Lab 4. Discrete Time Fourier Transform

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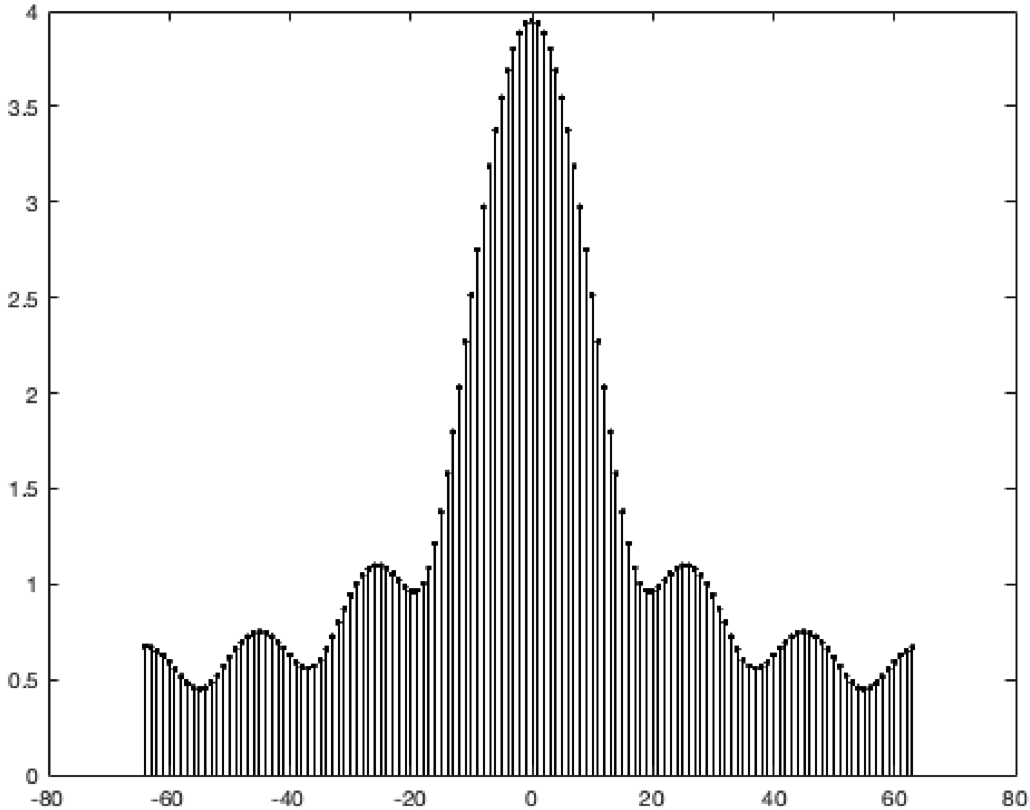
A. Discrete-TimeFourierTransform(DTFT)

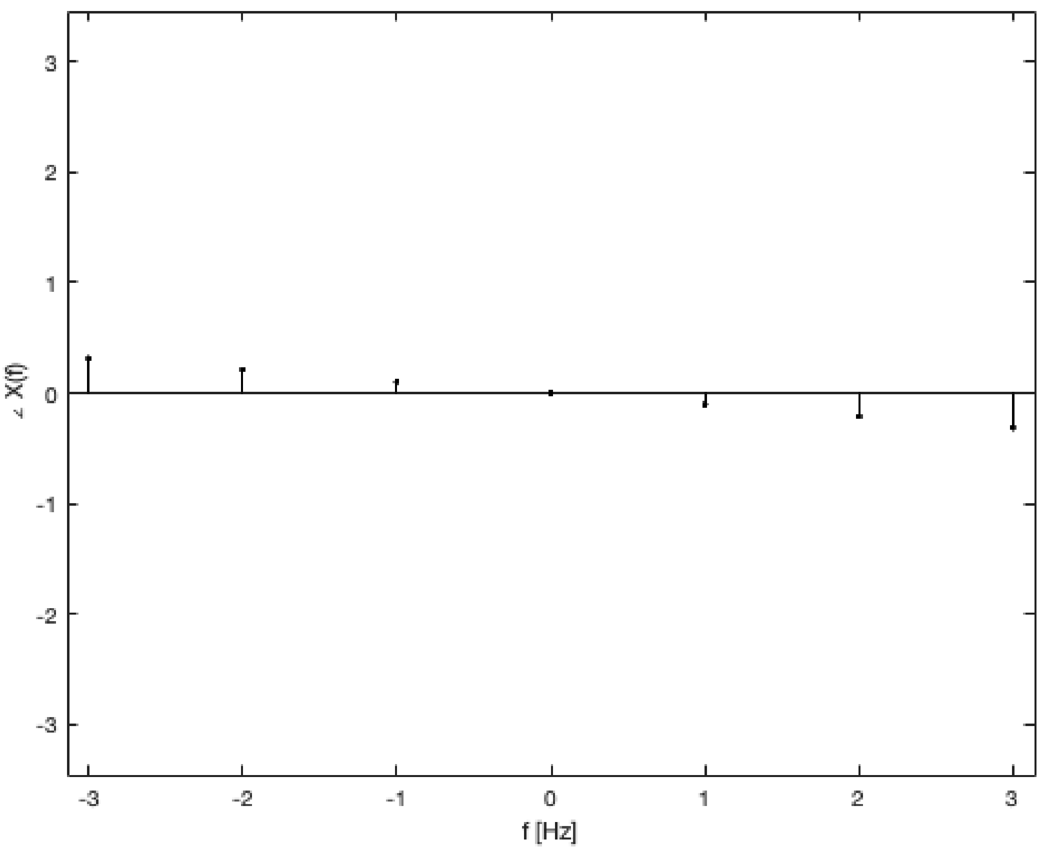
1.

```
N_0 = 128; T = 1/128; n = (0:N_0-1);
x = (0.8.^n).*(1.0.*(n>=0 & n < 7));clc
X = fft(x);

f = (0:N_0-1)/(T*N_0); stem(f,abs(X),'k.');
axis([0 50 0 5]); xlabel('f [Hz]'); ylabel('|X(f)|');

stem(f-1/(T*2),fftshift(abs(X)),'k.');
```



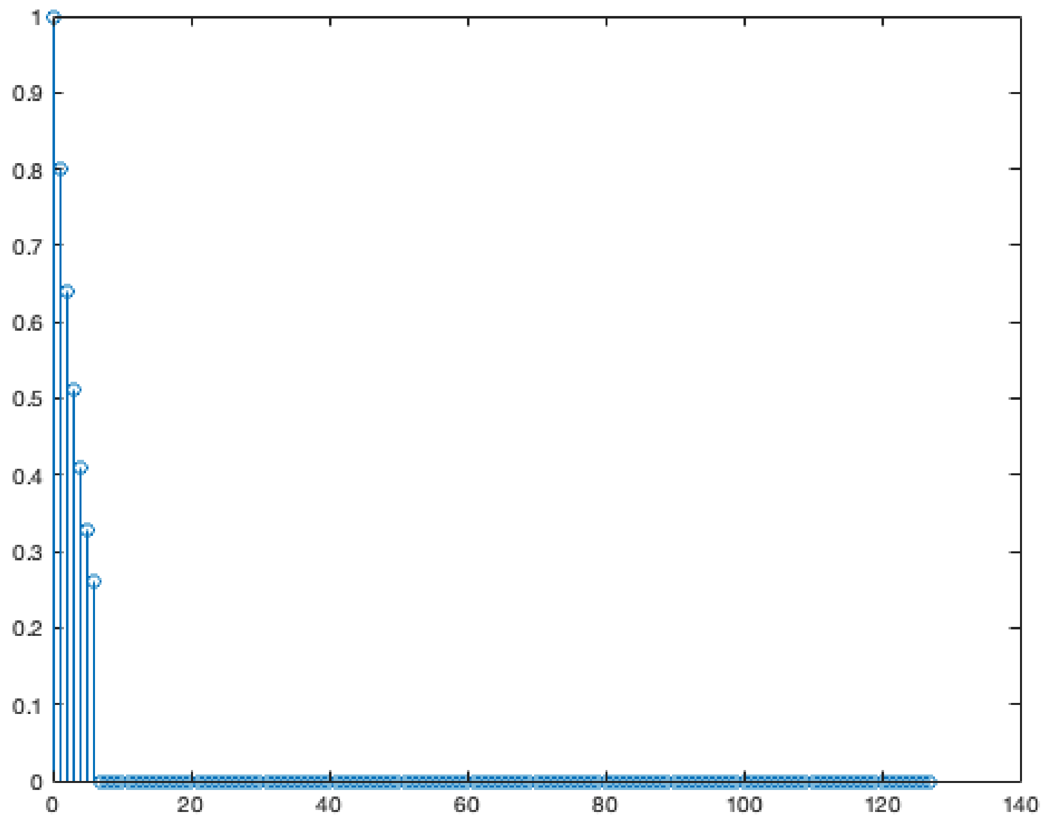
2.

```
stem(f-1/(T*2),fftshift(angle(X)),'k.');
axis([-pi pi -1.1*pi 1.1*pi]); xlabel('f [Hz]'); ylabel('\angle X(f)');
```



3.

```
x_2 = ifft(X);
stem(n,x_2);


% Yes the signal is the same because we are taking the inverse fourier
% transform
```

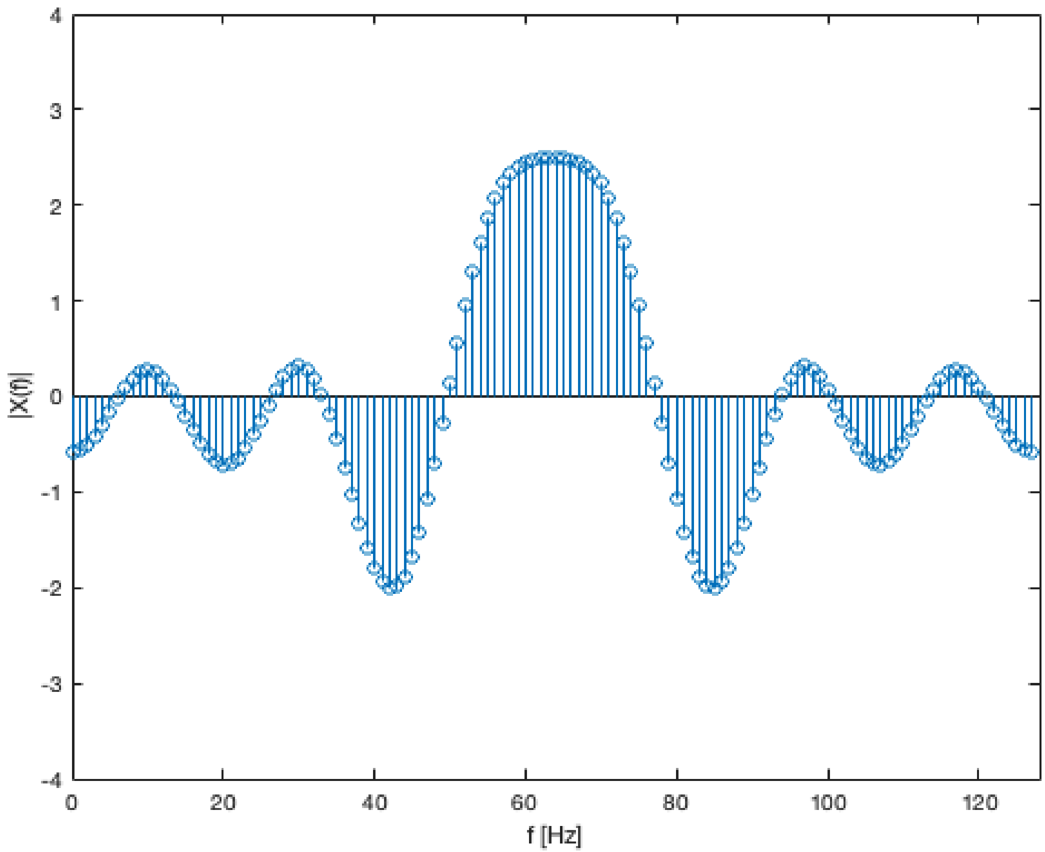


B. TimeConvolution

1.

```
x_1 = sin(2*pi*n/10).*(1.0.*(n>=0 & n < 7));

omega= linspace(-pi,pi,128);
W_omega = exp(-1i).^((0:length(x_1)-1)'*omega);
CONV = (x_1*W_omega);

stem(n,CONV);
axis([0 128 -4 4]); xlabel('f [Hz]'); ylabel('|X(f)|');
```

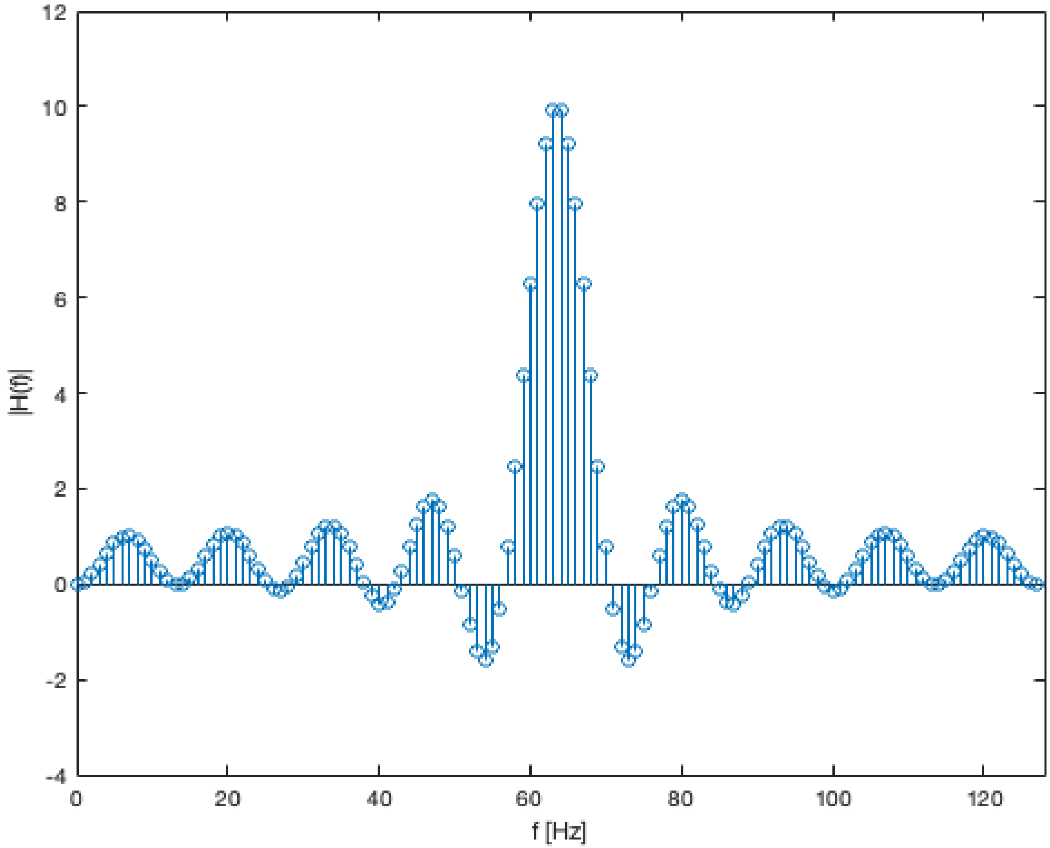
Warning: Using only the real component of complex data.



2.

```
h = 1.0.*(n>=0 & n<10);

W_omega2 = exp(-1i).^((0:length(h)-1)'*omega);
CONV_2 = (h*W_omega);
stem(n,CONV_2);
axis([0 128 -4 12]); xlabel('f [Hz]'); ylabel('|H(f)|');
```

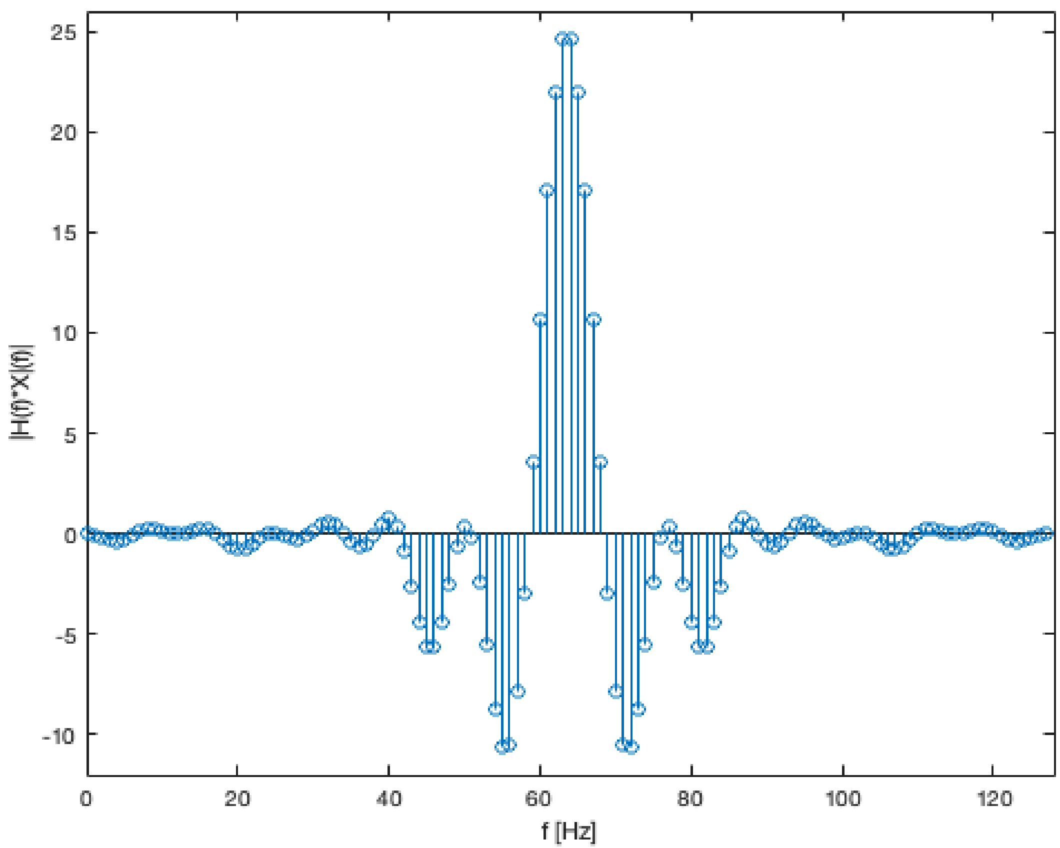
Warning: Using only the real component of complex data.



3.

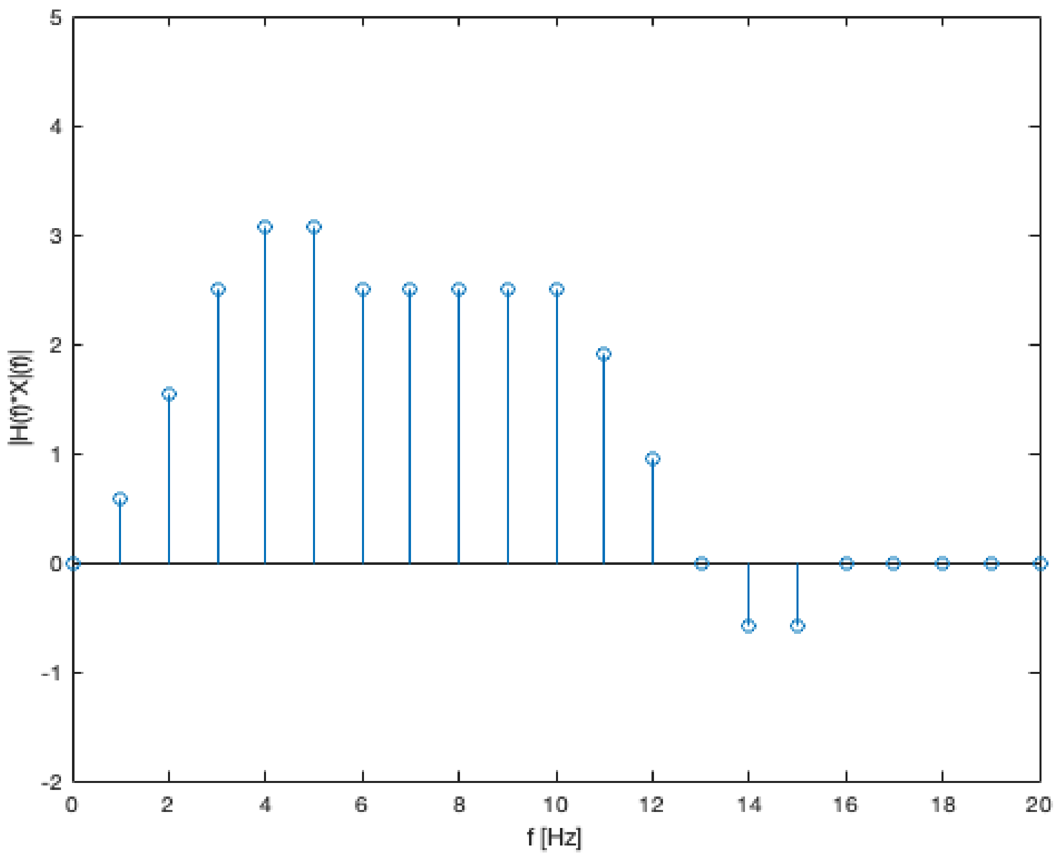
```
CONV_3 = (CONV.*CONV_2);

stem(n,CONV_3);
axis([0 128 -12 26]); xlabel('f [Hz]'); ylabel('|H(f)*X|(f)|');
```

Warning: Using only the real component of complex data.



4.

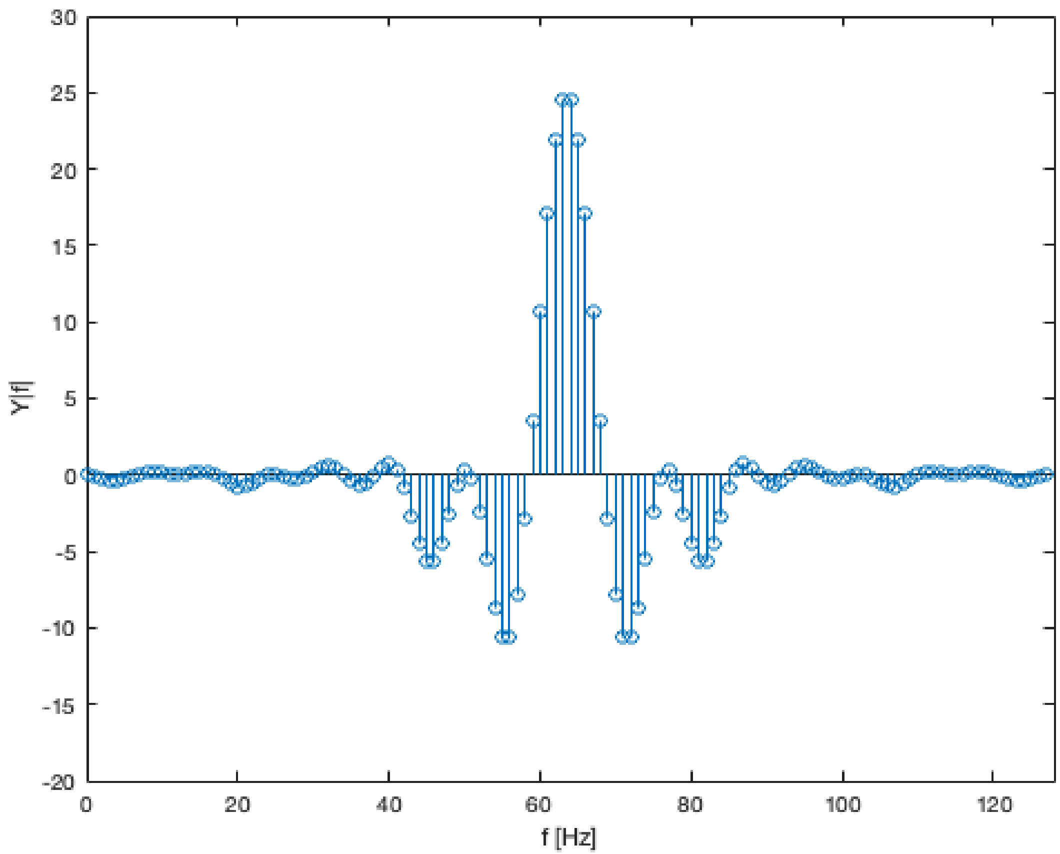
```
n = (0:254);
y = conv(x_1,h);

stem(n,y);
axis([0 20 -2 5]); xlabel('f [Hz]'); ylabel('|H(f)*X|(f)|');
```



5.

```
W_omega3 = exp(-1i).^((0:length(y)-1)'*omega);
y_dtft = (y*W_omega3);
n = 0:127;

stem(n,y_dtft);
axis([0 128 -20 30]); xlabel('f [Hz]'); ylabel('Y|f|');
```

Warning: Using only the real component of complex data.

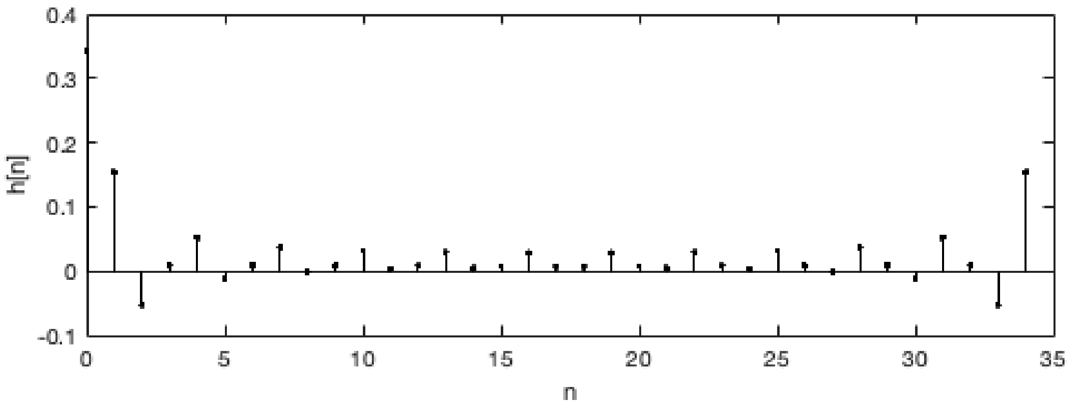


6. Yes the results of 3 and 5 are the same. This is because in 3 we first turned the x and h from time to frequency domain and did multiplicaiton and in 5 we did convulation of the result y.

C. FIR Filter Design by Frequency Sampling

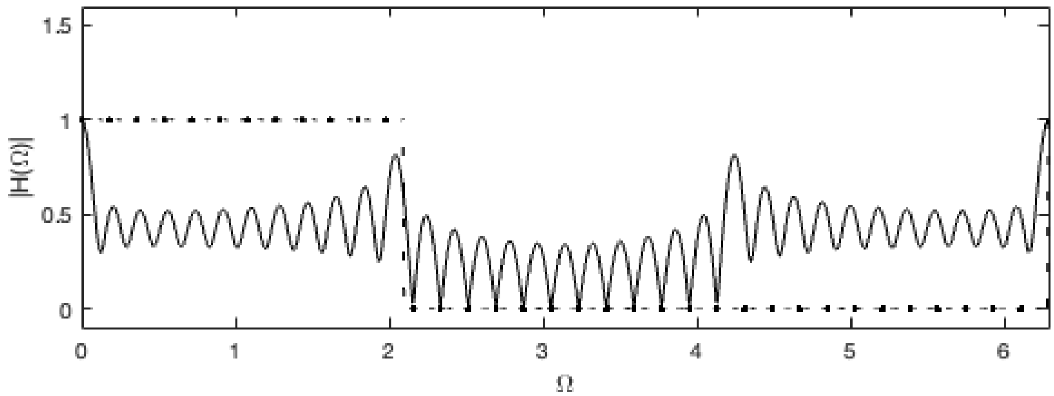
1.

```
H_d = @(Omega) (mod(Omega,2*pi)<2*pi/3)+(mod(Omega,2*pi/3)>2*pi-2*pi/3);
N = 35;


h = CH9MP1(N,H_d);
Omega = linspace(0,2*pi,1000); samples = linspace(0,2*pi*(1-1/N),N);
H = CH5MP1(h,1,Omega);


subplot(2,1,1); stem([0:N-1],h,'k.'); xlabel('n'); ylabel('h[n]');
```



2.

```
plot(samples,H_d(samples),'k.',Omega,H_d(Omega),'k:',Omega,abs(H),'k');
axis([0 2*pi -0.1 1.6]); xlabel('\Omega'); ylabel('|H(\Omega)|');
```

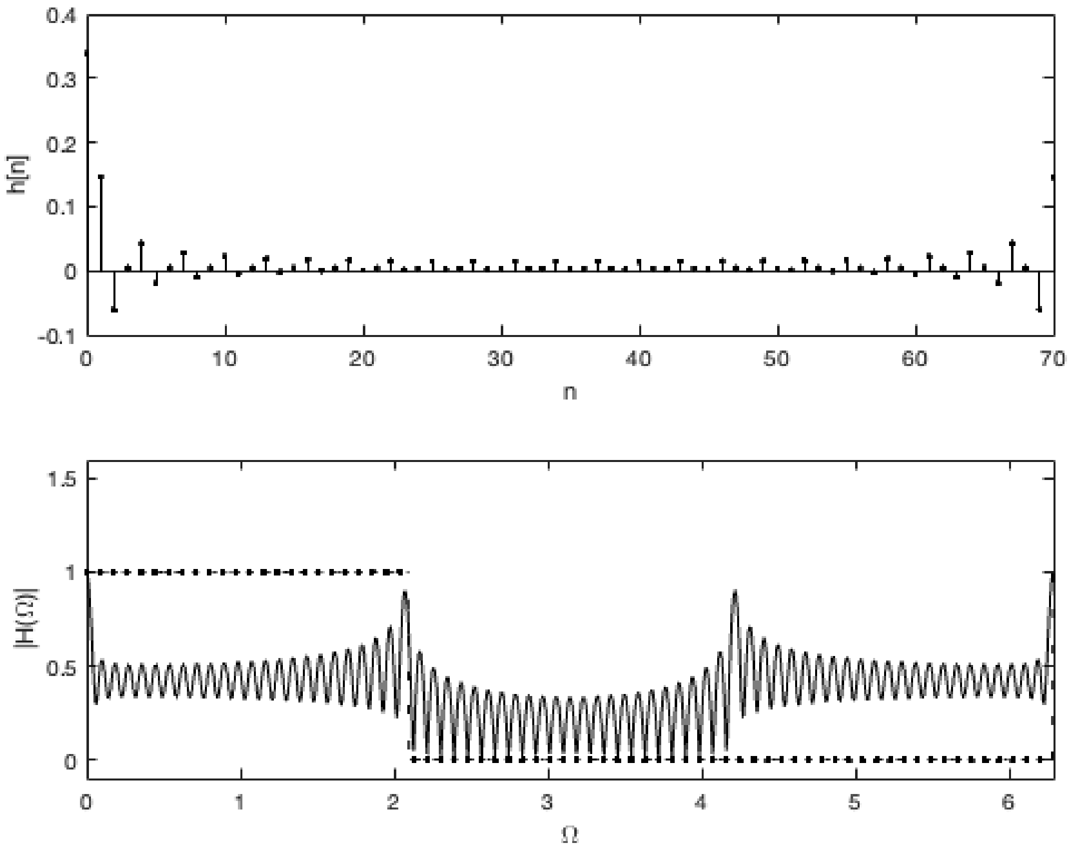


3.

```
% The results are pretty similar
```

4.

```
H_d = @(Omega) (mod(Omega,2*pi)<2*pi/3)+(mod(Omega,2*pi/3)>2*pi-2*pi/3);
N = 71;


h = CH9MP1(N,H_d);
Omega = linspace(0,2*pi,1000); samples = linspace(0,2*pi*(1-1/N),N);
H = CH5MP1(h,1,Omega);


subplot(2,1,1); stem([0:N-1],h,'k.'); xlabel('n'); ylabel('h[n]');
subplot(2,1,2);
plot(samples,H_d(samples),'k.',Omega,H_d(Omega),'k:',Omega,abs(H),'k');
axis([0 2*pi -0.1 1.6]); xlabel('\Omega'); ylabel('|H(\Omega)|');
```



5.

```
% With the number increase the length of filter increases too
```

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