EXPERIMENT NO 1

Aim: To study the basic (DT) signal operations in MATLAB software.

Code :

```
clc;

clear all;

close all;

Sn = input ('Enter the signal:');

L = length (Sn);

x = 0:L-1;

subplot (3,2,1);

stem (x, Sn);

title('Discrete Time Signal x(n)');

a = input('Enter advance value of signal :');

Sa= [Sn, zeros(1, a)];

xa = -a:L-1;

subplot (3,2,2);

stem (xa, Sa);

title('Advance x(n+a): ');

d=input('Enter delay value of signal: ');

Sd = [zeros(1,d), Sn];

xd = 0:L-1+d;

subplot (3,2,3);

stem (xd, Sd);

title ('Delay x(n-a);');

c=2;

Sc= x/c;

xc= 0:L-1;

subplot (3,2, 4);

title('Compressed signal')

stem (xc, Sc);
```

```
Sc = x.*c

xc= 0:L-1;

subplot (3,2, 5);

title('expanded signal')

stem (xc,Sc);

ad= x+c

xc= 0:L-1;

sb= x-c

xc= 0:L-1;
```

EXPERIMENT NO. :- 2

Aim: - To study the linear convolution y(n) of the given input sequence x(n) and impulse response h(n).

Code :

```
clc;
clear all;
close all;
Xn = input ('Enter the signal X(n) ');
Hn = input ('Enter the signal H(n) ');
L = length (Xn);
M = length (Hn);
N = L+M-1;
xn=[Xn , zeros(1,N-L)];
hn=[Hn , zeros(1,N-M)];
X1k = fft (xn)
H1k = fft (hn)
Yk = X1k.*H1k
yn= ifft (Yk)
Y1n = conv (Xn, Hn)
```

<u>EXPERIMENT NO. : 03</u>

Aim :- To study overlap save method of filtering of long data sequence.

Code :

```
clc
clear all;
close all;

Xn = [3,-1,0,1,3,2,0,1,2];
hn = [1,1,1];
l = 3;
m = 3;
n = l+m-1;

%Overlap Save.

disp('Overlap Save Method.');
x1 = [0,0,3,-1,0];
x2 = [-1,0,1,3,2];
x3 = [3,2,0,1,2];
x4 = [1,2,0,0,0];

z = [1,1,1,0,0];
Hn = [z;circshift(z,[0 1]);
    circshift(z,[0 2]);
```

```
        circshift(z,[0 3]);
        circshift(z,[0 4])]
h1 = Hn.'

y1 = h1*x1'
y2 = h1*x2'
y3 = h1*x3'
y4 = h1*x4'

yn = [y1(3:5)', y2(3:5)', y3(3:5)', y4(3:5)']
```

EXPERIMENT NO. : 04

Aim :- To study overlap add method of filtering of long data sequence.

Code :

```
clc
clear all;
close all;

Xn = [3,-1,0,1,3,2,0,1,2];
hn = [1,1,1];
l = 3;
m = 3;
n = l+m-1;

%Overlap Add.

disp('Overlap Add Method.');
```

```
x1 = [3,-1,0,zeros(1,(m-1))];

x2 = [1,3,2,zeros(1,(m-1))];

x3 = [0,1,2,zeros(1,(m-1))];


H=[1,1,1,zeros(1,(m-1))];


hm = [H;circshift(H,[0 1]);

      circshift(H,[0 2]);

      circshift(H,[0 3]);

      circshift(H,[0 4])]

hm1 = hm.'


y1 = hm1*x1'

y2 = hm1*x2'

y3 = hm1*x3'


yn = [y1', y2', y3']
```

EXPERIMENT NO.5

Aim: Design a digital low pass IIR Butterworth filter using MATLAB.

Code :

```
clc
clear all;
close all;

fp = 4000;
fs = 8000;
fsamp = 24000;
rp = 0.108;
rs = 0.01;
w = 0:0.01:pi;
T = 1/fsamp;

wp = (2*pi*fp)/fsamp;
ws = (2*pi*fs)/fsamp;

Wp = (2/T)*tan(wp/2);
Ws = (2/T)*tan(ws/2);

Ap = -20*log(1-rp);
As = -20*log(rs);

[n,W] = buttord(Wp,Ws,Ap,As,'s')
[ns,ds] = butter(n,Ws,'s');

[z,p,k] = tf2zp(ns,ds);
subplot(3,1,1); zplane(z,p)
title('Pole-Zero Plot.')

HS = tf(ns,ds);

[nz,dz] = bilinear(ns,ds,fsamp);
HZ = tf(nz,dz,fsamp,'variable','z^-1')
HW = freqz(nz,dz,w);

a = abs(HW);
subplot(3,1,2); plot(a)
title('Magnitude Plot.'); xlabel('Frequency.'); ylabel('Magnitude.')

b = angle(HW);
subplot(3,1,3); plot(b)
title('Phase Plot.'); xlabel('Frequency.'); ylabel('Phase.')
```

EXPERIMENT NO.6

Aim: To implement FIR filter using window technique.

Code :

```
clc
clear all;
close all;

rp = 0.03;
rs = 0.01;
fp = 1400;
fs = 2000;
fsamp = 8000;

wp = 2*(fp/fsamp);
ws = 2*(fs/fsamp);
w = 0:0.01:pi;

nr = 20*log(sqrt(rp*rs))-13;
dr = 14.6*((fp-fs)/fsamp);
n = nr/dr;
n = ceil(n)
N = n+1;

%Hamming Window.
y1 = hamming(N);
subplot(6,3,1); plot(y1)
title('Hamming Window.'); xlabel('N'); ylabel('Magnitude')
h = fir1(n,wp,y1);
H1 = freqz(h);
M1 = abs(H1);
subplot(6,3,2); plot(M1)
title('Magnitude Plot of Hamming Window.'); xlabel('Frequency'); ylabel('Magnitude')
P1 = angle(H1);
subplot(6,3,3); plot(P1)
title('Phase Plot of Hamming Window.'); xlabel('Frequency'); ylabel('Phase ')

%Rectwin Window.
y1 = rectwin(N);
subplot(6,3,4); plot(y1)
title('Rectwin Window.'); xlabel('N'); ylabel('Magnitude')
h = fir1(n,wp,y1);
H1 = freqz(h);
M1 = abs(H1);
subplot(6,3,5); plot(M1)
title('Magnitude Plot of Rectwin Window.'); xlabel('Frequency'); ylabel('Magnitude')
P1 = angle(H1);
subplot(6,3,6); plot(P1)
```

```
title('Phase Plot of Rectwin Window.'); xlabel('Frequency'); ylabel('Phase ')

%Hanning Window.
y1 = hanning(N);
subplot(6,3,7); plot(y1)
title('Hanning Window.'); xlabel('N'); ylabel('Magnitude')
h = fir1(n,wp,y1);
H1 = freqz(h);
M1 = abs(H1);
subplot(6,3,8); plot(M1)
title('Magnitude Plot of Hanning Window.'); xlabel('Frequency'); ylabel('Magnitude')
P1 = angle(H1);
subplot(6,3,9); plot(P1)
title('Phase Plot of Hanning Window.'); xlabel('Frequency'); ylabel('Phase ')

%Blackman Window.
y1 = blackman(N);
subplot(6,3,10); plot(y1)
title('Blackman Window.'); xlabel('N'); ylabel('Magnitude')
h = fir1(n,wp,y1);
H1 = freqz(h);
M1 = abs(H1);
subplot(6,3,11); plot(M1)
title('Magnitude Plot of Blackman Window.'); xlabel('Frequency'); ylabel('Magnitude')
P1 = angle(H1);
subplot(6,3,12); plot(P1)
title('Phase Plot of Blackman Window.'); xlabel('Frequency'); ylabel('Phase ')


%Bartlett Window.
y1 = bartlett(N);
subplot(6,3,16); plot(y1)
title('Bartlett Window.'); xlabel('N'); ylabel('Magnitude')
h = fir1(n,wp,y1);
H1 = freqz(h);
M1 = abs(H1);
subplot(6,3,17); plot(M1)
title('Magnitude Plot of Bartlett Window.'); xlabel('Frequency'); ylabel('Magnitude')
P1 = angle(H1);
subplot(6,3,18); plot(P1)
title('Phase Plot of Bartlett Window.'); xlabel('Frequency'); ylabel('Phase ')
```

EXPERIMENT NO. -: 07

AIM:- To Realization of IIR System equation using following

forms:

Code :

```
clc
clear all;
close all;

n = [1 1/3];
d = [1 -3/4 1/8];
tf(n,d,1,'variable','z^-1')

a = [1 1 2];
b = [1 -0.2 -0.15 0.5];
tf(a,b,1,'variable','z^-1')

h1 = dfilt.df1(n,d);
h2 = dfilt.df2(n,d);
h11 = dfilt.df2(n,d);
h12 = dfilt.df2(a,b);
hc = dfilt.cascade(h11,h12);
hp = dfilt.parallel(h11,h12);

realizemd1 (h1)
realizemd1 (h2)
realizemd1 (hc)
realizemd1 (hp)
```

EXPERIMENT NO. : 08

Aim: Given a sequence x((n),plot and observe magnitude and phase spectrum for given sequence using DFT.

Code :

```
clc;
clear all;
close all;

x = input ('Enter input x(n) : ');
N = length(x);

for k = 0:N-1
   for n = 0:N-1
      w(n+1,k+1) = exp((-1j*2*pi*n*k)/N);
   end
end

xk = x*w;
magnitude = abs(xk);
phase = angle(xk);
n = 0:1:N-1;
subplot(2,1,1);
stem(n, magnitude)
title('Magnitude Plot of  x(k).');
xlabel('n');
ylabel('Magnitude')
subplot(2,1,2);
stem(n, phase)
title('Phase Plot of x(k).');
xlabel('n');
ylabel('Phase')
```

EXPERIMENT NO. 9

Aim: To plot and observe the following for different frequency selective filters:

- Pole Zero plot
- Magnitude Response
- Phase Response

Code :

```
clc
clear all;
close all;

%Digital Resonator.
r = 0.5;
w = -pi:0.01:pi;
h = 1/(1-r)*(1-r*exp(-2j*w));
hmag = abs(h);
hpha = angle(h);
subplot(4,3,1); plot(w,hmag)
title('Magnitude Plot of Digital Resonator.'); xlabel('Frequeny.'); ylabel('Magnitude.')
subplot(4,3,2); plot(w,hpha)
title('Phase Plot of Digital Resonator.'); xlabel('Frequeny.'); ylabel('Phase.')
a = [1,0];
b = [0.5,0,-0.25];
[z,p,k] = tf2zp(a,b);
subplot(4,3,3); zplane(z,p)
title('Pole-Zero Plot of Digital Resonator.')

%Notch Filter.
h1 = 1-2*exp(-1j*w)*cos(pi/4)+exp(-2j*w);
hmag1 = abs(h1);
hpha1 = angle(h1);
subplot(4,3,4); plot(w,hmag1)
title('Magnitude Plot of Notch Filter.'); xlabel('Frequeny.'); ylabel('Magnitude.')
subplot(4,3,5); plot(w,hpha1)
title('Phase Plot of Notch Filter.'); xlabel('Frequeny.'); ylabel('Phase.')
a = [1,-2*cos(pi/4),1];
b = [1,0,0];
[z,p,k] = tf2zp(a,b);
subplot(4,3,6); zplane(z,p)
title('Pole-Zero Plot of Notch Filter.')

%Comb Filter.
m = 6;
```

```
h2 = (1/m+1)*exp(-0.5j*w*m).*(sin(((m+1)/2)*w)./sin(w/2));
hmag2 = abs(h2);
hpha2 = angle(h2);
subplot(4,3,7); plot(w,hmag2)
title('Magnitude Plot of Comb Filter.'); xlabel('Frequeny.'); ylabel('Magnitude.')
subplot(4,3,8); plot(w,hpha2)
title('Phase Plot of Comb Filter.'); xlabel('Frequeny.'); ylabel('Phase.')
a = [1,0,0,0,0,0,0,-1];
b = [1,-1,0,0,0,0,0,0];
[z,p,k] = tf2zp(a,b);
subplot(4,3,9); zplane(z,p)
title('Pole-Zero Plot of Comb Filter.')


%All Pass Filter.
m1 = 0.8;
h3 = (exp(-1j*w)-inv(m1))./(exp(-1j*w)-m1);
hmag3 = abs(h3);
hpha3 = angle(h3);
subplot(4,3,10); plot(w,hmag3)
title('Magnitude Plot of All Pass Filter.'); xlabel('Frequeny.'); ylabel('Magnitude.')
subplot(4,3,11); plot(w,hpha3)
title('Phase Plot of All Pass Filter.'); xlabel('Frequeny.'); ylabel('Phase.')
a = [1,-inv(m1)];
b = [1,-m1];
[z,p,k] = tf2zp(a,b);
subplot(4,3,12); zplane(z,p)
title('Pole-Zero Plot of All Pass Filter.')
```