Note: Team is not responsible for any issues regarding execution and exam.

DSP Lab Record

DFT

```
clc;
clear all;
close all;
x=[1 1 1 1];
n=length(x);
for k=1:n;
y(k)=0;
for  i=1:n;
y(k)=y(k)+x(i)*exp(-j*2*pi*(k-1)*(i-1)/n);
end
end
k=1:n;
subplot(2,1,1);
display((y(k)));
stem(k,abs(y(k)))
xlabel('samples k');
ylabel('amplitude');
title('dft');
subplot(2,1,2);
k=1:n
stem(k,angle((y(k)))*180./pi);
xlabel('sample k');
ylabel('angle');
title('phase');
```

IDFT

```
clc;
clear all;
close all;
```

```
x=[4 0 0 0];
n=length(x);
for i=1:n;
y(i)=0;
for  k=1:n;
y(i)=y(i)+1/n*(x(k)*exp(j*2*pi*(k-1)*(i-1)/n));
end
end
i=1:n;
subplot(2,1,1);
stem(i,abs(y(i)));
xlabel('samples k');
ylabel('amplitude');
title('dft');
grid on;
subplot(2,1,2);
stem(i,atan(imag(y(i))./real(y(i))));
xlabel('sample k');
ylabel('angle');
title('phase');
grid on;
```

Stability:

```
clc
close all
clear all
b=[-1  2]
a=[1 -1/4  -3/8]
h=filt(b,a);
z=zero(h)
disp('zeros are');
disp(z)
[r p k]=residuez(b,a)
disp('poles are')
disp(p)
zplane(b,a);
if abs(p)<=1
    disp('all poles are within unit circle');
    disp('system is stable');
else
    disp('all poles are not within unit circle');
    disp('system is unstable');
end
```

FFT:

```
clc
clear all
close all
x=input('enter the sequence x=');
n=length(x);
z=zeros(0,n-1);
x=[x,z];
x1=bitrevorder(x);
s=log2(n);
for  p=1:s
   temp=[ ];
   r=2^(s-p);
   for  i=1:r
      t=n/r;
      a=x1(t*(i-1)+1:i*t);
      l=length(a);
      temp1=a(1:l/2);
      temp2=a(l/2+1:l);
      k=0:(l/2-1);
      w=exp(1-j*2*pi*r*k)/n;
      temp3=temp1+w.*temp2;
      temp4=temp1-w.*temp2;
      temp=[temp,temp3,temp4];
   end
   x1=temp;
end
y=x1;
disp('DFT sequence X')
y
z=fft(x,n);
disp('DFT sequence using fft is');
z
stem(abs(temp));
```

LP FIR :

```
clc
close all
clear all
wp=0.6*pi;
ws=0.5*pi;
rp=0.25;
as=60;
tr_width=ws-wp;
wc=(ws+wp)/2
N=ceil(11*pi/tr_width)+1;
n=[0:1:(N-1)];
if N<=0
    error('N should be greater than 0');
    return
end
if wc>pi
    error('cut off freq should be less than pi');
    return
end
alpha=(N-1)/2;
n=0:1:N-1;
m=(n-alpha);
hd=(wc/pi)*sinc(wc*m/pi);
if nargout==0
    stem(n,hd);
    title('impulse response of ideal lpf');
    xlabel('n');
    ylabel('hd(n)')
end
w_hamming=hamming(N)
h=hd.*w_blackman;
    [mag,w]=freqz(h,[1],1000)
    db=20*log10(abs(mag))
    pha=angle(mag)
    subplot(221)
    stem(n,w_hamming)
    title('hamming window')
    xlabel('n')
    ylabel('w(n)')
    subplot(222)
    stem(n,h)
```

```
xlabel('n')
ylabel('h(n)')
title('impulse response')
subplot(223)
plot(w/pi,db)
title('magnitude response')
xlabel('n')
ylabel('amplitude')
subplot(224)
plot(w/pi,pha/pi)
title('phase response')
xlabel('frequency')
ylabel('phase angle')
```

HP FIR :

```
clc
close all
clear all
wp=0.6*pi;
ws=0.5*pi;
rp=0.25;
as=60;
tr_width=ws-wp;
wc=(ws+wp)/2
N=ceil(1.8*pi/tr_width)+1;
n=[0:1:(N-1)];
if N<=0
    error('N should be greater than 0');
    return
end
if wc>pi
    error('cut off freq should be less than pi');
    return
end
alpha=(N-1)/2;
n=0:1:N-1;
m=(n-alpha);
hd1=(pi/pi)*sinc(pi*m/pi);
hd2=(wc/pi)*sinc(wc*m/pi);
hd=hd1-hd2;
if nargout==0
    stem(n,hd);
    title('impulse response of ideal lpf');
    xlabel('n');
    ylabel('hd(n)')
end
w_rect=rectwin(N)
h=hd.*w_rect;
    [mag,w]=freqz(h,[1],1000)
    db=20*log10(abs(mag))
    pha=angle(mag)
    subplot(221)
    stem(n,w_rect)
    title('rectangular window')
    xlabel('n')
    ylabel('w(n)')
```

```
subplot(222)
stem(n,h)
xlabel('n')
ylabel('h(n)')
title('impulse response')
subplot(223)
plot(w/pi,db)
title('magnitude response')
xlabel('n')
ylabel('amplitude')
subplot(224)
plot(w/pi,pha/pi)
title('phase response')
xlabel('frequency')
ylabel('phase angle')
```

LP IIR :

```
clc
close all
clear all
wp=0.2*pi;
ws=0.3*pi;
Rp=7;
As=16;
if(wp>pi | ws>pi)
    error('wp and ws should be less than pi')
end
wp=wp/pi;ws=ws/pi;
[N,wn]=buttord(wp,ws,Rp,As);
disp('butterworth filter order is')
N
disp('cut off frequency is')
wn
[b,a]=butter(N,wn,'low');
[mag,w]=freqz(b,a,1000);
db=20*log(abs(mag));
pha=angle(mag);
subplot(2,2,1);
plot(w/pi,mag);
title('magnitude response');
xlabel('frequency in pi units');
ylabel('amplitude');
subplot(2,2,2);
plot(w/pi,db);
title('magnitude response');
xlabel('freq in pi units');
ylabel('amplitude');
sublpot(2,2,3);
plot(w/pi,pha/pi);
title('phase response');
xlabel('frequency in pi units');
ylabel('radians in pi');
[grd,w]=grpdelay(b,a,1000);
subplot(224)
plot(w/pi,grd)
title('group delay')
xlabel('frequency in pi units');
ylabel('samples');
```

HP IIR :

```
clc
close all
clear all
wp=0.2*pi;
ws=0.3*pi;
Rp=7;
As=16;
if(wp>pi | ws>pi)
    error('wp and ws should be less than pi')
end
wp=wp/pi;ws=ws/pi;
[N,wn]=buttord(wp,ws,Rp,As);
disp('butterworth filter order is')
N
disp('cut off frequency is')
wn
[b,a]=butter(N,wn,'high');
[mag,w]=freqz(b,a,1000);
db=20*log(abs(mag));
pha=angle(mag);
subplot(2,2,1);
plot(w/pi,mag);
title('magnitude response');
xlabel('frequency in pi units');
ylabel('amplitude');
subplot(2,2,2);
plot(w/pi,db);
title('magnitude response');
xlabel('freq in pi units');
ylabel('amplitude');
sublpot(2,2,3);
plot(w/pi,pha/pi);
title('phase response');
xlabel('frequency in pi units');
ylabel('radians in pi');
[grd,w]=grpdelay(b,a,1000);
subplot(224)
plot(w/pi,grd)
title('group delay')
xlabel('frequency in pi units');
ylabel('samples');
```

DECIMATION :

```
clc
clear all
close all
x=[3 2 1 2 3 1 2 3 1 2]
ni=-3;
M=2;
l=length(x);
if(ni<=0)
    n=[ni:ni+l-1];
else
    n=[0:ni+l-1]
    x=[zeros(1,ni),x];
end
m=fix(n(1)/M):fix(n(end)/M);
a=1;
y=zeros(1,length(m));
for i=min(m):max(m)
    y(a)=x(n==M*i);
    a=a+1;
end
subplot(211)
stem (n,x)
title('x(n)');
xlabel('n')
ylabel('x(n)');
subplot(212)
stem(m,y)
title('y(m)=x(m*n)');
xlabel('m');
ylabel('y(m)')
```

INTERPOLATION :

```
clc
clear all
close all
x=[3 2 1 2 3 1 2 3 1 2]
l=length(x);
ni=-3;
M=2;
I=2;
if(ni<=0)
    n=[ni:(ni+l-1)];
else
    n=[0:ni+l-1]
    x=[zeros(1,ni),x];
end
m=fix(n(1)*M):fix(n(end)*M);
a=1;
y=zeros(1,length(m));
for i=min(m):max(m)
    if((i/l)==fix(i/l))
    y1(a)=x(n==((i/M)));
    end
    a=a+1;
end
subplot(211)
stem (n,x)
title('x(n)');
xlabel('n')
ylabel('x(n)');
subplot(212)
stem(m,y)
title('y(m)=x(m*n)');
xlabel('m');
ylabel('y(m)')
```

I/D Program:

```
Clc
Clear all
Close all
x=[3 2 1 2 3 1 2 3 1 2]
I=2
l=length(x)
n=0:l-1
m=fix(n(1)*I):fix(n(end)*I)
a=1
For i=min(m):max(m)
if(i/I==fix(i/I))
y1(a)=x(n==i/I)
End
a=a+1
End
subplot(2,2,1)
stem(n,x)
title('x(n)')
subplot(2,2,2)
stem(m,y1)
title('y1(m)')
M=2
l=length(y1)
n=0:l-1
m=fix(n(1)/M);fix(n(end)/M)
a=1
For i=min(m):max(m)
y2(a)=y1(n==M*i)
a=a+1
End
subplot(2,2,3)
stem(n,y1)
title('y1(n)')
subplot('2,2,4')
stem(m,y2)
title('y2(m)')
```