Preparation Exercises

1.

```
%% Signal definitions

n = -10:20;
h = [1 1 1 1 ];

x1 = sin((12/100*pi).*n);

u1=(n>=0);
u2=(n>=6);
x2 = u1 -u2;

x3 = ((9/10).^n).*u1;

delta1 = (n==1);
delta2 = (n==2);
delta3 = (n==3);
x4 = ((5/10).*delta1)+ delta2+((5/10).*delta3);

x5 = ((9/10).^n).*(cos(((2/10)*pi).*n));

%x6 = sin(((2/10)*pi).*n)./(((2/10)*pi).*n);
x6 = sinc(((2/10)*pi).*n);
```

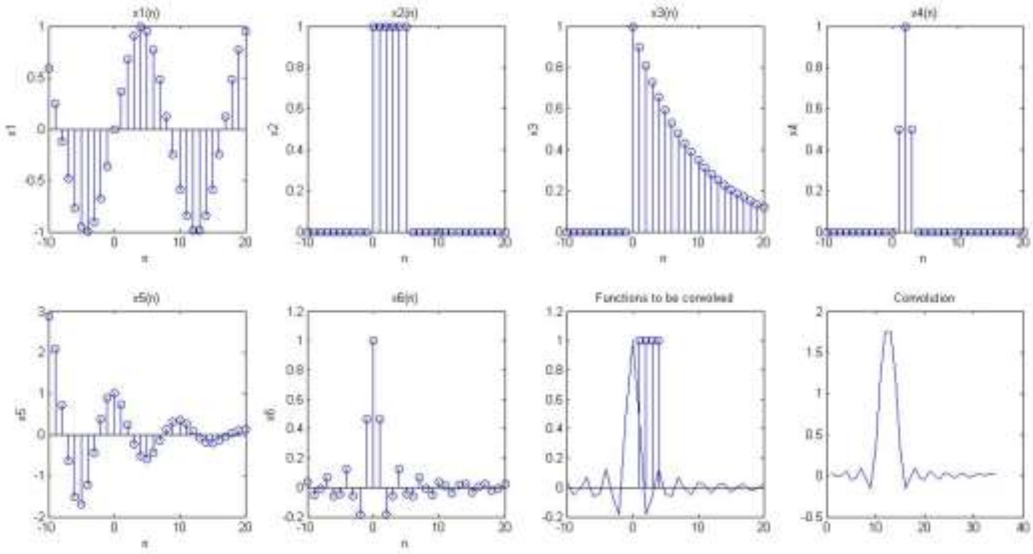
2. Convolution Example
x(n) = δ(n) + δ(n − 1) + δ(n − 2) → [0 1 2]
h(n) = δ(n) − δ(n − 1) → [0 1]

						y(n)
h(n)		0	1			
x(n)	0	1	2			
			2			2
h(n)		0	1			
x(n)		0	1	2		
			1			1
h(n)		0	1			
x(n)			0	1	2	
			0			0

3. Second-order System
When a(1) and a(2) are zero the system is stable.

Experiments

6.1 Discrete Time Signals




```
%% Plots

figure

subplot(2,4,1);
stem(n,x1);
xlabel('n');
ylabel('x1');
title('x1(n)');

subplot(2,4,2);
stem(n,x2);
title('x2(n)');
xlabel('n');
ylabel('x2');

subplot(2,4,3);
stem(n,x3);
title('x3(n)');
xlabel('n');
ylabel('x3');

subplot(2,4,4);
stem(n,x4);
title('x4(n)');
xlabel('n');
ylabel('x4');

subplot(2,4,5);
stem(n,x5);
title('x5(n)');
xlabel('n');
ylabel('x5');

subplot(2,4,6);
stem(n,x6);
title('x6(n)');
xlabel('n');
ylabel('x6');

%% Convolution
```

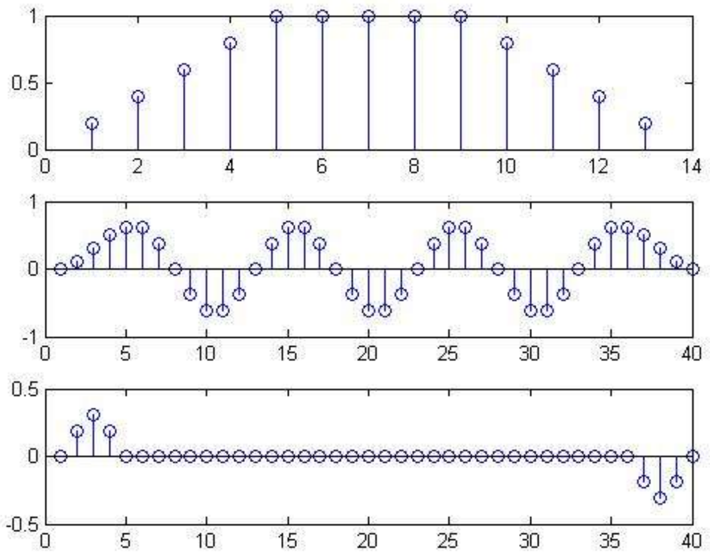
```
y = convmat(x6,h);
subplot(2,4,7);
plot(n,x6);
hold on;
stem(h);
title('Functions to be convolved');
subplot(2,4,8);
plot(y);
title('Convolution');
```

Convolution

```
function [ y ] = convmat( x,h )
%CONVMAT Summary of this function goes here
%   Detailed explanation goes here
%x,h,y are column vectors
lenx=length(x);
lenh=length(h);
N=lenx+lenh-1;
H=[];
for (count=1:lenx)
    tmp=[zeros(count-1,1);h;zeros(N-count-lenh+1,1)];
    H=[H tmp];

end
y=H*x;

end
```

Averaging Filter

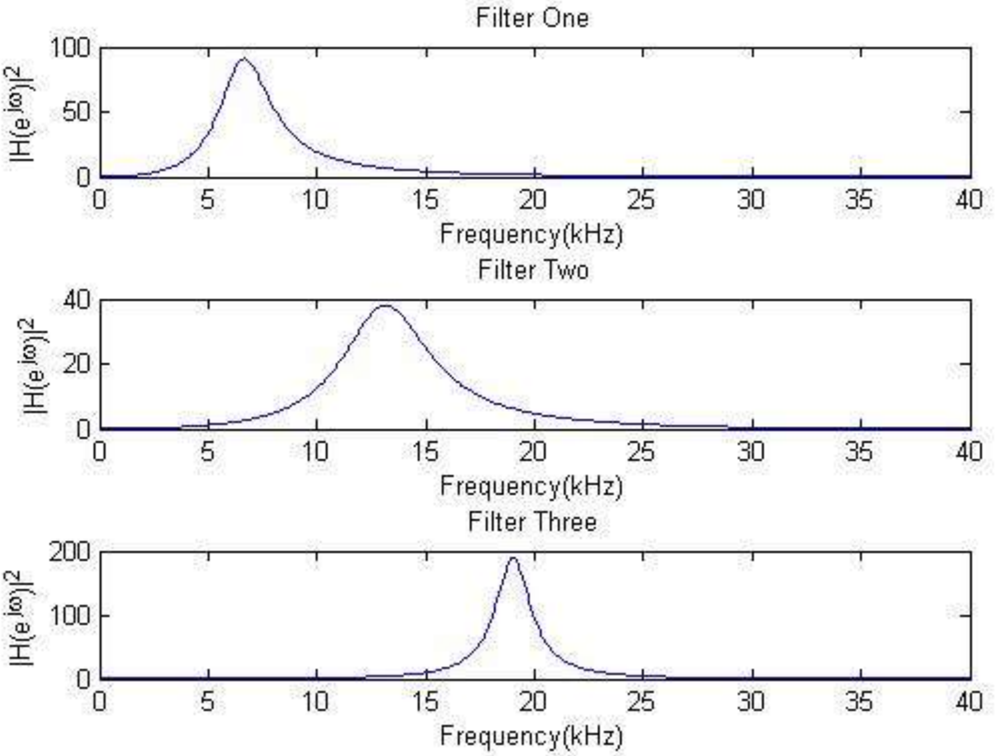
```
clear all;
clc;

u = ones(1,5);
h = u.*(2/10);

x1 = ones(1,9);
n = 0:35;
x2 = sin(((2/10)*pi).*n);
x3 = sin(((4/10)*pi).*n);
y1 = convmat(x1,h);
y2 = convmat(x2,h);
y3 = convmat(x3,h);

figure (1);
subplot(3,1,1);
stem(y1);
subplot(3,1,2);
stem(y2);
subplot(3,1,3);
stem(y3);
```

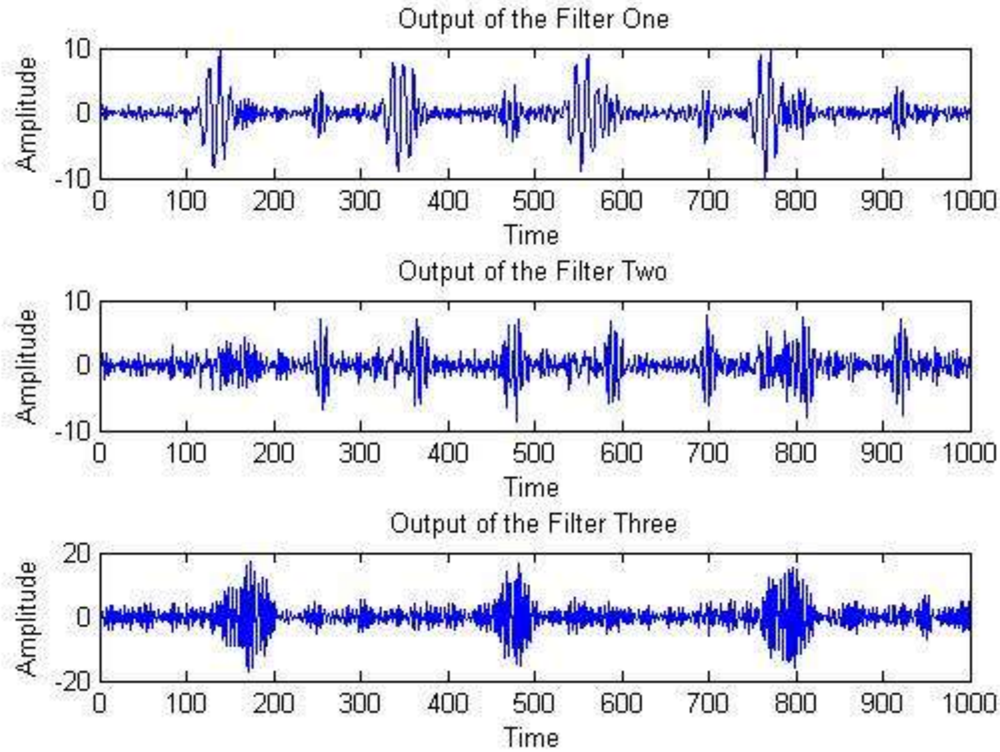


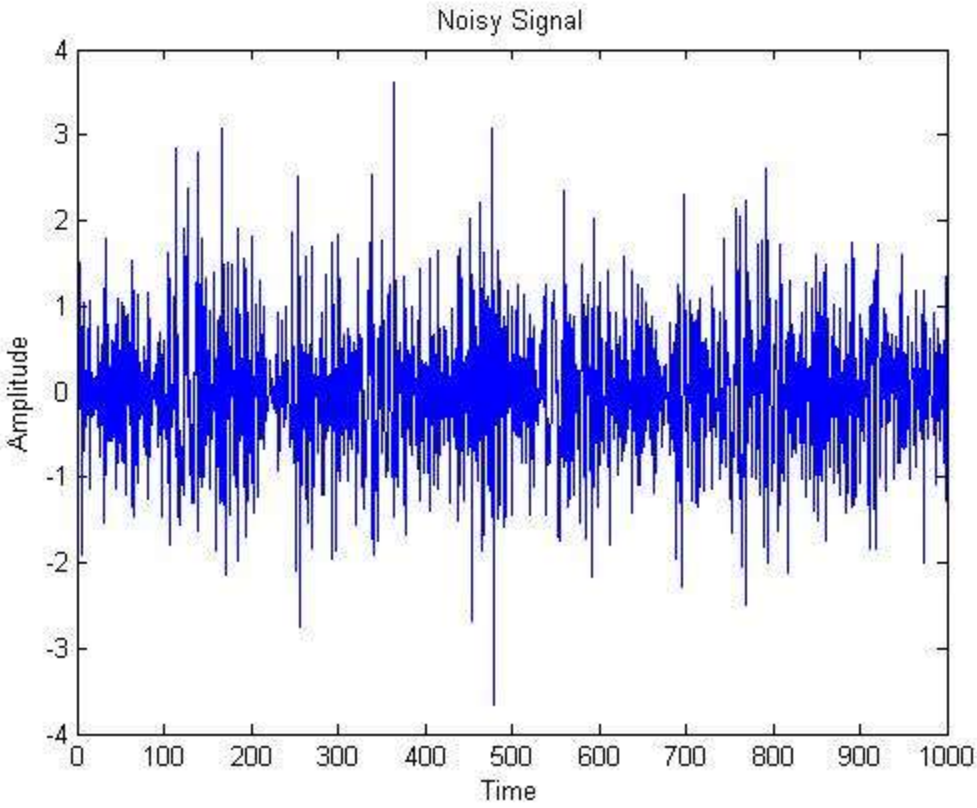
6.4 Bandpass Filtering

```
clear all;
clc;
%Sample with hidden pulses loaded
 load('..\Lab_2\files_lab2\b3pulses.mat');
%Sampling frenquency (in Hz)
fs = 80000;
%Stopband and Passband Frequency ranges (in Hz)
fp1 = 5000;     fs1 = 8000;
fp2 = 10500;    fs2 = 15500;
fp3 = 18000;    fs3 = 20000;
f01 = (fp1+fs1)/2; f02 = (fp2+fs2)/2;  f03 = (fp3+fs3)/2;
%Digital frequency bands
w01 = f01/fs*2*pi;
w02 = f02/fs*2*pi;
w03 = f03/fs*2*pi;
%Range (Digital domain)
delW = [(fs1-fp1)/fs*2*pi; (fs2-fp2)/fs*2*pi; (fs3-fp3)/fs*2*pi;];

r=[];
for i=1:3
    tmp=roots([4 -(8+delW(i)^2) 4]);
    r=[r tmp(2)];
end

b=[1 0 -1];
a1=[1 -2*r(1)*cos(w01) r(1)^2];
a2=[1 -2*r(2)*cos(w02) r(2)^2];
a3=[1 -2*r(3)*cos(w03) r(3)^2];

figure(1);
plot(x);
title('Noisy Signal');
xlabel('Time');
ylabel('Amplitude');

figure(2);
subplot(3,1,1);
```

```
[H1,w1]=freqz(b,a1);
plot(w1/2/pi*fs/1000,abs(H1).^2);
title('Filter One');
xlabel('Frequency(kHz)');ylabel('|H(e^{ j\omega})|^2');

subplot(3,1,2);
[H2,w2]=freqz(b,a2);
plot(w2/2/pi*fs/1000,abs(H2).^2);
title('Filter Two');
xlabel('Frequency(kHz)');ylabel('|H(e^{ j\omega})|^2');


subplot(3,1,3);
[H3,w3]=freqz(b,a3);
plot(w3/2/pi*fs/1000,abs(H3).^2);
title('Filter Three');
xlabel('Frequency(kHz)');ylabel('|H(e^{ j\omega})|^2');

y1=filter(b,a1,x);
y2=filter(b,a2,x);
y3=filter(b,a3,x);

figure(3);
subplot(3,1,1);
plot(y1);
title('Output of the Filter One');
xlabel('Time');ylabel('Amplitude');
subplot(3,1,2);
plot(y2);
title('Output of the Filter Two');
xlabel('Time');ylabel('Amplitude');
subplot(3,1,3);
plot(y3);
title('Output of the Filter Three');
xlabel('Time');ylabel('Amplitude');
```


Filter One
$|H(e^{j\omega})|^2$
Frequency(kHz)
Filter Two
$|H(e^{j\omega})|^2$
Frequency(kHz)
Filter Three
$|H(e^{j\omega})|^2$
Frequency(kHz)


Output of the Filter One
Amplitude
Time
Output of the Filter Two
Amplitude
Time
Output of the Filter Three
Amplitude
Time



Noisy Signal
Amplitude
Time
4
3
2
1
0
-1
-2
-3
-4
0
100
200
300
400
500
600
700
800
900
1000