**Lab6.m**

%% Q1

% x(k) = {2,1,1,0,1)

N=5; k = 0:N-1;

xk= [2 1 1 0 1];

% a)

% X(r)

Xr = fftshift(fft(xk));

w = -pi:2\*pi/N:pi-2\*pi/N;

subplot(2,1,1),stem(w, Xr);

xlabel('r');

ylabel('X[r]');

title('X[r]');

% X\*[M-r] conjucate of complex x+yj -> x-yj and vise versa

cXr = conj(Xr);

subplot(2,1,2),stem(w, cXr);

xlabel('r');

ylabel('X\*[M-r]');

title('X\*[M-r]');

%they are the same

% Shifted for better observation purpose

Xr = fftshift(fft(xk));

w = -pi:2\*pi/N:pi-2\*pi/N;

subplot(2,1,1),stem(w, Xr);

xlabel('r');

ylabel('X[r]');

title('X[r]');

% X\*[M-r] conjucate of complex x+yj -> x-yj and vise versa

cXr = conj(Xr);

subplot(2,1,2),stem(w, cXr);

xlabel('r');

ylabel('X\*[M-r]');

title('X\*[M-r]');

%they are the same

%% b)

subplot(2,1,1),stem(w, abs(Xr));

xlabel('r');

ylabel('|X[r]|');

title('|X[r]|');

%stem(w, abs(fftshift(xk)))

subplot(2,1,2),stem(w, abs(cXr));

xlabel('r');

ylabel('|X[M-r]|');

title('|X[M-r]|');

%they are the same

%% c)

subplot(2,1,1),stem(w, angle(Xr));

xlabel('r');

ylabel('<X[r]');

title('<X[r]');

subplot(2,1,2),stem(w, -angle(cXr));

xlabel('r');

ylabel('-<X[M-r]');

title('-<X[M-r]');

%they are the same

%% Q2

N1=7; k1=0:N1-1;

x1k = [2 1 0 0 0 0 1];

X1r = fft(x1k);

X1r = fftshift(X1r);

w1 = -pi:2\*pi/N1:pi-2\*pi/N1;

subplot(3,1,1),stem(w1, X1r);

xlabel('r');

ylabel('X1[r]');

title('X1[r]');

N2=5; k2=0:N2-1;

x2k = [5 1 1 1 1];

X2r = fft(x2k);

X2r = fftshift(X2r);

w2 = -pi:2\*pi/N2:pi-2\*pi/N2;

subplot(3,1,2),stem(w2, X2r);

xlabel('r');

ylabel('X2[r]');

title('X2[r]');

N3=6; k3=0:N3-1;

x3k = [1 3 3 0 3 3];

X3r = fft(x3k);

X3r = fftshift(X3r);

w3 = -pi:2\*pi/N3:pi-2\*pi/N3;

subplot(3,1,3),stem(w3, X3r);

xlabel('r');

ylabel('X3[r]');

title('X3[r]');

%% testing

N3=6; k3=0:N3-1;

x3k = [1 3 3 0 3 3];

subplot(2,1,1),stem(x3k);

X3r = fft(x3k, 16);

X3r = fftshift(X3r);

nlen= length(X3r);

w3 = -pi:2\*pi/N3:pi-2\*pi/N3;

subplot(2,1,2),stem(X3r);

N = 10; k = 0:N-1; % set length of DT sequence to N = 10

x = 0.6.\*k; % compute the DT sequence

X = fft(x); % determine the 201-point DFT

X = fftshift(X); % shift the DFT coefficients

w = -pi:2\*pi/N:pi-2\*pi/N; % compute DTFT frequencies

stem(w, X);

%%

%ii

N1=7; k1=0:N1-1;

x1k = [2 1 0 0 0 0 1];

X1r = fft(x1k, 16);

X1r = fftshift(X1r);

w1 = -pi:2\*pi/N1:pi-2\*pi/N1;

subplot(3,1,1),stem(X1r);

xlabel('r');

ylabel('X1[r]');

title('X1[r]');

N2=5; k2=0:N2-1;

x2k = [5 1 1 1 1];

X2r = fft(x2k,16);

X2r = fftshift(X2r);

w2 = -pi:2\*pi/N2:pi-2\*pi/N2;

subplot(3,1,2),stem(X2r);

xlabel('r');

ylabel('X2[r]');

title('X2[r]');

N3=6; k3=0:N3-1;

x3k = [1 3 3 0 3 3];

X3r = fft(x3k,16);

X3r = fftshift(X3r);

w3 = -pi:2\*pi/N3:pi-2\*pi/N3;

subplot(3,1,3),stem(X3r);

xlabel('r');

ylabel('X3[r]');

title('X3[r]');

%% Q3

%% 1)

[cy1,fs1]=audioread('CScale.wav');

[cy2,fs2]=audioread('CScaleZ.wav');

subplot(2,1,1),plot(abs(fftshift(fft(cy1))));

xlabel('t');

ylabel('fft');

title('DFT of Cscale');

subplot(2,1,2),plot(abs(fftshift(fft(cy2))));

xlabel('t');

ylabel('fft');

title('DFT of CscaleZ');

% no,they look the same

[cy,fs]=audioread('Cmajor1.wav');

plot(abs(fftshift(fft(cy))));

y = fft(cy1);

nlen=length(y);

f=(0:1/nlen:1-1/nlen)\*fs1;

plot(f,y);

%% 2

%for Cscale

plot(abs(fftshift(fft(cy1))));

xlabel('t');

ylabel('fft');

title('DFT of Cscale');

%%3

x1 = cy1(1:4000);

x2 = cy1(4001:8000);

x3 = cy1(8001:12000);

x4 = cy1(12001:16000);

x5 = cy1(16001:20000);

x6 = cy1(20001:24000);

x7 = cy1(24001:28000);

x8 = cy1(28001:32000);

subplot(4,2,1),plot(abs(fft(x1)))

title('x1');

subplot(4,2,2),plot(abs(fft(x2)))

title('x2');

subplot(4,2,3),plot(abs(fft(x3)))

title('x3');

subplot(4,2,4),plot(abs(fft(x4)))

title('x4');

subplot(4,2,5),plot(abs(fft(x5)))

title('x5');

subplot(4,2,6),plot(abs(fft(x6)))

title('x6');

subplot(4,2,7),plot(abs(fft(x7)))

title('x7');

subplot(4,2,8),plot(abs(fft(x8)))

title('x8');

%%4

names = {'x1fft' 'x2fft' 'x3fft' 'x3fft' 'x3fft' 'x3fft' 'x3fft' 'x3fft'};

for index = 1 : length(names)

s.(names{index}) = fft(cy1((index-1)\*4000+1:index\*4000), 4000); % Assign index to s.fred, s.sam, and s.al

end

%%5

for i=1:8

xfft = cy1((i-1)\*4000+1:i\*4000);

xfft = fftshift(fft(xfft, 4000));

spect(:,i) =xfft;

end

window\_length = 4000;

spect\_mag=20\*log10(abs(spect));

plot(spect\_mag)

t=(0:window\_length:(length(cy1)-window\_length))/fs1;

f=(1:window\_length)\*fs1/window\_length;

imagesc(t, f, spect\_mag);

axis xy

colormap(jet)

colorbar

%for CscaleZ %%%%%%%%%%%

%2

plot(abs(fftshift(fft(cy2))));

xlabel('t');

ylabel('fft');

title('DFT of Cscale');

%%3

x1 = cy2(1:4000);

x2 = cy2(4001:8000);

x3 = cy2(8001:12000);

x4 = cy2(12001:16000);

x5 = cy2(16001:20000);

x6 = cy2(20001:24000);

x7 = cy2(24001:28000);

x8 = cy2(28001:32000);

subplot(4,2,1),plot(abs(fft(x1)))

title('x1');

subplot(4,2,2),plot(abs(fft(x2)))

title('x2');

subplot(4,2,3),plot(abs(fft(x3)))

title('x3');

subplot(4,2,4),plot(abs(fft(x4)))

title('x4');

subplot(4,2,5),plot(abs(fft(x5)))

title('x5');

subplot(4,2,6),plot(abs(fft(x6)))

title('x6');

subplot(4,2,7),plot(abs(fft(x7)))

title('x7');

subplot(4,2,8),plot(abs(fft(x8)))

title('x8');

%%4

names = {'x1fft' 'x2fft' 'x3fft' 'x3fft' 'x3fft' 'x3fft' 'x3fft' 'x3fft'};

for index = 1 : length(names)

s.(names{index}) = fft(cy2((index-1)\*4000+1:index\*4000), 4000); % Assign index to s.fred, s.sam, and s.al

end

%%5

for i=1:8

xfft = cy2((i-1)\*4000+1:i\*4000);

xfft = fftshift(fft(xfft));

spect(:,i) =xfft;

end

window\_length = 4000;

spect\_mag=20\*log10(abs(spect));

plot(spect\_mag)

t=(0:window\_length:(length(cy2)-window\_length))/fs2;

f=(1:window\_length)\*fs2/window\_length;

imagesc(t, f, spect\_mag);

axis xy

colormap(jet)

colorbar

%% Q4

subplot(2,1,1),spectrogram(cy1, [], fs1, 'yaxis'), title('spectrogram of Cscale.wav');

subplot(2,1,2),spectrogram(cy2, [], fs2, 'yaxis'), title('spectrogram of CscaleZ.wav');