**HW5 MATLAB code**

1.

T = 1/4;

N = 16;

n = 0:N-1;

hn = cos(2\*pi\*n\*T);

wr = ones(1,N);

Hk = fft(hn.\*wr);

W = @(f) exp(1j\*pi\*(N-1)\*T\*f).\*sinc(N\*T\*f)./sinc(T\*f)\*N; % sinc(x)=sin(pi\*x)/(pi\*x) in MATLAB

Hk\_theo = 1/2\*W(n/(N\*T)-1) + 1/2\*W(n/(N\*T)+1);

plot(n,abs(Hk),'o',n,abs(Hk\_theo),'x');

title('Result oh H[k]');

xlabel('k'); ylabel('|H[k]|');

legend('FFT','Theoretical');

A picture containing chart

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2.

%(a)

L = 64;

W = @(w) exp(-1j\*w\*(L-1)/2).\*sin(w\*L/2)./sin(w/2);

fs = 10000;

w = -pi:1/fs:pi;

W\_a = W(w);

figure(1);

plot(w,abs(W\_a));

xlim([-pi pi]);

title('Amplitude of W(e^{j\omega})');

xlabel('\omega'); ylabel('|W(e^{j\omega})|');

grid on

%(b)

A0 = 1;

A1 = 0.75;

theta0 = 0;

theta1 = 0;

w0 = 2\*pi/6;

w1 = 2\*pi/3;

V\_b = A0/2\*exp(1j\*theta0)\*W(w-w0)+A0/2\*exp(-1j\*theta0)\*W(w+w0)+A1/2\*exp(1j\*theta1)\*W(w-w1)+A1/2\*exp(-1j\*theta1)\*W(w+w1);

figure(2);

plot(w,abs(V\_b));

title('Amplitude of V(e^{j\omega}) for \omega\_0 = 2\pi/6 and \omega\_1 = 2\pi/3');

xlabel('\omega'); ylabel('|V(e^{j\omega})|');

xlim([-pi pi]);

grid on

%(c)

w0 = 2\*pi/14;

w1 = 4\*pi/15;

V\_c = A0/2\*exp(1j\*theta0)\*W(w-w0)+A0/2\*exp(-1j\*theta0)\*W(w+w0)+A1/2\*exp(1j\*theta1)\*W(w-w1)+A1/2\*exp(-1j\*theta1)\*W(w+w1);

figure(3);

plot(w,abs(V\_c));

title('Amplitude of V(e^{j\omega}) for \omega\_0 = 2\pi/14 and \omega\_1 = 4\pi/15');

xlabel('\omega'); ylabel('|V(e^{j\omega})|');

xlim([-pi pi]);

grid on

%(d)

w0 = 2\*pi/14;

w1 = 2\*pi/12;

V\_d = A0/2\*exp(1j\*theta0)\*W(w-w0)+A0/2\*exp(-1j\*theta0)\*W(w+w0)+A1/2\*exp(1j\*theta1)\*W(w-w1)+A1/2\*exp(-1j\*theta1)\*W(w+w1);

figure(4);

plot(w,abs(V\_d));

title('Amplitude of V(e^{j\omega}) for \omega\_0 = 2\pi/14 and \omega\_1 = 2\pi/12');

xlabel('\omega'); ylabel('|V(e^{j\omega})|');

xlim([-pi pi]);

grid on

%(e)

w0 = 2\*pi/14;

w1 = 4\*pi/25;

V\_e = A0/2\*exp(1j\*theta0)\*W(w-w0)+A0/2\*exp(-1j\*theta0)\*W(w+w0)+A1/2\*exp(1j\*theta1)\*W(w-w1)+A1/2\*exp(-1j\*theta1)\*W(w+w1);

figure(5);

plot(w,abs(V\_e));

title('Amplitude of V(e^{j\omega}) for \omega\_0 = 2\pi/14 and \omega\_1 = 4\pi/25');

xlabel('\omega'); ylabel('|V(e^{j\omega})|');

xlim([-pi pi]);

grid on

Chart, histogram

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Chart, line chart

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3.

%(a)

N = 64;

A0 = 1;

A1 = 0.75;

w0 = 2\*pi/14;

w1 = 4\*pi/15;

theta0 = 0;

theta1 = 0;

n = 0:N-1;

v = A0\*cos(w0\*n+theta0)+A1\*cos(w1\*n+theta1);

figure(1);

stem(n,v,'.');

title('v[n]');

xlabel('n'); ylabel('Amplitude');

xlim([0 N]);

%(b)

V = fft(v);

figure(2);

stem(n,real(V),'.');

title('Re\{V[k]\}');

xlabel('k,\omegaN/2\pi'); ylabel('Amplitude');

xlim([0 N]);

%(c)

figure(3);

stem(n,imag(V),'.');

title('Im\{V[k]\}');

xlabel('k,\omegaN/2\pi'); ylabel('Amplitude');

xlim([0 N]);

%(d)

figure(4);

stem(n,abs(V),'.');

title('|V[k]|');

xlabel('k,\omegaN/2\pi'); ylabel('Amplitude');

xlim([0 N]);

%(e)

figure(5);

stem(n,angle(V),'.');

title('\angleV[k]');

xlabel('k,\omegaN/2\pi'); ylabel('Radians');

xlim([0 N]);

%(f)

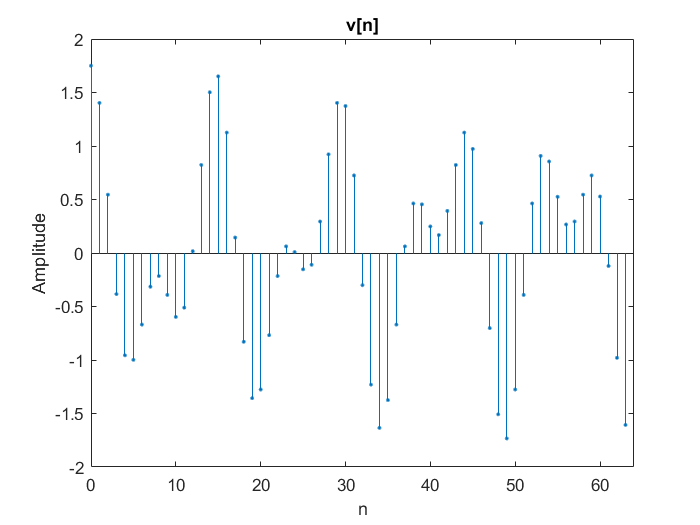
figure(6);

plot((0:1023)\*2\*pi/1024,abs(fft(v,1024)));

title('|V(e^{j\omega})|');

xlabel('\omega'); ylabel('Amplitude');

xlim([0 2\*pi]);

Chart, histogram

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4.

T = 0.1;

N = 32;

n = (0:N-1)';

hn = cos(2\*pi\*n\*T\*1.1) + 0.07\*cos(2\*pi\*n\*T\*2.9);

fs = 1/T;

N\_fft = 256;

f = (-N\_fft/2:N\_fft/2-1)\*fs/N\_fft;

w\_r = rectwin(N);

H = fft(hn.\*w\_r);

figure(1);

stem(n,abs(H),'.');

title('Amplitude of H[k]');

xlabel('k'); ylabel('|H[k]|');

figure(2);

plot(f,abs(fftshift(fft(hn.\*w\_r,N\_fft))));

title('Amplitude of H[k]');

xlabel('f'); ylabel('|H[k]|');

w\_hm = hamming(N);

figure(3);

subplot(2,2,1);

stem(n,hn,'.');

title('h[n]');

xlabel('n'); ylabel('h[n]');

subplot(2,2,2);

stem(n,w\_hm,'.');

title('w\_{hm}[n]');

xlabel('n'); ylabel('w\_{hm}[n]');

subplot(2,2,3:4);

stem(n,hn.\*w\_hm,'.');

title('h[n]w\_{hm}[n]');

xlabel('n'); ylabel('h[n]w\_{hm}[n]');

H = fft(hn.\*w\_hm);

figure(4);

stem(n,abs(H),'.');

title('Amplitude of H[k]');

xlabel('k'); ylabel('|H[k]|');

figure(5);

plot(f,abs(fftshift(fft(hn.\*w\_hm,N\_fft))));

title('Amplitude of H[k]');

xlabel('f'); ylabel('|H[k]|');

w\_b = blackman(N);

figure(6);

subplot(2,2,1);

stem(n,hn,'.');

title('h[n]');

xlabel('n'); ylabel('h[n]');

subplot(2,2,2);

stem(n,w\_b,'.');

title('w\_b[n]');

xlabel('n'); ylabel('w\_b[n]');

subplot(2,2,3:4);

stem(n,hn.\*w\_b,'.');

title('h[n]w\_b[n]');

xlabel('n'); ylabel('h[n]w\_b[n]');

H = fft(hn.\*w\_b);

figure(7);

stem(n,abs(H),'.');

title('Amplitude of H[k]');

xlabel('k'); ylabel('|H[k]|');

figure(8);

plot(f,abs(fftshift(fft(hn.\*w\_b,N\_fft))));

title('Amplitude of H[k]');

xlabel('f'); ylabel('|H[k]|');

(a)

Chart, histogram

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(b)

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(c)

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6.

f1 = 1\*10^3;

f2 = 1.01\*10^3;

fs = 2500;

T = 1/fs;

N = 1000;

n = 0:N-1;

vn = cos(2\*pi\*f1\*n\*T)+cos(2\*pi\*f2\*n\*T);

N\_fft = 2^nextpow2(N);

V = fft(vn,N\_fft);

figure(1);

stem(0:N\_fft-1,abs(V),'.');

title('DFT of v[n] (N=1000,f\_s=2500Hz)');

xlabel('k'); ylabel('V[k]');

N\_fft = 16\*2^nextpow2(N);

V = fft(vn,N\_fft);

figure(2);

plot((-N\_fft/2:N\_fft/2-1)\*fs/N\_fft,abs(fftshift(V)));

title('DTFT of v[n] (N=1000,f\_s=2500Hz)');

xlabel('f'); ylabel('V(f)');

w = bartlett(N)';

V\_b = fft(vn.\*w,N\_fft);

figure(3);

stem(0:N\_fft-1,abs(V\_b),'.');

title('DFT of v[n] with Bartlett window (N=1000,f\_s=2500Hz)');

xlabel('k'); ylabel('V[k]');

V\_b = fft(vn.\*w,N\_fft);

figure(4);

plot((-N\_fft/2:N\_fft/2-1)\*fs/N\_fft,abs(fftshift(V\_b)));

title('DTFT of v[n] with Bartlett window (N=1000,f\_s=2500Hz)');

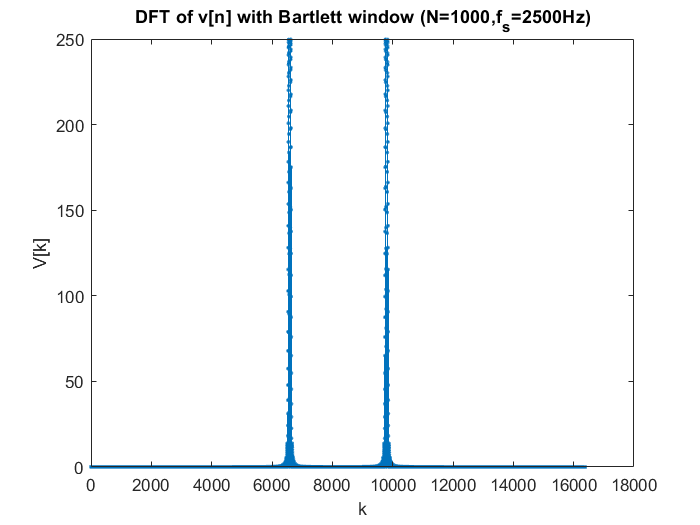
xlabel('f'); ylabel('V(f)');

Chart, bubble chart

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Chart

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Chart, histogram

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