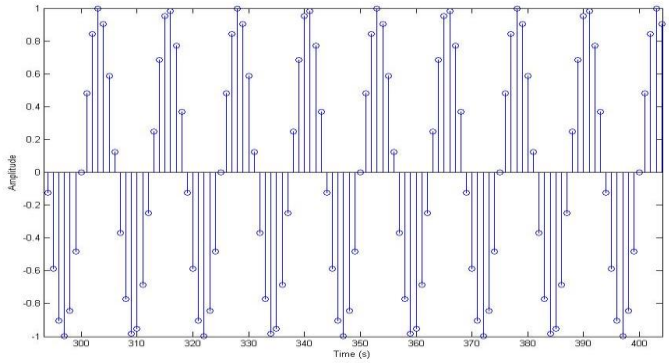
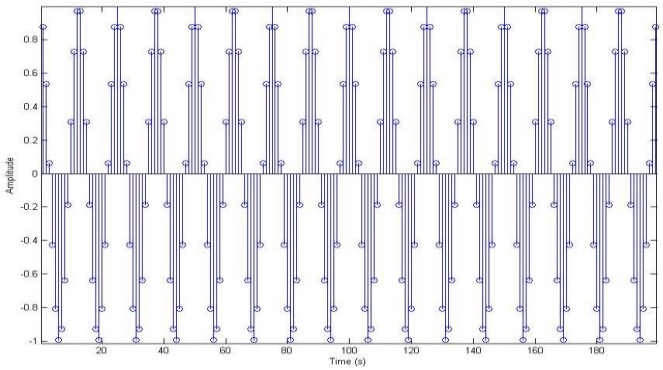
1.

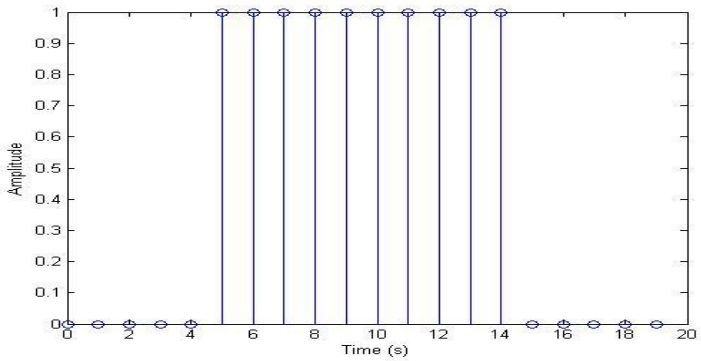
a)
```
%signal 1 - Sine
f1=40;
fs1=500;
T1=1;
t1=[0:1/fs1:T1-1/fs1];
s1=sin(2*pi*f1*t1);
n1=[0:length(s1)-1];
 stem(n1,s1);xlabel('n');
ylabel('Amplitude');
axis([0 length(s1)-1 -1 1]);
title('Sine Signal, s1');
```



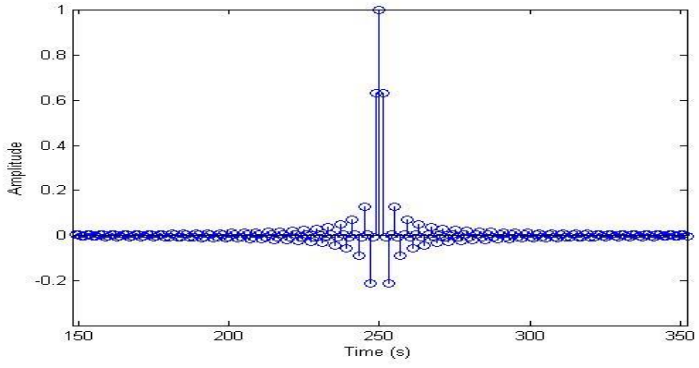
b)
```
% %signal 2 - Cosine
f2=40;
fs2=500;
T2=1;
t2=[0:1/fs2:T2-1/fs2];
s2=cos(2*pi*f2*t2);
n2=[0:length(s2)-1];
stem(n2,s2);
xlabel('n');
ylabel('Amplitude');
axis([0 length(s1)-1 -1 1]);
title('Cosine Signal, s1');
```



c)
```
%signal 3 - Rect
L3=20;
s3=[zeros(1,L3/4),ones(1,L3/2),
zeros(1,L3/4)];
n3=[0:length(s3)-1];
stem(n3,s3);
xlabel('n');
ylabel('Amplitude');
title('Rectangular Signal, s3');
```

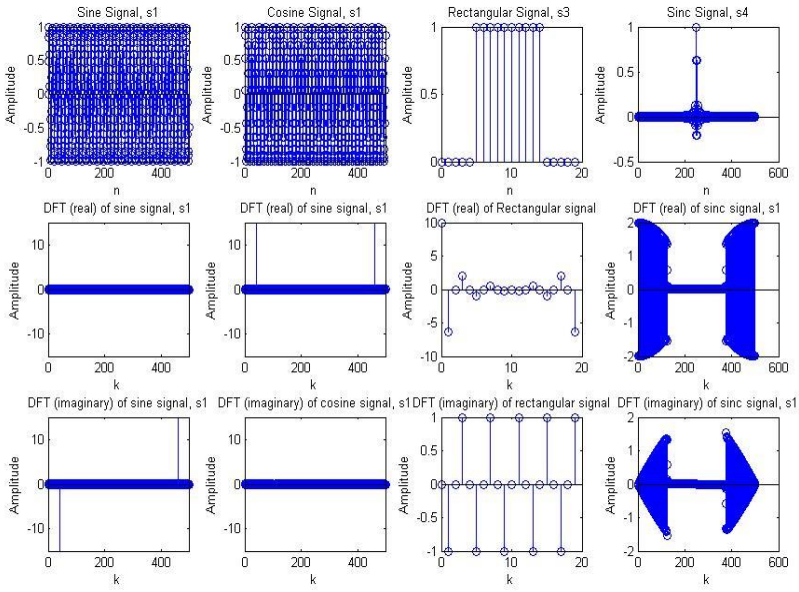


d)
```
%signal 4 - Sinc
f4=40;
fs4=500;T4=1;
t4=[0:1/fs4:T4];
s4=sinc(2*pi*f4*(t4-0.5));
n4=[0:length(s4)-1];
stem(n4,s4);xlabel('n');
ylabel('Amplitude');
title('Sinc Signal, s4');
```

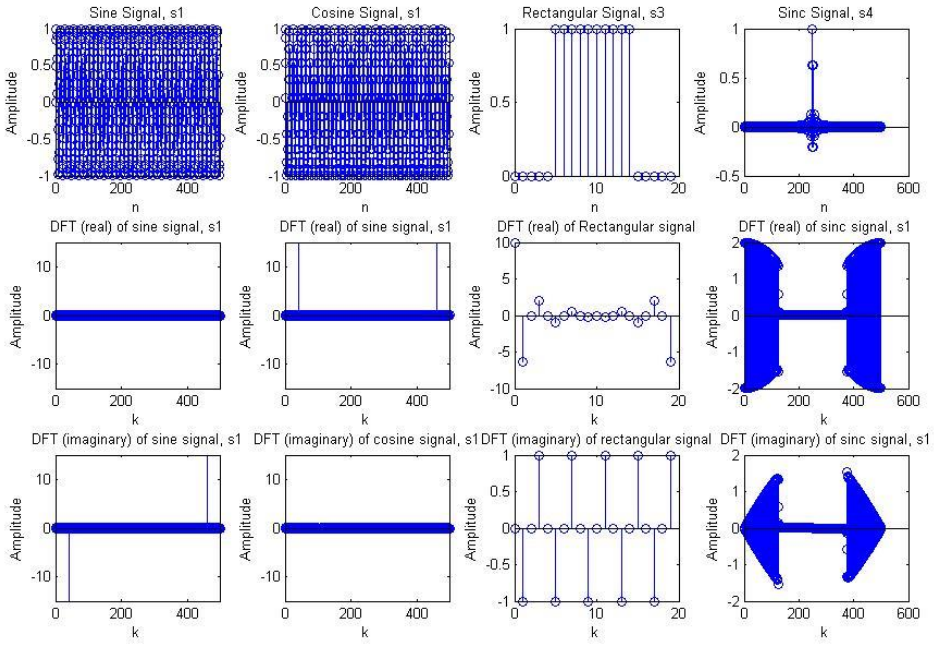


2. %DFT of signals

```
N1=length(s1);    S1=fft(s1,N1);
N2=length(s2);    S2=fft(s2,N2);
N3=length(s3);    S3=fft(s3,N3);
N4=length(s4);    S4=fft(s4,N4);

%Plotting of Signals
subplot(3,4,1); stem(n1,s1);xlabel('n');ylabel('Amplitude');axis([0
length(s1)-1 -1 1]); title('Sine Signal, s1');
subplot(3,4,5); stem([0:N1-1], real(S1(1:N1))); xlabel('k');
ylabel('Amplitude'); axis([0 N1-1 -15 15]);
title('DFT (real) of sine signal, s1');
subplot(3,4,9); stem([0:N1-1], imag(S1(1:N1))); xlabel('k');
ylabel('Amplitude'); axis([0 N1-1 -15 15]);
title('DFT (imaginary) of sine signal, s1');

subplot(3,4,2); stem(n2,s2);xlabel('n');ylabel('Amplitude');axis([0
length(s1)-1 -1 1]);
title('Cosine Signal, s1');
subplot(3,4,6); stem([0:N2-1], real(S2(1:N2))); xlabel('k');
ylabel('Amplitude'); axis([0 N2-1 -15 15]);
title('DFT (real) of sine signal, s1');
subplot(3,4,10); stem([0:N2-1], imag(S2(1:N2))); xlabel('k');
ylabel('Amplitude'); axis([0 N2-1 -15 15]);
title('DFT (imaginary) of cosine signal, s1');

subplot(3,4,3); stem(n3,s3); xlabel('n');ylabel('Amplitude');
title('Rectangular Signal, s3 ');
subplot(3,4,7); stem([0:N3-1], real(S3(1:N3))); xlabel('k');
ylabel('Amplitude');
title('DFT (real) of Rectangular signal');
subplot(3,4,11); stem([0:N3-1], imag(S3(1:N3))); xlabel('k');
ylabel('Amplitude');
title('DFT (imaginary) of rectangular signal');

subplot(3,4,4); stem(n4,s4);
xlabel('n');
ylabel('Amplitude');
title('Sinc Signal, s4');
subplot(3,4,8);
stem([0:N4-
1],real(S4(1:N4)));
xlabel('k');
ylabel('Amplitude');
title('DFT (real) of sinc
signal, s4');
subplot(3,4,12);
stem([0:N4-
1],imag(S4(1:N4)));
xlabel('k');
ylabel('Amplitude');
title('DFT(imag) of sinc
signal, s4');
```



a.

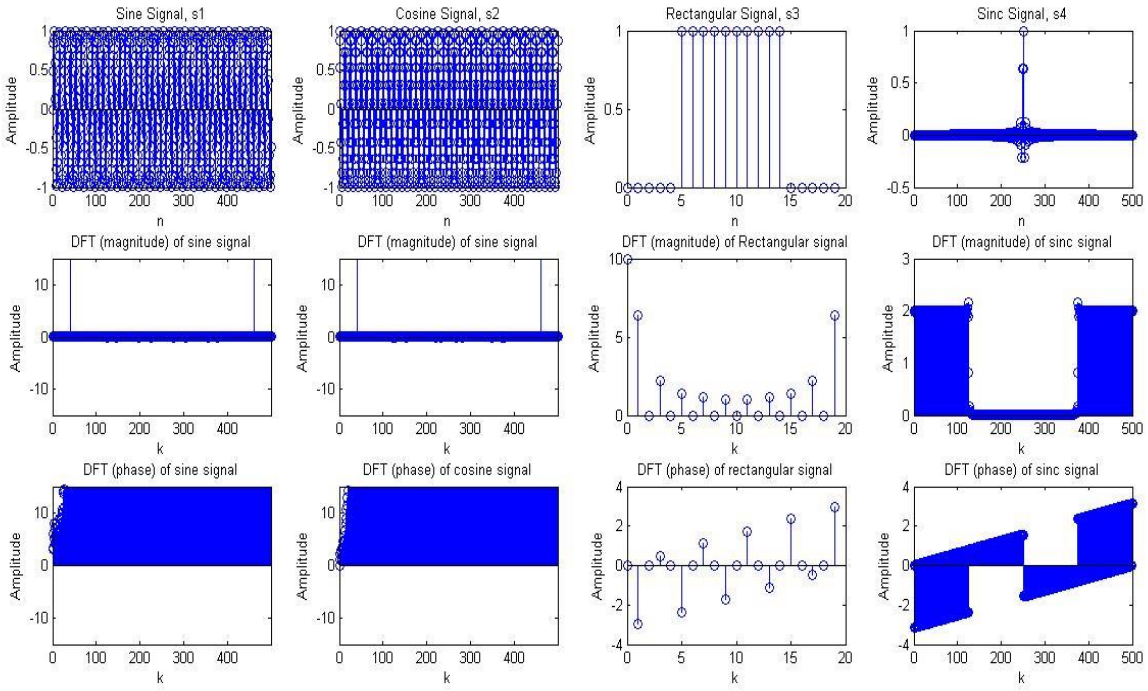


As can be seen in the output curves are symmetric about the line parallel to Y-axis and passing through the central frequency. For sine the imaginary plot is symmetric about origin and for the cosine, the real part is symmetric about a line parallel to the y axis.

b.

```
%Plotting of Signals
subplot(3,4,1); stem(n1,s1);xlabel('n');ylabel('Amplitude');axis([0
length(s1)-1 -1 1]);
title('Sine Signal, s1');
subplot(3,4,5); stem([0:N1-1], abs(S1(1:N1))); xlabel('k');
ylabel('Amplitude'); axis([0 N1-1 -15 15]);
title('DFT (magnitude) of sine signal');
subplot(3,4,9); stem([0:N1-1], phase(S1(1:N1))); xlabel('k');
ylabel('Amplitude'); axis([0 N1-1 -15 15]);
title('DFT (phase) of sine signal');

subplot(3,4,2); stem(n2,s2);xlabel('n');ylabel('Amplitude');axis([0
length(s1)-1 -1 1]);
title('Cosine Signal, s2');
subplot(3,4,6); stem([0:N2-1], abs(S2(1:N2))); xlabel('k');
ylabel('Amplitude'); axis([0 N2-1 -15 15]);
title('DFT (magnitude) of sine signal');
subplot(3,4,10); stem([0:N2-1], phase(S2(1:N2))); xlabel('k');
ylabel('Amplitude'); axis([0 N2-1 -15 15]);
title('DFT (phase) of cosine signal');

subplot(3,4,3); stem(n3,s3); xlabel('n');ylabel('Amplitude');
title('Rectangular Signal, s3 ');
```

```
subplot(3,4,7); stem([0:N3-1], abs(S3(1:N3))); xlabel('k');
ylabel('Amplitude');
title('DFT (magnitude) of Rectangular signal');
subplot(3,4,11); stem([0:N3-1], phase(S3(1:N3))); xlabel('k');
ylabel('Amplitude');
title('DFT (phase) of rectangular signal');

subplot(3,4,4); stem(n4,s4);xlabel('n');ylabel('Amplitude');
title('Sinc Signal, s4');
subplot(3,4,8); stem([0:N4-1], abs(S4(1:N4))); xlabel('k');
ylabel('Amplitude');
title('DFT (magnitude) of sinc signal');
subplot(3,4,12); stem([0:N4-1], phase(S4(1:N4))); xlabel('k');
ylabel('Amplitude');
title('DFT (phase) of sinc signal');
```

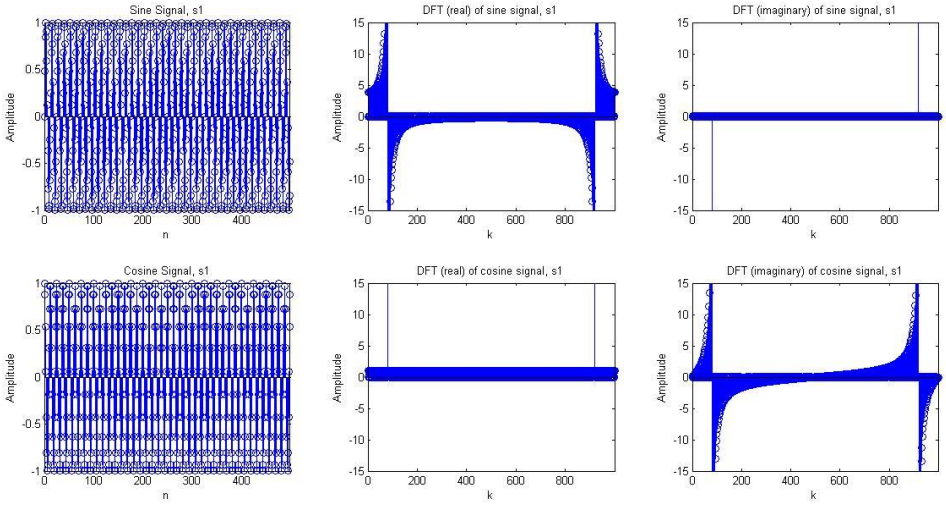


As we can see the magnitude spectrum is similar about the amplitude axis.

c.

```
%signal 1 - Sine
f1=40;
fs1=500;
T1=1;
t1=[0:1/fs1:T1-1/fs1];
s1=sin(2*pi*f1*t1);
n1=[0:length(s1)-1];

% %signal 2 - Cosine
```

```
f2=40;fs2=500;T2=1;
t2=[0:1/fs2:T2-1/fs2];
s2=cos(2*pi*f2*t2);
n2=[0:length(s2)-1];

N1=2*length(s1);
st1=zeros(1,N1);
for i=1:length(s1)
    st1(2*i)= s1(i);
end
   S1=fft(st1,N1);
N2=2*length(s2);
st2=zeros(1,2*length(s2));
for i=1:length(s2)
      st2(2*i)= s2(i);
end
   S2=fft(st2,N2);

%Plotting of Signals
subplot(2,3,1); stem(n1,s1);xlabel('n');ylabel('Amplitude');axis([0
length(s1)-1 -1 1]);
title('Sine Signal, s1');
subplot(2,3,2); stem([0:N1-1], abs(S1(1:N1))); xlabel('k');
ylabel('Amplitude'); axis([0 N1-1 -15 15]);
title('DFT (real) of sine signal, s1');
subplot(2,3,3); stem([0:N1-1], phase(S1(1:N1))); xlabel('k');
ylabel('Amplitude'); axis([0 N1-1 -15 15]);
title('DFT (imaginary) of sine signal, s1');

subplot(2,3,4); stem(n2,s2);xlabel('n');ylabel('Amplitude');axis([0
length(s1)-1 -1 1]);
title('Cosine Signal, s1');
subplot(2,3,5); stem([0:N2-1], abs(S2(1:N2))); xlabel('k');
ylabel('Amplitude'); axis([0 N2-1 -15 15]);
title('DFT (real) of cosine signal, s1');
subplot(2,3,6); stem([0:N2-1], phase(S2(1:N2))); xlabel('k');
ylabel('Amplitude'); axis([0 N2-1 -15 15]);
title('DFT (imaginary) of cosine signal, s1');
```



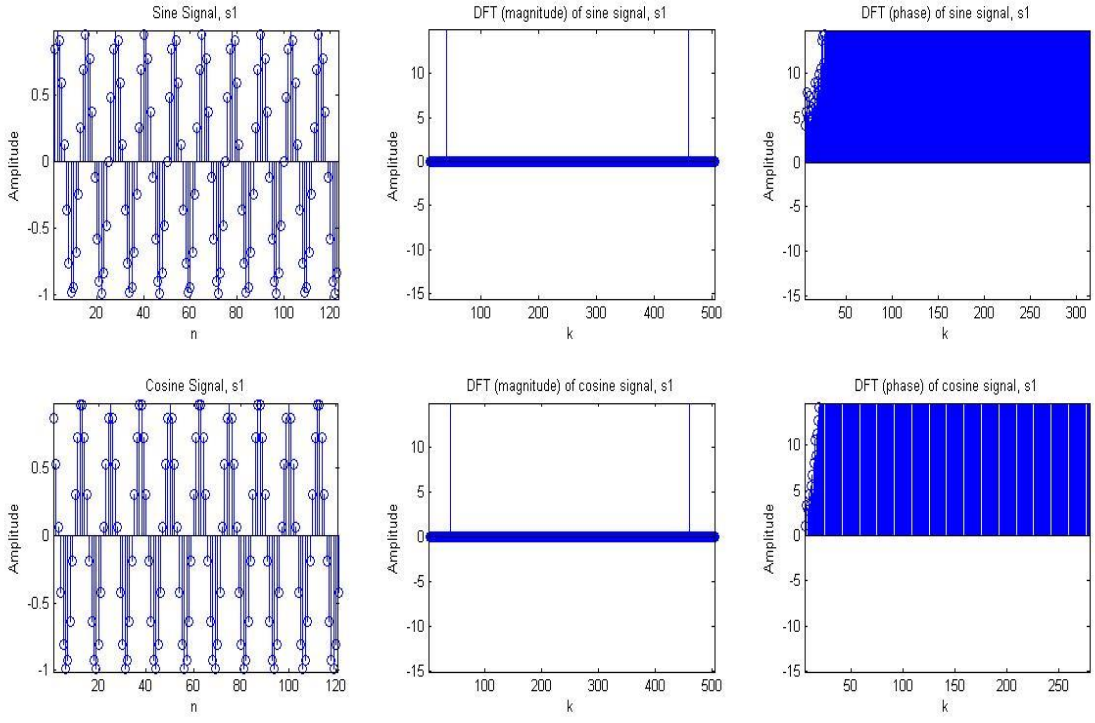
We

can observe that the spikes in the magnitude and phase spectrums got smoothened as N is increased.

d.

To fix this, the function has to be upscaled in the time domain.

```
N1=2*length(s1);
st1=zeros(1,N1);
for i=1:length(s1)
    st1(2*i)= s1(i);
end
   S1=fft(st1,N1);
N2=2*length(s2);
st2=zeros(1,2*length(s2));
for i=1:length(s2)
      st2(2*i)= s2(i);
end
   S2=fft(st2,N2);
```




```
L=64;
fs1=40;
t=[0:1/fs1:1-1/fs1];
s1=sin(2*pi*t1*f1);
y=blackman(L); y=y';
s1_wnd=s1.*y;
```

```
nfft=2^nextpow2(L);
S1=fft(s1_wnd,nfft)/L;
subplot(1,3,1);stem([0:L-1],abs(S1(1:L)));title('Blackman_Harris for Sine');

%Hann
y=hann(L);y=y';
s1_wnd=s1.*y;
nfft=2^nextpow2(L);
S1=fft(s1_wnd,nfft)/L;
subplot(1,3,2);stem([0:L-1],abs(S1(1:L)));title('Hanning for Sine');

%Gaussian
y=gausswin(L);y=y';
s1_wnd=s1.*y;
nfft=2^nextpow2(L);
S1=fft(s1_wnd,nfft)/L;
subplot(1,3,3);stem([0:L-1],abs(S1(1:L)));title('Gaussian for Sine');
```