(SCHOOL OF ELECTRONICS AND COMMUNICATION ENGINNERING)

TASK-3

DIGITAL SIGNAL PROCESSING

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OBJECTIVE: To compute the discrete Fourier Transform without using inbuilt function. Also check the same using in built fft function. Also plot its spectrum.

Q.1) (a). Write a MATLAB Program to compute the discrete Fourier Transform without using inbuilt function. Also check the same using in built fft function. Also plot its spectrum.

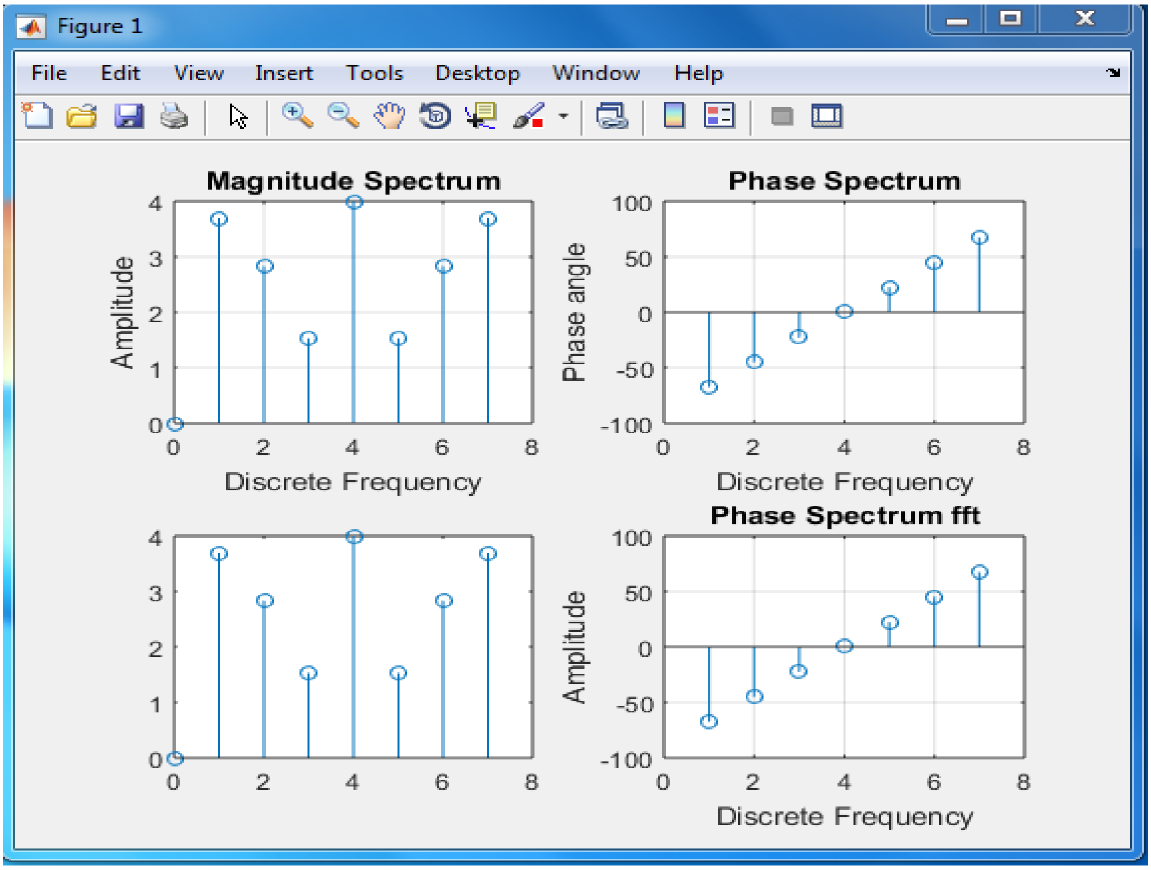
X(n)= {1,-1,-1,-1,1,1,1,-1}

Code:

```
clc;
close all;
clear all;
x=input('Enter the sequence x=');
N=input('Enter the length of the DFT N=');
len=length(x);
if N>len
    x=[x zeros(1,N-len)];
else
    x=x(1:N);
end
i=sqrt(-1);
w=exp(-i*2*pi/N);
n=0:(N-1);
k=0:(N-1);
nk=n'*k;
W=w.^nk;
X=x*W;
disp(X);
subplot(2,2,1);
stem(k,abs(X));
title('Magnitude Spectrum');
xlabel('Discrete Frequency');
```

```
ylabel('Amplitude');
grid on;
subplot(2,2,2);
stem(k,atand(imag(X)./real(X)));
title('Phase Spectrum');
xlabel('Discrete Frequency');
ylabel('Phase angle');
grid on;
Y=fft(x,N);
subplot(2,2,3);
title('Magnitude Spectrum fft');
xlabel('Discrete Frequency');
ylabel('Amplitude');
grid on;
stem(k,abs(Y));
subplot(2,2,4);
stem(k,atand(imag(X)./real(X)));
title('Phase Spectrum fft');
xlabel('Discrete Frequency');
ylabel('Amplitude');
grid on;
```

Output waveform



OBJECTIVE: Write a MATLAB program to generate 10Hz, 30 Hz, and 50 Hz sinusoidal signals.

Design a Low Pass Butterworth Filter to pass only 10Hz signal.

Design a high pass Butterworth Filter to pass only 50 Hz signal.

Q 1. (b) Write a MATLAB program to generate 10Hz, 30 Hz, and 50 Hz sinusoidal signals. Add all the signals and generate the spectrum.

i) Design a Low Pass Butterworth Filter to pass only 10Hz signal. Plot the magnitude spectrum of the signal obtained at the output of the filter.

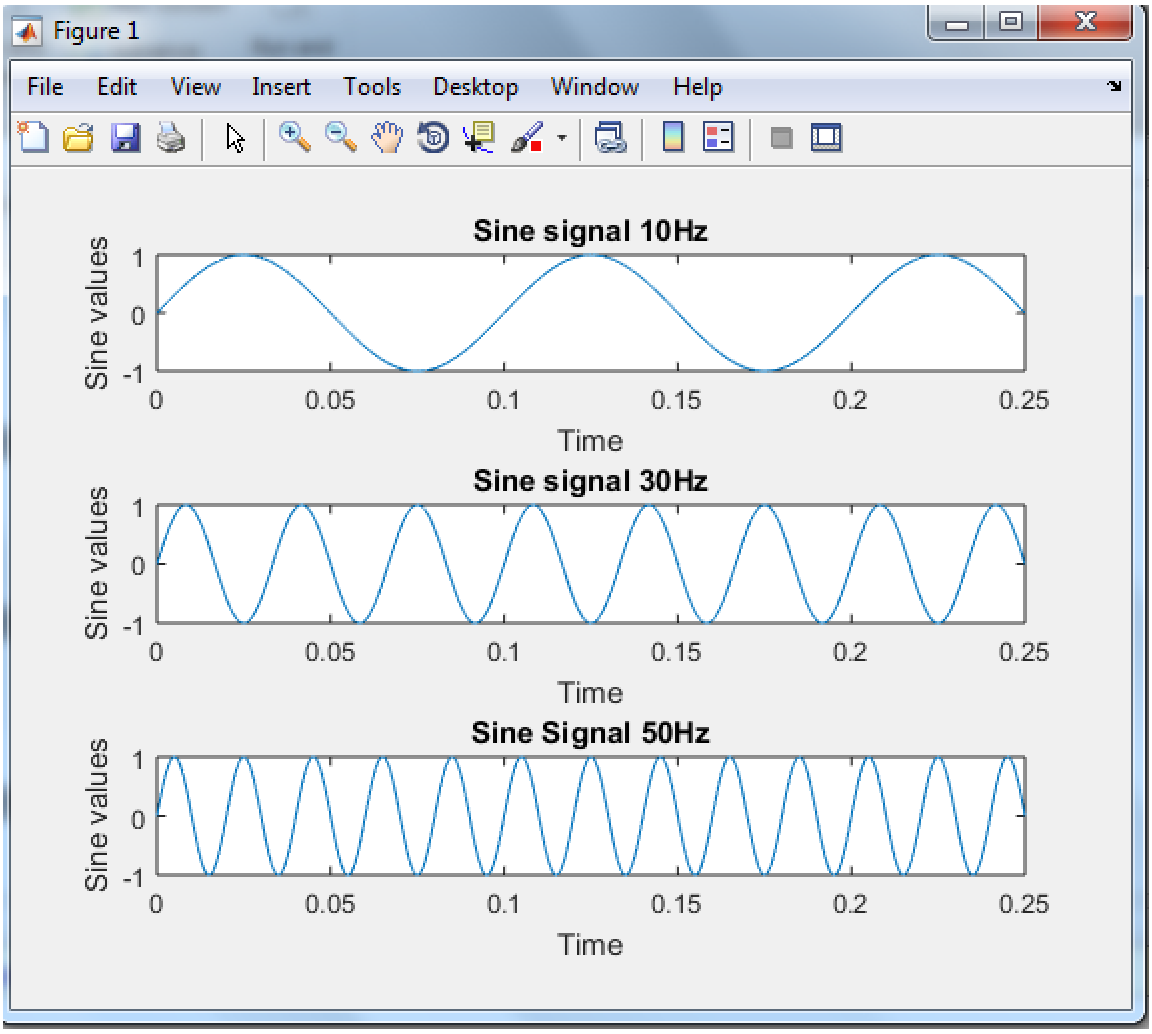
ii) Design a high pass Butterworth Filter to pass only 50 Hz signal. Plot the magnitude spectrum of the signal obtained at the output of the filter.

Code

```
clc
close all
clear all
fs=30000;
t=0:1/fs:0.25;
x=sin(2*pi*10*t);
y=sin(2*pi*30*t);
z=sin(2*pi*50*t);
figure
subplot(3,1,1);
plot(t,x);
title('Sine signal 10Hz')
xlabel('Time')
ylabel('Sine values')
subplot(3,1,2);
plot(t,y);
title('Sine signal 30Hz')
xlabel('Time')
ylabel('Sine values')
subplot(3,1,3);
plot(t,z);
title('Sine Signal 50Hz')
```

```
xlabel('Time')
ylabel('Sine values')
```

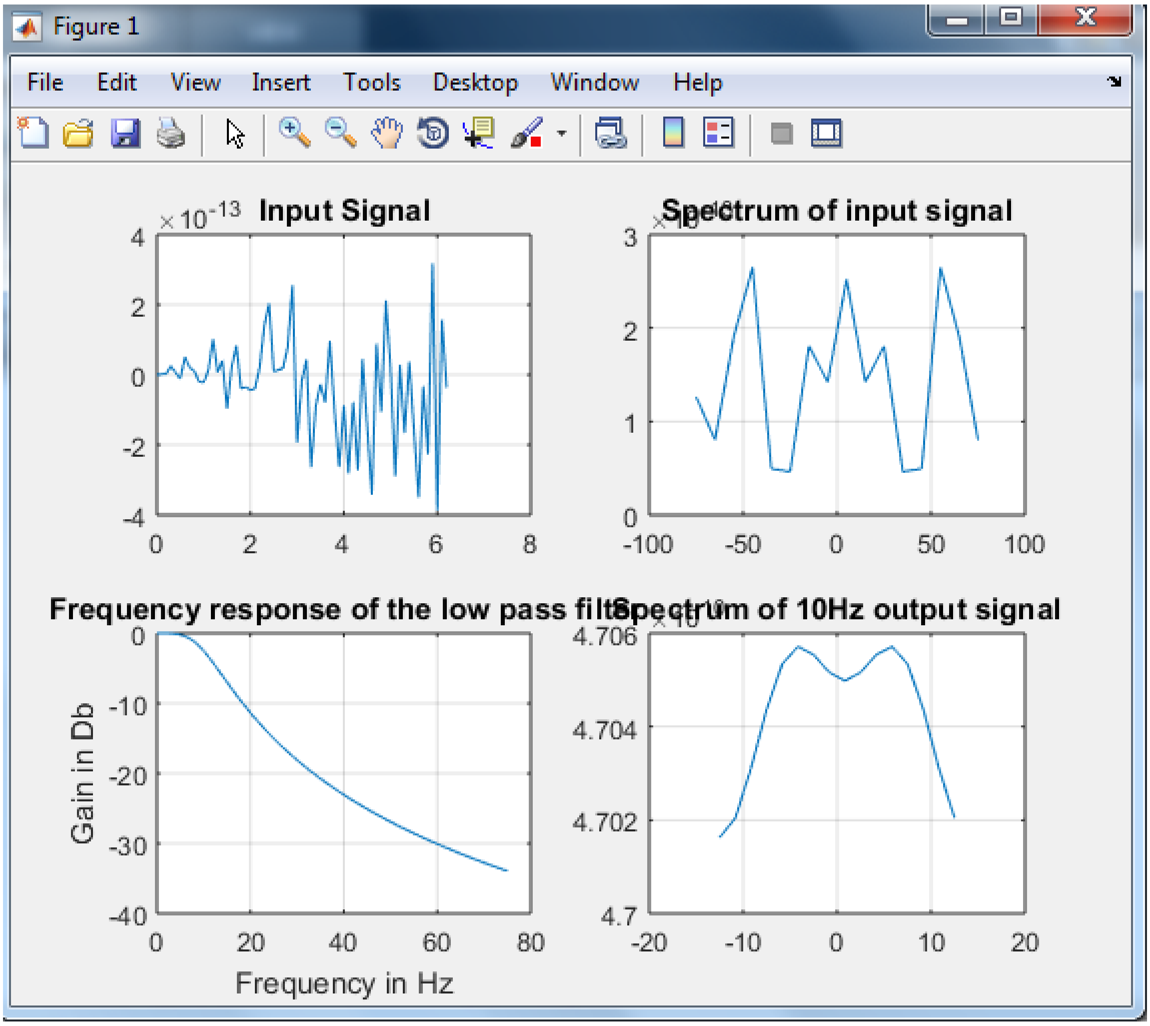
OUTPUT WAVEFORM



B (i)

```
clc
close all
clear all
fs=150;
t=[0:0.1:2*pi]
x=sin(2*pi*10*t)+sin(2*pi*30*t)+sin(2*pi*50*t);
subplot(2,2,1);
plot(t,x);
grid on;
title('Input Signal');
N=16;
y=abs(fft(x,N));
f=linspace(-fs/2,fs/2,N);
subplot(2,2,2);
plot(f,y);
grid on;
title('Spectrum of input signal');
fp=5;fs=25;ap=1;as=15;
wp=2*pi*fp;ws=2*pi*fs;
[N,wn]=buttord(wp,ws,ap,as,'s')
[b,a]=butter(N,wn,'s');
w=0:(3*ws)/511:3*ws;
h=freqs(b,a,w);
subplot(2,2,3);
plot(w/(2*pi),20*log10(abs(h)));grid on;
title('Frequency response of the low pass
filter');
xlabel('Frequency in Hz');
ylabel('Gain in Db');
out=filter(b,a,x)
N=16;
z=abs(fft(out,N));
f=linspace(-fs/2,fs/2,N);
subplot(2,2,4);
plot(f,z);
grid on;
title('Spectrum of 10Hz output signal');
```

OUTPUT WAVEFORM



ii. Design a high pass Butterworth Filter to pass only 50 Hz signal. Plot the magnitude spectrum of the signal obtained at the output of the filter

CODE:

```
fp=60; fst=40, ap=.5, as=25

wp=2*pi*fp/fs; ws=2*pi*fst/fs;

[N,wn]=buttord(wp,ws,ap,as,'s')
```

```
[bt,at]=butter(N,wn,'s')

[b,a]=lp2hp(bt,ap,2*pi*50

W=0:(3*ws)/511:3*ws;

H=freqs(b,a,w);

subplot(2,2,3)

plot(w/(2*pi),20*log10(abs(h))); grid on;

title('frequency response of high pass
filter');

xlabel('frequency in Hz'); ylabel('gain in
db');

out=filter(b,a,x)

N=16

Z=abs(fft(out,N));

f=linspace(-fs/2,fs/2,N);

subplot(2,2,4);

plot(f,z); grid on;

title('spectrum of 50Hz output signal');
```

OUTPUT

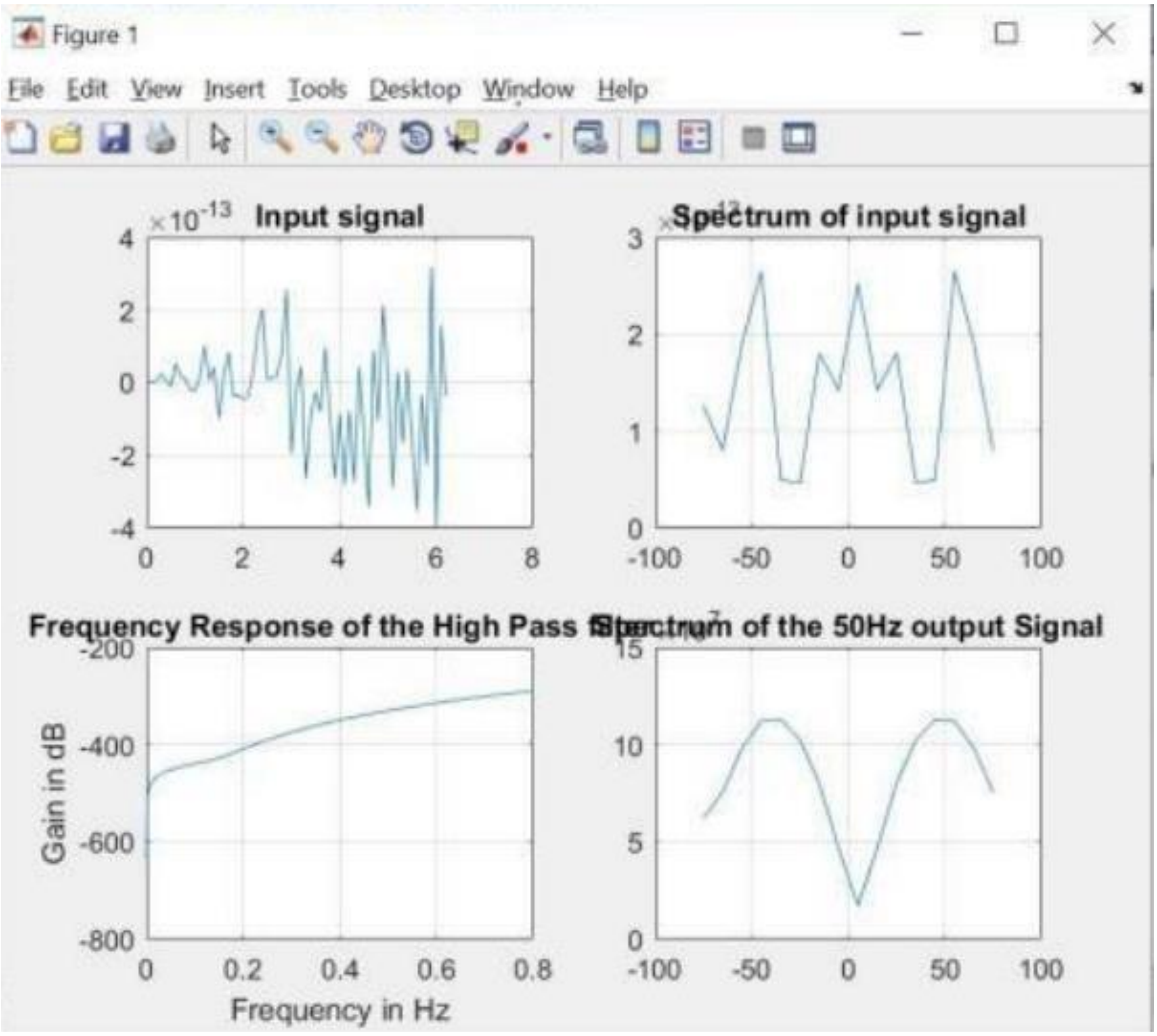


Figure 1
File Edit View Insert Tools Desktop Window Help
Input signal
×10^-13
Spectrum of input signal
Frequency Response of the High Pass filter
Spectrum of the 50Hz output Signal
Gain in dB
Frequency in Hz

ATTESTATION

[illegible]

Task-3

(a) Write a Matlab program to compute discrete fourier transform without using in-built function. Also check same for in-built fft fourier transform

~~(b) Write a Matlab program to generate 10Hz, 30Hz & 50Hz sinusoidal signals. Add all the signals~~

$x(n) = \{1, -1, -1, -1, 1, 1, 1, -1\}$

$$X(K) = \sum_{n=0}^{N-1} x(n) e^{-j\left(\frac{2\pi}{N}\right)Kn} \quad \text{where } K = 0, 1, \ldots N-1$$

$$= \sum_{n=0}^{N-1} x(n) \cdot e^{-j\left(\frac{2\pi}{8}\right)Kn}$$

$$= \sum_{n=0}^{N-1} x(n) \cdot e^{-j(\pi/4)(Kn)}$$

$$= x(0) \cdot e^{-j0} + x(1) e^{-jK\pi/4} + x(2) e^{-jK\pi/2}$$

$$+ x(3) e^{-jK3\pi/4} + x(4) e^{-jK\pi} + x(5) e^{-jK5\pi/4}$$

$$+ x(6) \cdot e^{-jK3\pi/2} + x(7) e^{-jK7\pi/4}$$

[illegible]

K=0

$X(0) = x(0) + x(1) + x(2) \ldots x(7) = 0$

$K=1$; $X(1) = 1 + (-1)$

$X(K) = 1 + \left(-\cos\frac{K\pi}{4}\right) - \cos\left(\frac{K\pi}{2}\right) - \cos\frac{3K\pi}{4}$

$+ \cos K\pi + \cos\frac{5K\pi}{4} + \cos\frac{3K\pi}{2} - \cos\frac{7K\pi}{4}$

$+ j\left(-\sin\frac{K\pi}{4} - \sin\left(\frac{K\pi}{2}\right) - \sin\left(\frac{3K\pi}{4}\right) + \sin K\pi\right.$

$\left. + \sin\frac{5K\pi}{4} + \sin\frac{3K\pi}{2} - \sin\frac{7K\pi}{4}\right)$

$\{0, -\sqrt{2}+(2+\sqrt{2})j, 2-2j, \sqrt{2}(2+\sqrt{2})j, 4, \sqrt{2}(2+\sqrt{2})j, 2, -\sqrt{2}+(2+\sqrt{2})j\}$

$-2j$

Output

o/p 0.0+0.0j, -1.4142+3.4142i, 2-2j, 1.4142-0.5858i, 4, 1.4142+0.5858i, 2+2i, -1.4142-3.4142j

Verified

P.R.

Task-3

Write a matlab code to generate 10Hz, 30Hz & 50Hz sinusoidal signal. Add all the signals & generate spectrum

i) Design low-pass butterworth filter to pass only 10Hz signal. Plot magnitude of spectrum signal obtained at output of filter

$H(z) = \frac{b}{a}$

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ii) ~~Write~~ Design a high pass-butterworth filter to pass only 50Hz signal. Plot the magnitude spectrum of signal obtained at output of filter.

Verified
27/2/19.

$\omega = 2\pi f_c / f_s$

$2\pi\, 50/150 =$

INFERENCE

Hence by the codes and manual calculation lowpass and high pass filters can be designed. Other signals were also generated