Computer Assignment - 04 - Spring 2019

Submitted By - Sayam Kumar S20180010158 Sec-A

Sampling

For each of the signals, determine the appropriate bandwidth and the nyquist sampling rate -

a. $x(t) = (t-1)^2$ $0<t<2$

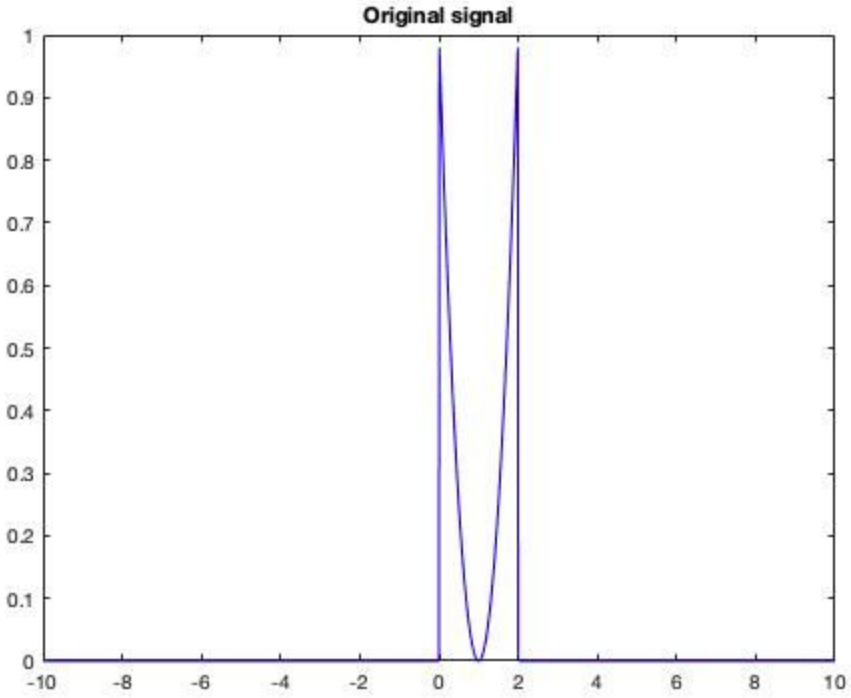
Solution :

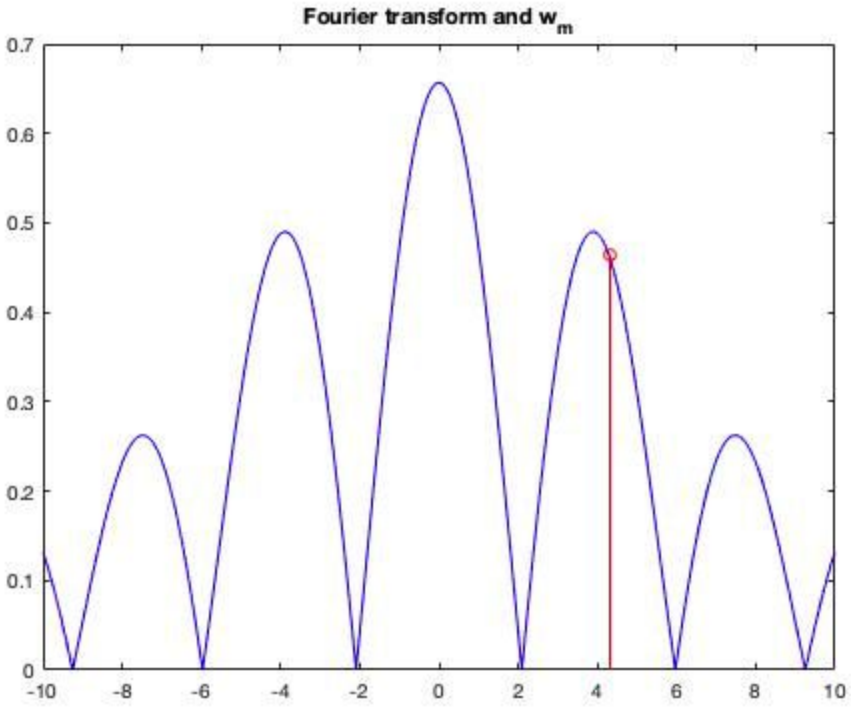
```
t = -10:0.01:10;
w = -10:0.01:10;
x = zeros(size(t));
x(t>0 & t<2) = (t(t>0 & t<2)-1).^2;
plot(t,x,'blue')
title('Original signal')

Xw =zeros(size(w));
for i = 1:length(w)
   basis = exp(-1i*w(i)*t);
   Xw(i) = trapz(t,x.*basis);
end

plot(w,abs(Xw),'blue')
title('Fourier transform and w_m')
hold on;
m = max(abs(Xw))/sqrt(2);
for i = length(w):-1:1001
   if(abs(abs(Xw(i))-m)<0.001)
      index=i;
      break
   end
```

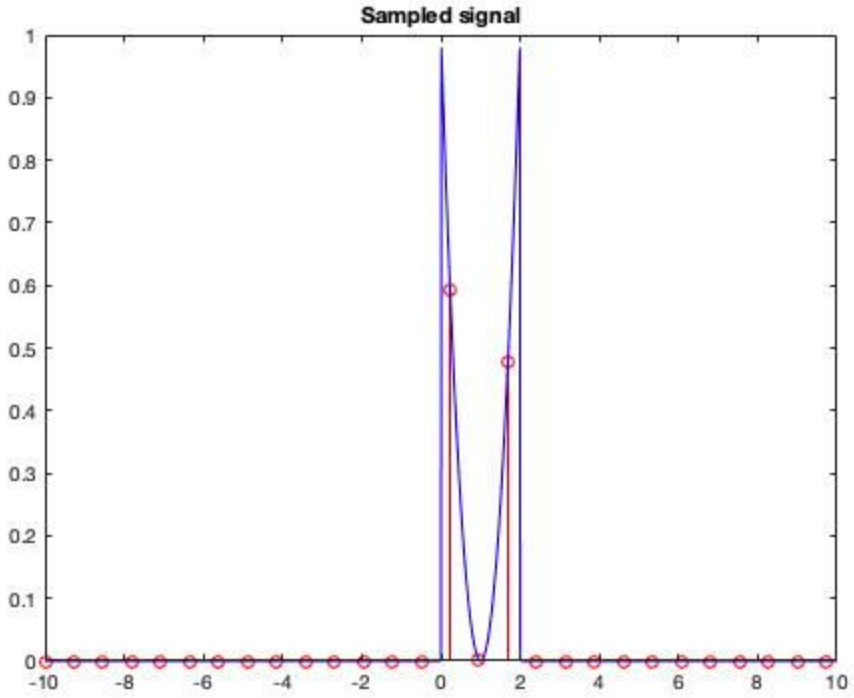
```
end
stem(-10+index*0.01,abs(Xw(index)),'red');
hold off;
w_m = (index-1000)*0.01;
fprintf('w_m is %.3f rad/s\n',w_m);
nyquist_rate = w_m/pi;
fprintf('nyquist_rate is %.3f Hz\n',nyquist_rate);

Ts = 1/nyquist_rate;
s_t = -10:Ts:10;
x2 = zeros(size(s_t));
for it = 1:length(s_t)
    x2(it) = x(find(abs(t - s_t(it)) < 0.005));
end

stem(s_t,x2,'red');
title('Sampled signal')
hold on;
plot(t,x,'blue');
hold off
```

Output:

```
W_m is 4.300 rad/s
Nyquist_rate is  1.369 Hz
```


Original signal
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-10
-8
-6
-4
-2
0
2
4
6
8
10


Fourier transform and w_m
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-10
-8
-6
-4
-2
0
2
4
6
8
10



B. $\sin^2 t / (t^2)$

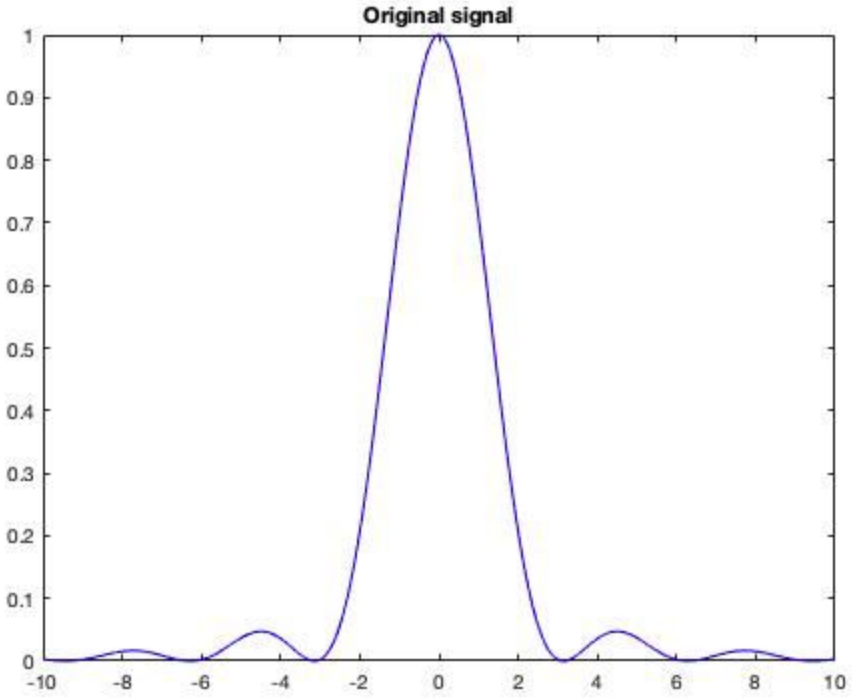
```
t = -10:0.01:10;
w = -10:0.01:10;
x = zeros(size(t));
x = (sinc(t/pi).^2);
plot(t,x,'blue')
title('Original signal')

Xw =zeros(size(w));
for i = 1:length(w)
    basis = exp(-1i*w(i)*t);
    Xw(i) = trapz(t,x.*basis);
end

plot(w,abs(Xw),'blue')
title('Fourier transform and w_m')
hold on;
```

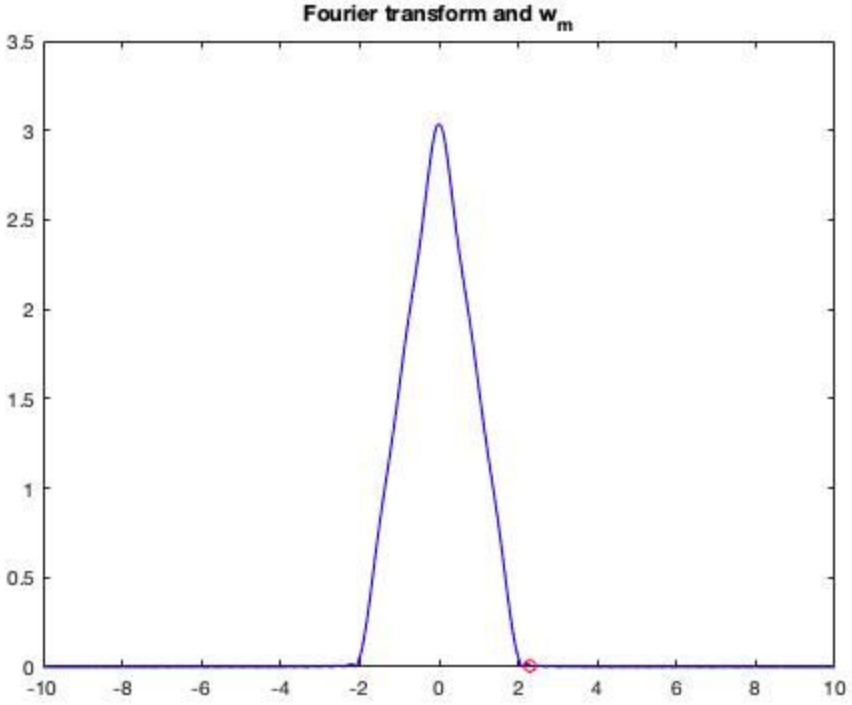
```
m = 0.02;
for i = length(w):-1:1001
    if(abs(abs(Xw(i))-m)<0.01)
        index=i;
        break
    end
end
stem(-10+index*0.01,abs(Xw(index)),'red');
hold off;
w_m = (index-1000)*0.01;
fprintf('w_m is %.3f rad/s\n',w_m);
nyquist_rate = w_m/pi;
fprintf('nyquist_rate is %.3f Hz\n',nyquist_rate);

Ts = 1/nyquist_rate;
s_t = -10:Ts:10;
x2 = zeros(size(s_t));
for it = 1:length(s_t)
    x2(it) = x(find(abs(t - s_t(it)) < 0.005));
end

stem(s_t,x2,'red');
title('Sampled signal')
hold on;
plot(t,x,'blue');
hold off
```

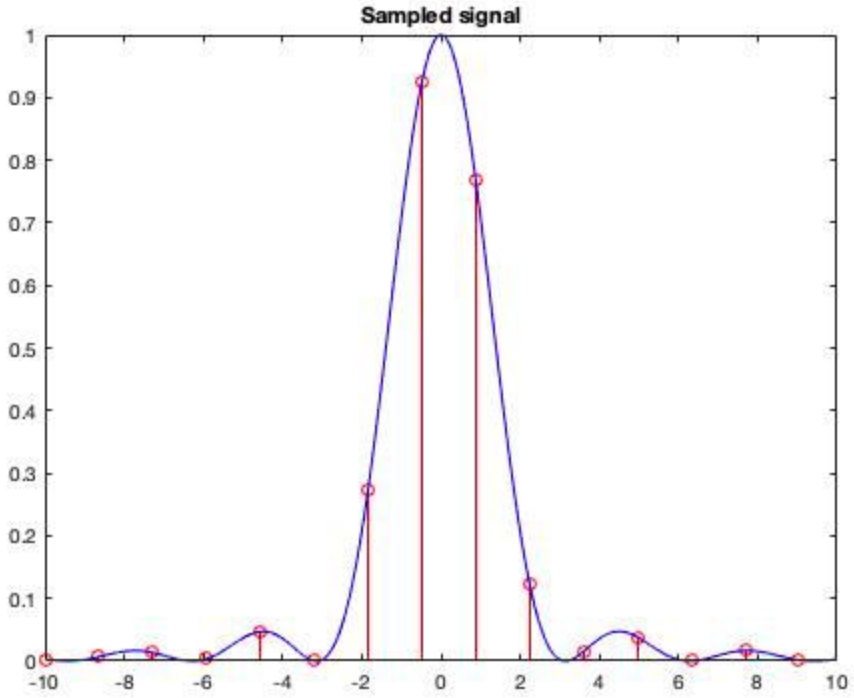
Output:

W_m is 2.310 rad/s

Nyquist_rate is 0.735 Hz


Original signal
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-10
-8
-6
-4
-2
0
2
4
6
8
10


Fourier transform and w_m
3.5
3
2.5
2
1.5
1
0.5
0
-10
-8
-6
-4
-2
0
2
4
6
8
10

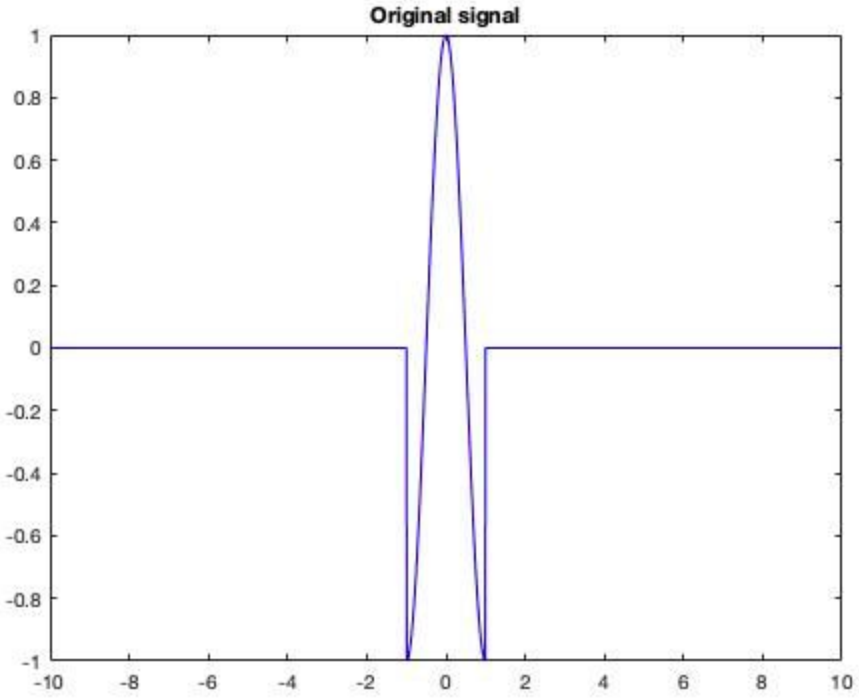


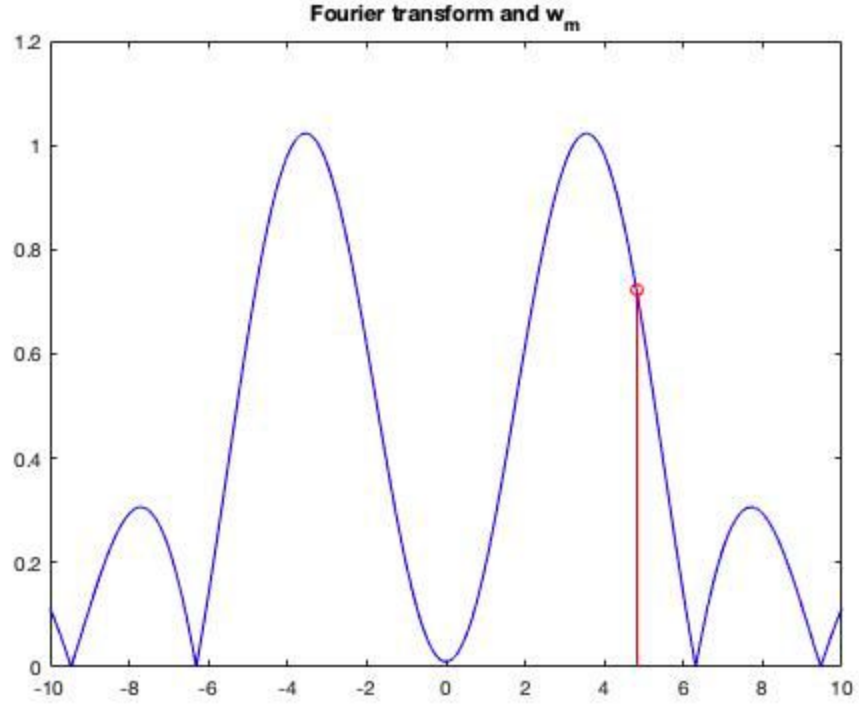
C. t = -10:0.01:10;
w = -10:0.01:10;
x = zeros(size(t));
x(t>-1 & t<1) = cos(pi*t(t>-1 & t<1));
plot(t,x,'blue')
title('Original signal')

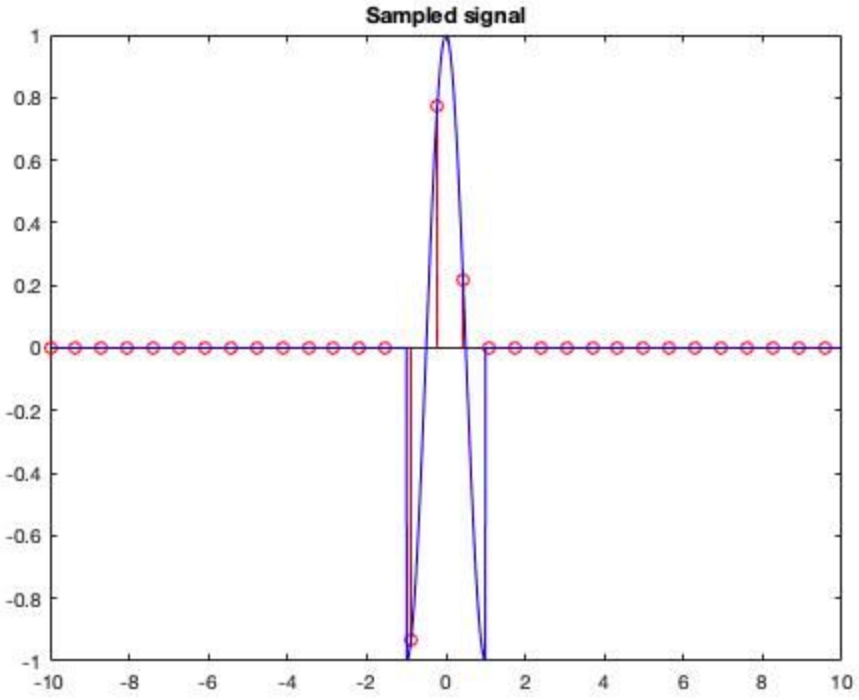
Xw =zeros(size(w));
for i = 1:length(w)
    basis = exp(-1i*w(i)*t);
    Xw(i) = trapz(t,x.*basis);
end

plot(w,abs(Xw),'blue')
title('Fourier transform and w_m')
hold on;
m = max(abs(Xw))/sqrt(2);

```
for i = length(w):-1:1001
    if(abs(abs(Xw(i))-m)<0.001)
        index=i;
        break
    end
end
stem(-10+index*0.01,abs(Xw(index)),'red');
hold off;
w_m = (index-1000)*0.01;
fprintf('w_m is %.3f rad/s\n',w_m);
nyquist_rate = w_m/pi;
fprintf('nyquist_rate is %.3f Hz\n',nyquist_rate);

Ts = 1/nyquist_rate;
s_t = -10:Ts:10;
x2 = zeros(size(s_t));
for it = 1:length(s_t)
    x2(it) = x(find(abs(t - s_t(it)) < 0.005));
end

stem(s_t,x2,'red');
title('Sampled signal')
hold on;
plot(t,x,'blue');
hold off
```


Original signal
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-10
-8
-6
-4
-2
0
2
4
6
8
10


Fourier transform and w_m
1.2
1
0.8
0.6
0.4
0.2
0
-10
-8
-6
-4
-2
0
2
4
6
8
10



Output:
W_m is 4.820 rad/s
Nyquist_rate is 1.534 Hz

Thank You