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CMPE362 - Spring '20
Homework 1 Report

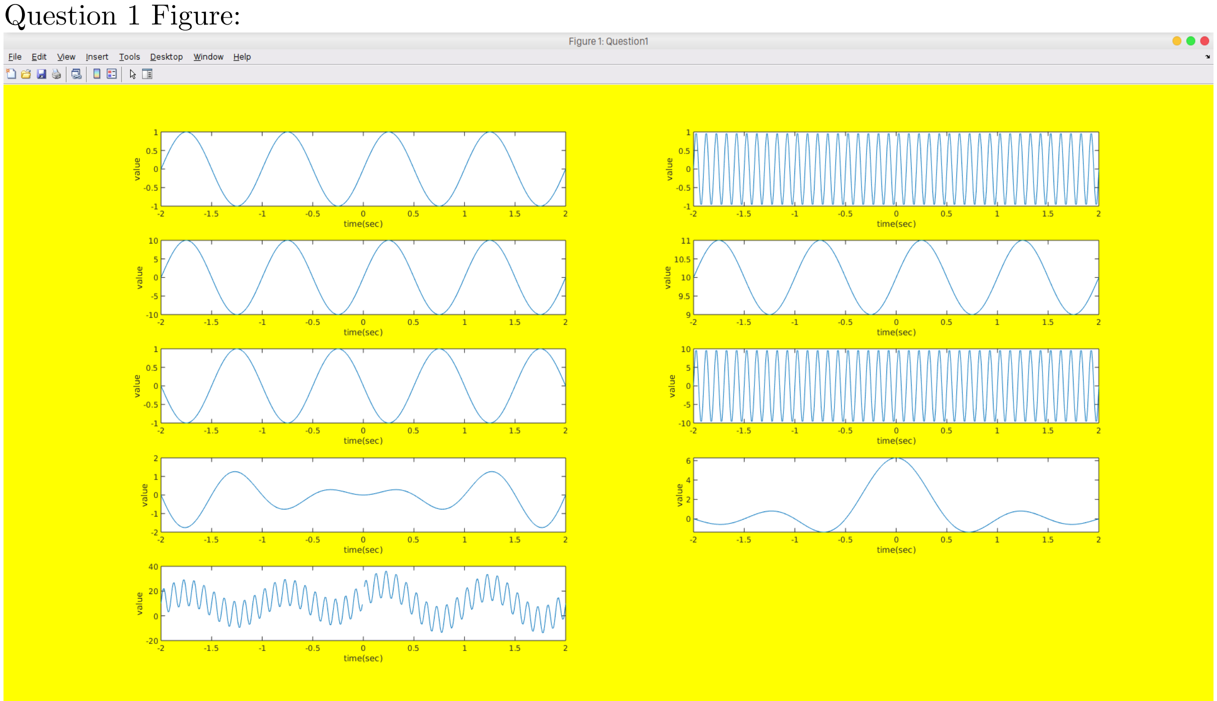
1. Question 1 - 6:

From questions 1 to 6, I've learned several matrix operations, plotting and figuring vector(s) or matrix(matrices) on screen. Working with great amount of data requires perfect visualization, the most efficient ways of manipulating data, and the best approach to store data.

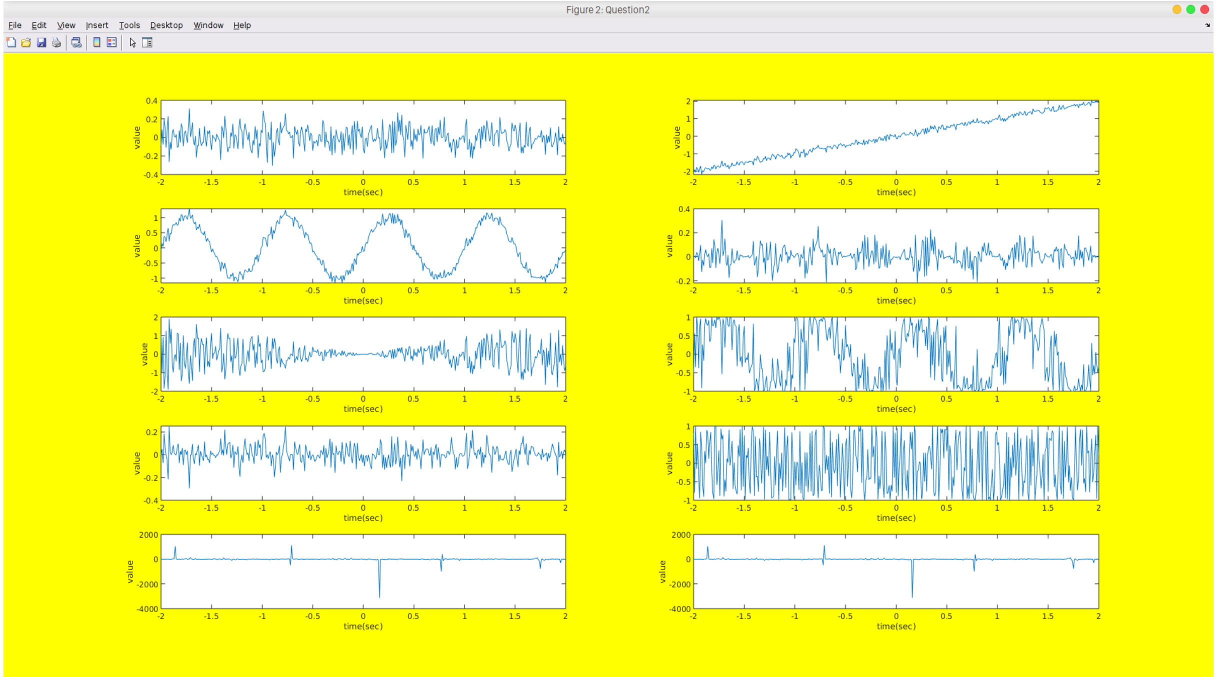
For visualization, I've learned how to illustrate several figures and several graphs into one figure. Adding labels for each dimension and setting plot/figure names are quite beneficial.

For matrix/vector operations, I've accustomed to do arithmetic operations on many vectors and matrices, by elementwise or by vector/matrixwise, whenever necessary. In addition to that, I've used sinusoidal functions and refreshed my knowledge of sinusoidal functions.

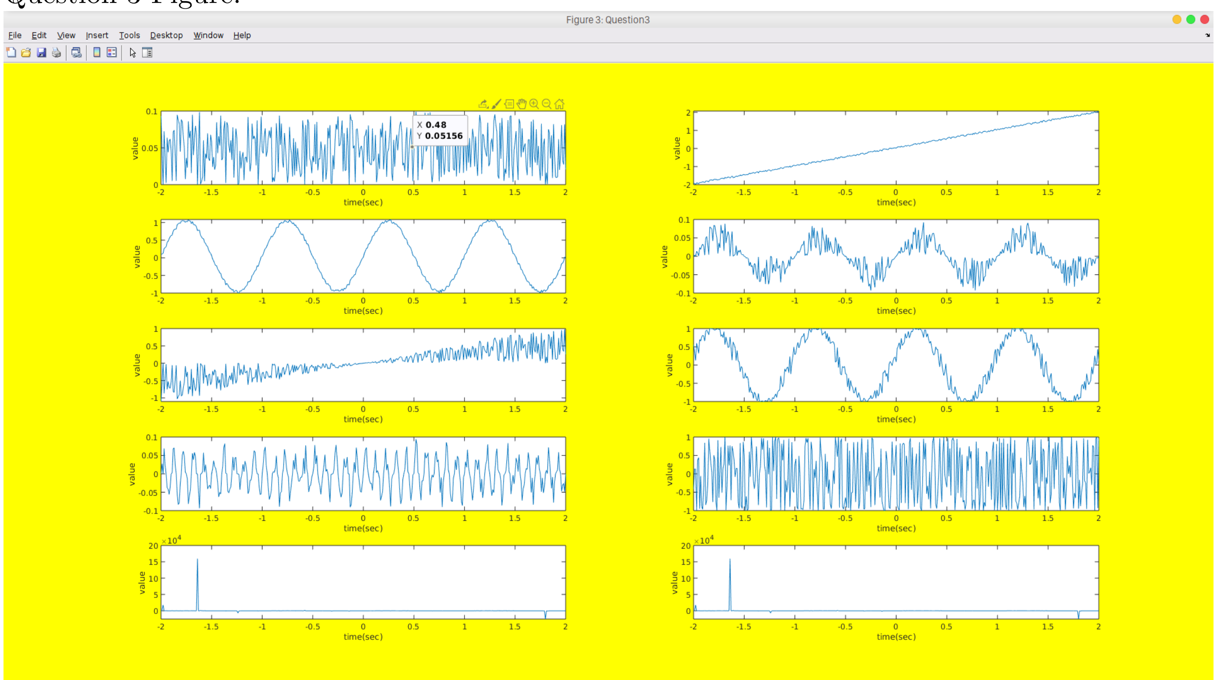
- Question 1 Figure:



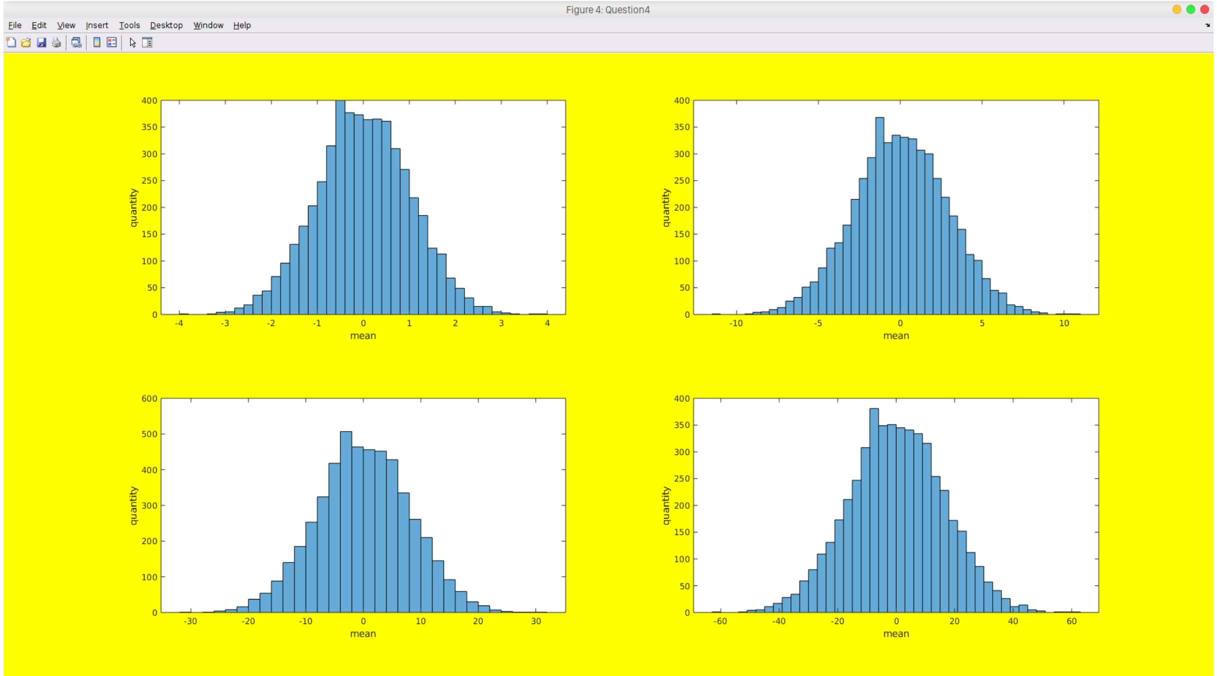
- Question 2 Figure:



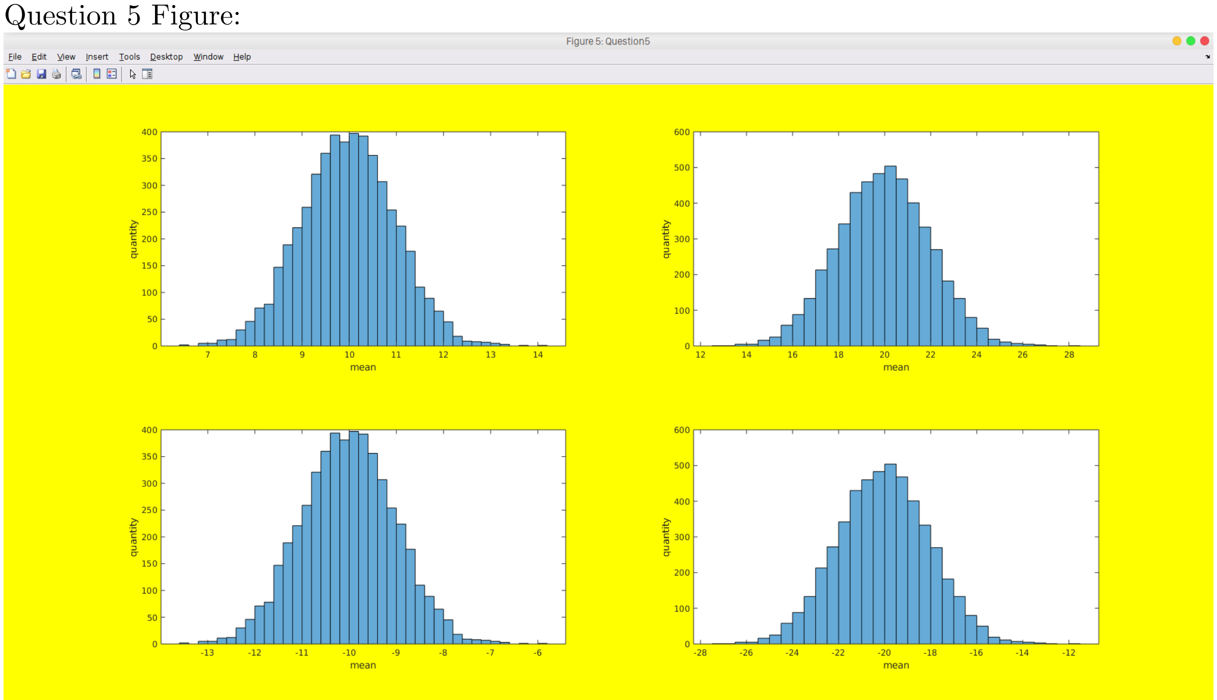
- Question 3 Figure:



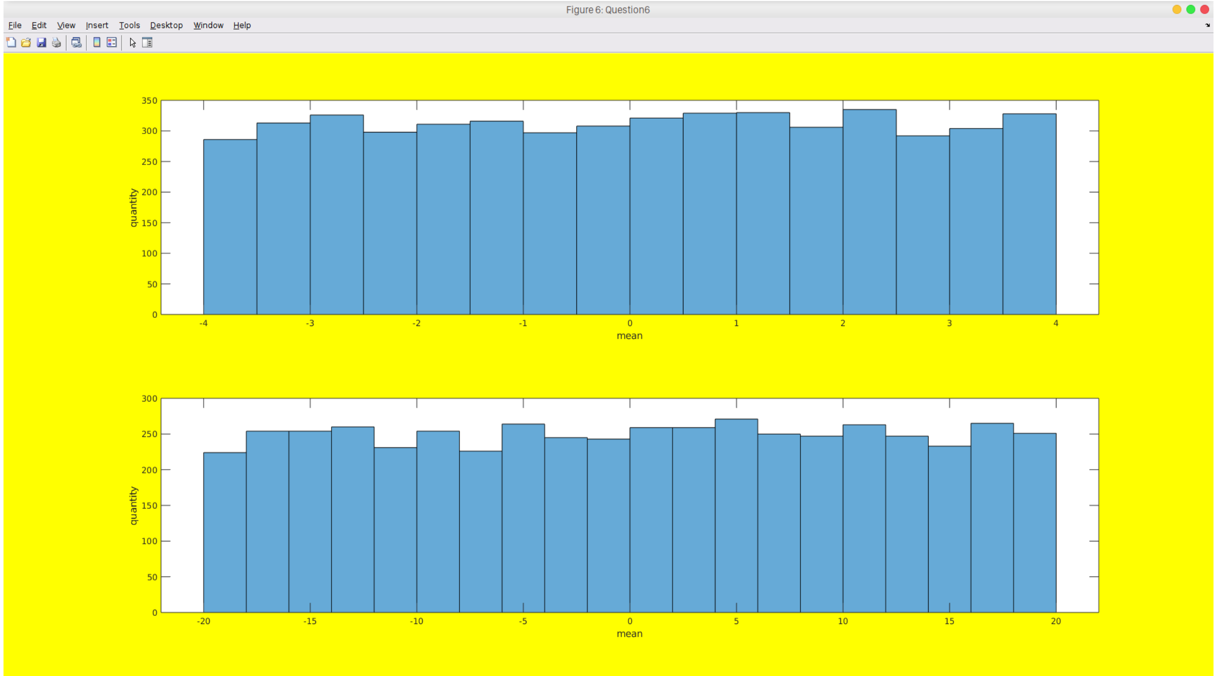
- Question 4 Figure:



- Question 5 Figure:



- Question 6 Figure:



2. Question 7:

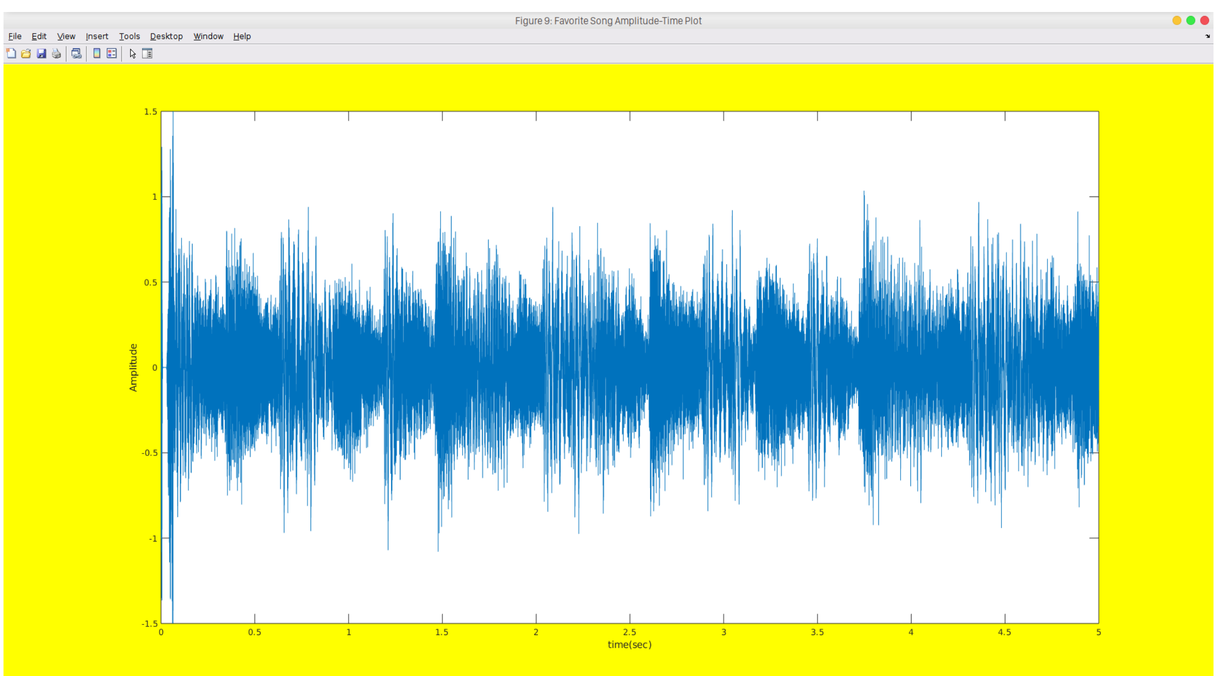
   The function of the signal given as 'mysignal.mat' file is below:

   $x(t) = 2167 + 4334cos(50 \cdot \pi \cdot t) + 4334cos(130 \cdot \pi \cdot t) + 4334cos(240 \cdot \pi \cdot t)$

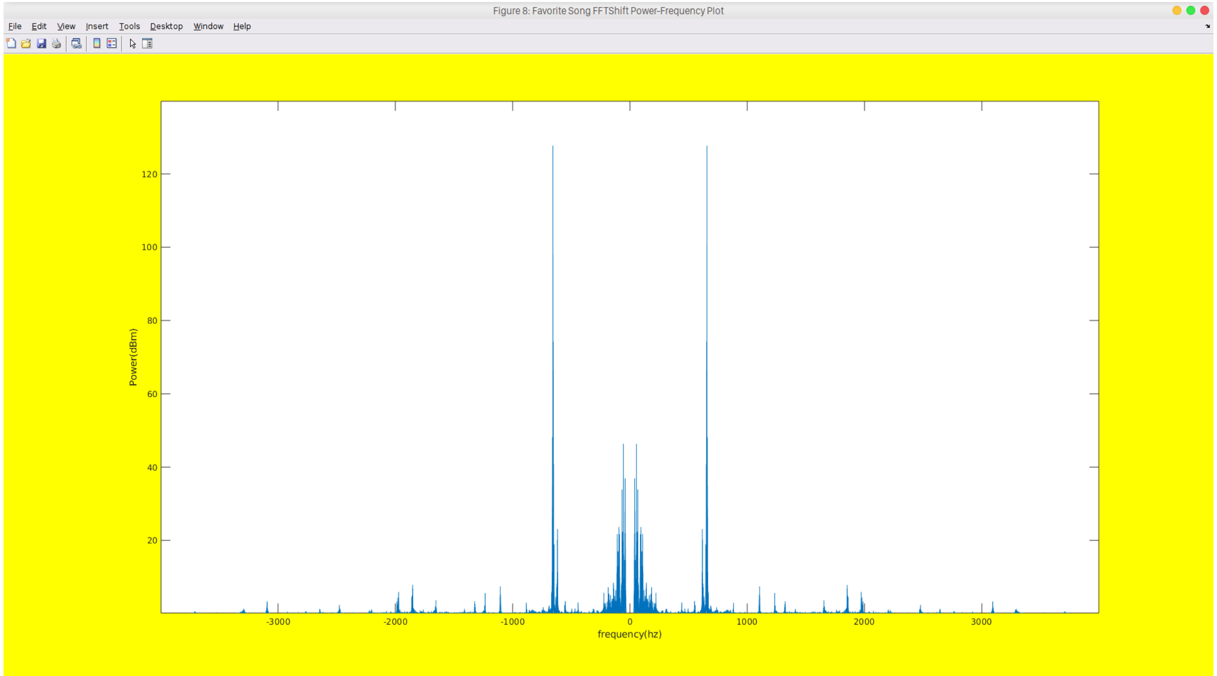
3. Question 8:

   For the song Anastasia(Slash ft. Myles Kennedy) between 45.5 and 50.5 seconds, the graphs of frequency and time are below:

- Time-Amplitude Graph:



- Frequency-Power Graph:



4. Question 9:

   The requested values are written below:

   Mean: 124.0425
   Standard deviation: 47.8556
   Minimum element value: 25
   Minimum element position(row, column): 72 4
   Maximum element value: 245
   Maximum element position(row, column): 274 396

5. Code of HW1_firstpart:

```
%%%%%%%%%%%%%%%%%%%%%%%%%%
% Problem 1%
t = (-2:0.01:2);
y1 = sin(2*pi*t);
y2 = sin(2*pi*t*10);
y3 = 10*sin(2*pi*t);
y4 = sin(2*pi*t)+10;
y5 = sin(2*pi*(t-0.5));
y6 = 10*sin(2*pi*t*10);
y7 = t.*sin(2*pi*t);
y8 = sin(2*pi*t) ./ t;
y9 = y1 + y2 + y3 + y4 + y5 + y6 + y7 + y8;
figure('Name', 'Question1', 'Color', 'Yellow');
subplot(5,2,1), plot(t, y1);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,2), plot(t, y2);
```

```
xlabel('time(sec)');
ylabel('value');
subplot(5,2,3), plot(t, y3);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,4), plot(t, y4);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,5), plot(t, y5);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,6), plot(t, y6);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,7), plot(t, y7);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,8), plot(t, y8);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,9), plot(t, y9);
xlabel('time(sec)');
ylabel('value');
% Problem 1 Ending %
%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%
% Problem 2 %
rand_vector1 = randn(1,401);
z = rand_vector1 .* 0.1;
y10 = z;
y11 = z + t;
y12 = z + y1;
y13 = z .* y1;
y14 = t .* sin(2 * pi .* z);
y15 = sin(2 * pi * (t + z));
y16 = z .* y2;
y17 = sin(2 * pi * (t + 10 .* z));
y18 = y1 ./ z;
y19 = y11 + y12 + y13 + y14 + y15 + y16 + y17 + y18;
figure('Name', 'Question2', 'Color', 'Yellow');
subplot(5,2,1), plot(t, y10);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,2), plot(t, y11);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,3), plot(t, y12);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,4), plot(t, y13);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,5), plot(t, y14);
xlabel('time(sec)');
```

```
ylabel('value');
subplot(5,2,6), plot(t, y15);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,7), plot(t, y16);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,8), plot(t, y17);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,9), plot(t, y18);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,10), plot(t, y19);
xlabel('time(sec)');
ylabel('value');
% Problem 2 Ending %
%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%
% Problem 3 %
rand_vector2 = rand(1, 401);
z = rand_vector2 .* 0.1;
y20 = z;
y21 = z + t;
y22 = z + y1;
y23 = z .* y1;
y24 = t .* sin(2 * pi * z);
y25 = sin(2 * pi * (t + z));
y26 = z .* y2;
y27 = sin(2 * pi * (t + 10 .* z));
y28 = y1 ./ z;
y29 = y21 + y22 + y23 + y24 + y25 + y26 + y27 + y28;
figure('Name', 'Question3', 'Color', 'Yellow');
subplot(5,2,1), plot(t, y20);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,2), plot(t, y21);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,3), plot(t, y22);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,4), plot(t, y23);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,5), plot(t, y24);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,6), plot(t, y25);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,7), plot(t, y26);
xlabel('time(sec)');
ylabel('value');
```

```
subplot(5,2,8), plot(t, y27);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,9), plot(t, y28);
xlabel('time(sec)');
ylabel('value');
subplot(5,2,10), plot(t, y29);
xlabel('time(sec)');
ylabel('value');
% Problem 3 Ending %
%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%
% Problem 4 %
rand_vector3 = randn(1, 5000);
r1 =  rand_vector3;
r2 = sqrt(8) .* rand_vector3;
r3 = sqrt(64) .* rand_vector3;
r4 = sqrt(256) .* rand_vector3;
figure('Name', 'Question4', 'Color', 'Yellow');
subplot(2,2,1), histogram(r1);
xlabel('mean');
ylabel('quantity');
subplot(2,2,2), histogram(r2);
xlabel('mean');
ylabel('quantity');
subplot(2,2,3), histogram(r3);
xlabel('mean');
ylabel('quantity');
subplot(2,2,4), histogram(r4);
xlabel('mean');
ylabel('quantity');
% Problem 4 Ending %
%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%
% Problem 5 %
rand_vector3 = randn(1, 5000);
r6 = 10 + rand_vector3;
r7 = 20 + sqrt(4) .* rand_vector3;
r8 = -10 + rand_vector3;
r9 = -20 + sqrt(4) .* rand_vector3;
figure('Name', 'Question5', 'Color', 'Yellow');
subplot(2,2,1), histogram(r6);
xlabel('mean');
ylabel('quantity');
subplot(2,2,2), histogram(r7);
xlabel('mean');
ylabel('quantity');
subplot(2,2,3), histogram(r8);
xlabel('mean');
ylabel('quantity');
subplot(2,2,4), histogram(r9);
xlabel('mean');
ylabel('quantity');
% Problem 5 Ending %
```

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%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%
% Problem 6 %
rand_vector4 = rand(1, 5000);
r11 = -4 + 8 .* rand_vector4;
r21 = -20 + 40 .* rand_vector4;
figure('Name', 'Question6', 'Color', 'Yellow');
subplot(2,1,1), histogram(r11);
xlabel('mean');
ylabel('quantity');
subplot(2,1,2), histogram(r21);
xlabel('mean');
ylabel('quantity');
% Problem 6 Ending %
%%%%%%%%%%%%%%%%%%%%%%%
```

6. Code of HW1_secondpart:

```
%%%%%%%%%%%%%%%%%%%%%%%
% Problem 7 %
mysignal = load('mysignal.mat'); %loaded the audio data
fftY = fft(mysignal.x); % converted raw data via 'Discrete Fast Fourier Transform'
fftshiftY = fftshift(fftY); % shifted the base value to show the negative parts and the positive parts of the signal as counterparts
n = length(mysignal.x); % found the sample size
f = (-n/2:n/2-1) * (mysignal.fs/n); % created the symmetric frequency axis to plot
power = (abs(fftshiftY) .^2 ) / n; % took the normalized power of signal
figure('Name', 'Question7', 'Color', 'Yellow');
plot(f, power); % plot the signal via freq-power tuples
xlabel('frequency(hz)');
ylabel('power(mW)');
% Problem 7 Ending %
%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%
% Problem 8 %
[favSong, fs] = audioread('slash.mp3'); % loaded the favsong
favSongData = favSong(:,1) + favSong(:,2) ./ 2; % since it is a stereo recorded song, I've taken the average of different signal layers.
n = length(favSongData); % found the sample size
favSongFFT = fft(favSongData); % transformed data under 'Discrete Fast Fourier Transform'
favSongFFTShift = fftshift(favSongFFT); % shifted the FFT data to show the counterparts of each signal
f = (-n/2:n/2-1) * (fs/n); % created the symmetric frequency axis
time = (0:5/n:5-5/n); % created the time axis
power = abs(favSongFFTShift) .^2 / n; % took the normalized power of the signal
figure('Name', 'Favorite Song FFTShift Power-Frequency Plot', 'Color', 'Yellow');
plot(f, power); % plotted the freq-power graph
xlabel('frequency(hz)');
```

```
ylabel('Power(dBm)');
figure('Name', 'Favorite Song Amplitude-Time Plot', 'Color', 'Yellow');
plot(time, favSongData); % plotted the time-amplitude graph
xlabel('time(sec)');
ylabel('Amplitude');
% Problem 8 Ending %
%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%
% Problem 9 %
lena_transform = imread('lena.png'); % read the image as 3D matrix with RGB values.
lena_gray_transform = rgb2gray(lena_transform); % transformed each RGB value into single grayscale value.
lena_mean = mean(lena_gray_transform, 'all'); % took the mean of grayscale matrix
disp("Mean: " + lena_mean);
lena_gray_array = double(lena_gray_transform(:));
lena_standard_deviation = std(lena_gray_array);
disp("Standard deviation: " + lena_standard_deviation);
[MIN, INMIN] = min(lena_gray_transform); % found the minimum value of each column and its indexes
[min, inmin] = min(MIN); % found the overall minimum value and its index
disp("Minimum element value: " + min);
disp("Minimum element position(row, column): " + INMIN(inmin) + " " + inmin);
[MAX, INMAX] = max(lena_gray_transform); % found the maximum value of each column and its indexes
[max, inmax] = max(MAX); % found the overall maximum value and its index
disp("Maximum element value: " + max);
disp("Maximum element position(row, column): " + INMAX(inmax) + " " + inmax);
% Problem 9 Ending %
%%%%%%%%%%%%%%%%%%%%%%%%
```

References:

- For Question 7, I've read the article below:
  https://www.mathworks.com/help/matlab/math/basic-spectral-analysis.html
- For Question 8, I've read the article below:
  https://www.mathworks.com/help/matlab/ref/audioread.html
- For Question 9, I've read the article below:
  https://www.mathworks.com/help/matlab/ref/std.html