   39.4827   39.4994   39.5161
  Columns 29 through 35
   39.5327   39.5494   39.5661   39.5827   39.5994   39.6161   39.6327
  Columns 36 through 42
   39.6494   39.6661   39.6827   39.6994   39.7994   59.9994   60.0160
```


amplitude
time (min)


Frequency
Amplitude



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