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LSS Lab 12 - Section C2 7/14/2017

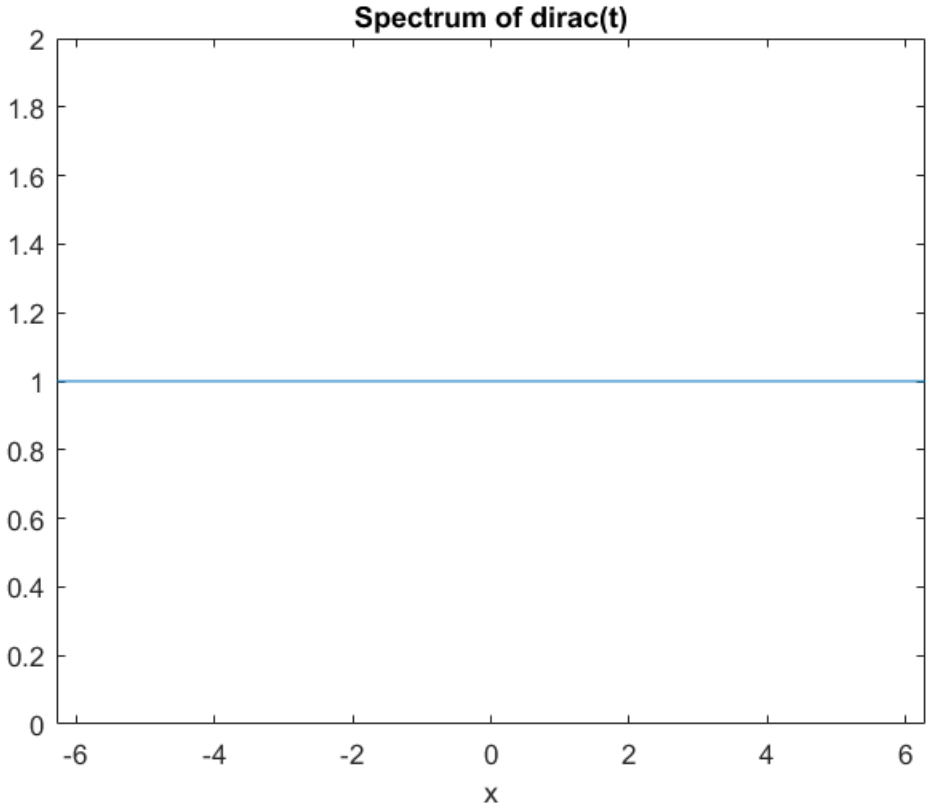
```
close all; clc; clear;
```

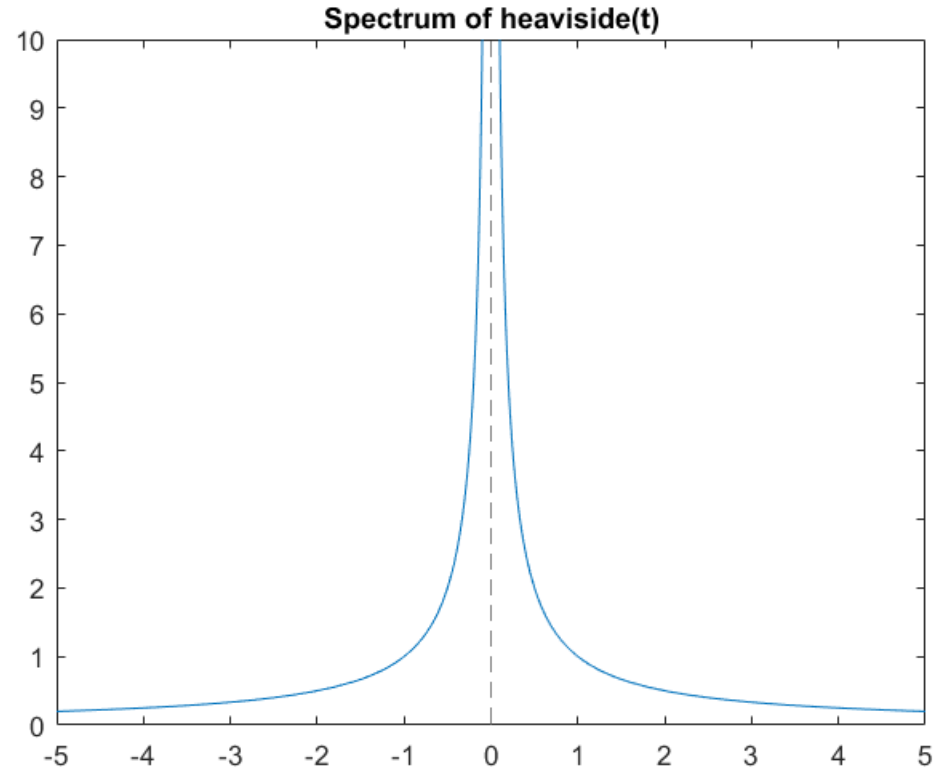
Problem 1

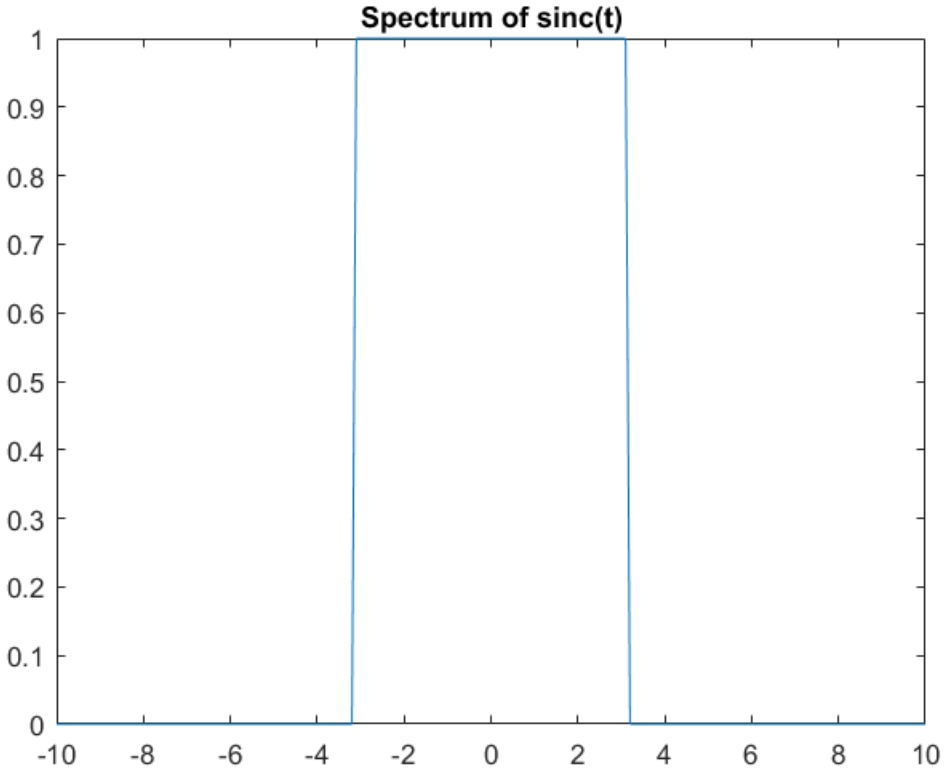
```
syms t w
w1 = -10:.1:10;

% 1.1
x1 = dirac(t);
x1 = fourier(x1)
figure;
ezplot(x1)
title('Spectrum of dirac(t)')
% Non-band limited since no zero cutoff frequency.

% 1.2
x2 = heaviside(t);
x2 = fourier(x2);
x2 = subs(x2,inf,1)
figure;
fplot(abs(x2))
ylim([0 10])
title('Spectrum of heaviside(t)')
% Non-band limited since no zero cutoff frequency.

% 1.3
x3 = sinc(t);
x3 = fourier(x3)
x3 = subs(x3,w,w1);
figure;
plot(w1,abs(x3))
title('Spectrum of sinc(t)')
% Band limited since there is zero-val cut off frequency

% % 1.4
x4 = exp(-abs(t));
x4 = fourier(x4)
```

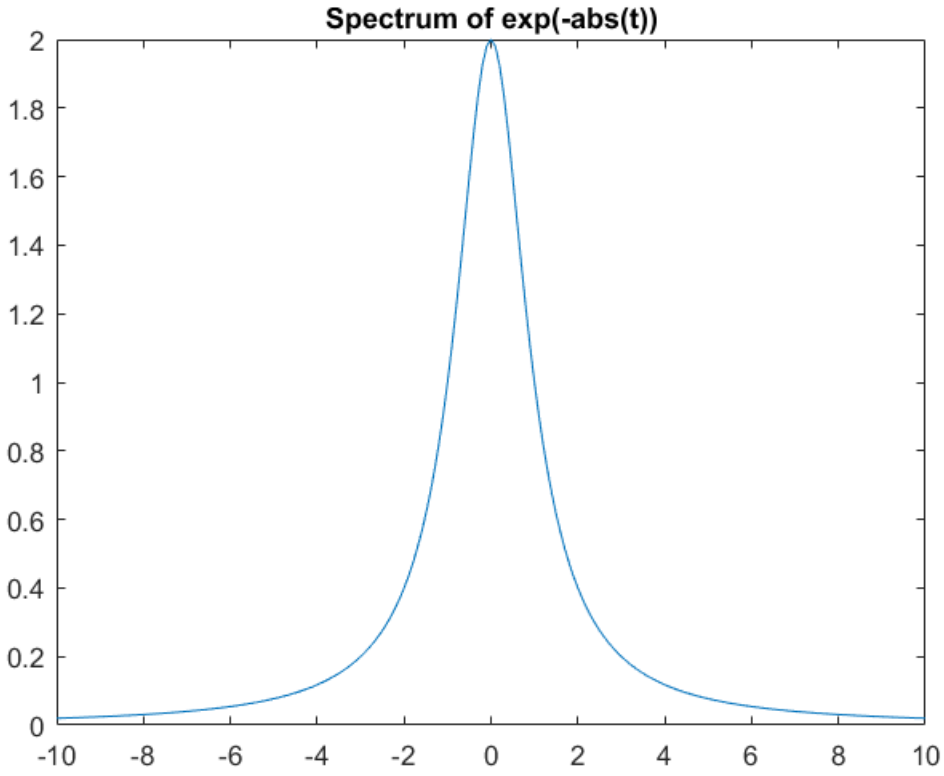
```
x4 = subs(x4,w,w1);
figure;
plot(w1,abs(x4))
title('Spectrum of exp(-abs(t))')
% Non-band limited since no zero cutoff frequency.

% 1.5
x5 = cos(t)+10*sin(15*t);
x5 = fourier(x5)
x5 = subs(x5,w,w1);
x5 = subs(x5,inf,1);
figure;
plot(w1,abs(x5))
title('Spectrum of cos(t)+10*sin(15*t)')
% Band limited since there is zero-val cut off frequency
```

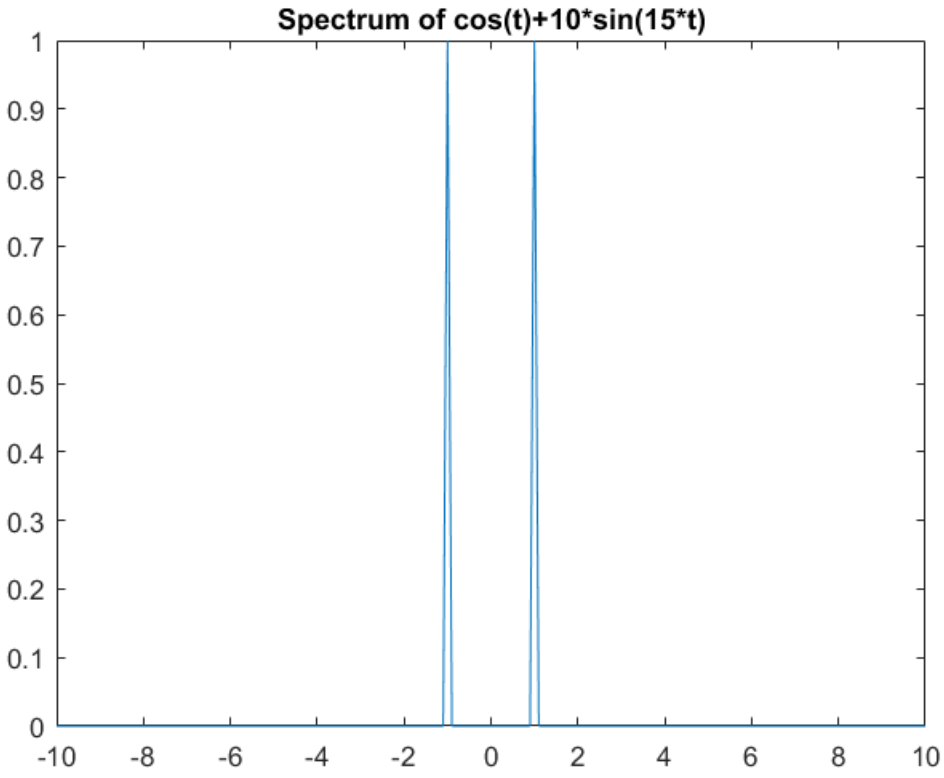
```
x1 =

1


x2 =

pi*dirac(w) - 1i/w


x3 =

(pi*heaviside(pi - w) - pi*heaviside(- w - pi))/pi


x4 =

2/(w^2 + 1)


x5 =

pi*(dirac(w - 1) + dirac(w + 1)) - pi*(dirac(w - 15) - dirac(w +
 15))*10i
```


Spectrum of dirac(t)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-6
-4
-2
0
2
4
6
x


Spectrum of heaviside(t)
10
9
8
7
6
5
4
3
2
1
0
-5
-4
-3
-2
-1
0
1
2
3
4
5


Spectrum of sinc(t)
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

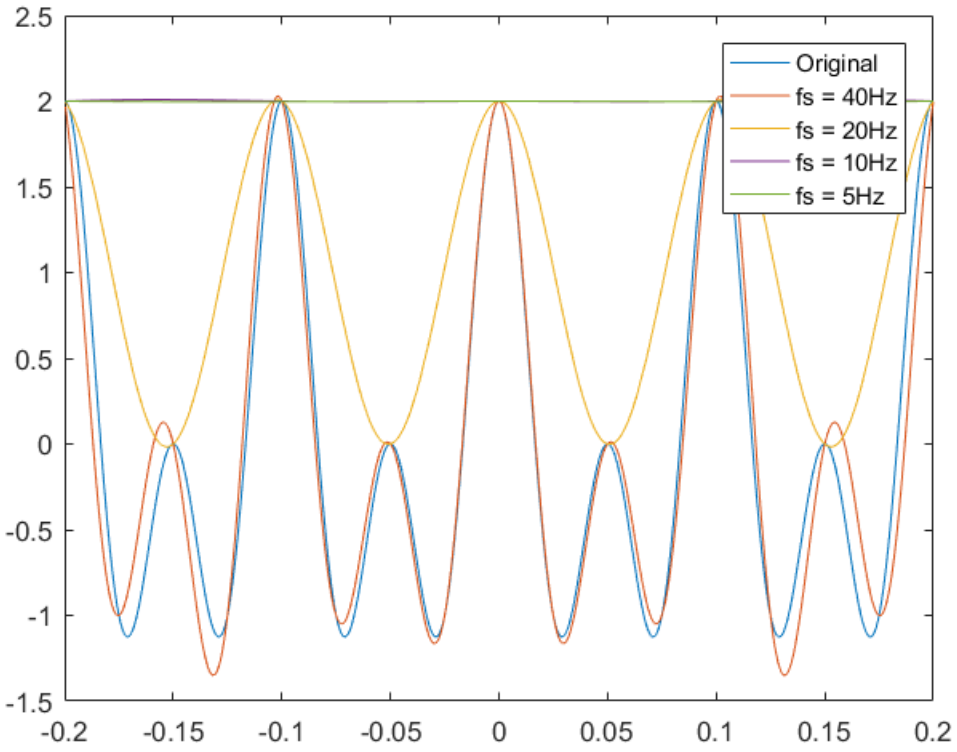

Spectrum of exp(-abs(t))
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-10
-8
-6
-4
-2
0
2
4
6
8
10



Problem 2

```
syms t w n

x = @(t) cos(20*pi*t)+cos(40*pi*t);

figure;
fplot(x)
hold on;

fs = 40;
T = 1/fs;
x1 = symsum(x(n*T).*sinc((t-n*T)/T),n,-10,10);
fplot(x1)

fs = 20;
T = 1/fs;
x2 = symsum(x(n*T).*sinc((t-n*T)/T),n,-10,10);
fplot(x2)

fs = 10;
T = 1/fs;
x3 = symsum(x(n*T).*sinc((t-n*T)/T),n,-10,10);
fplot(x3)
```

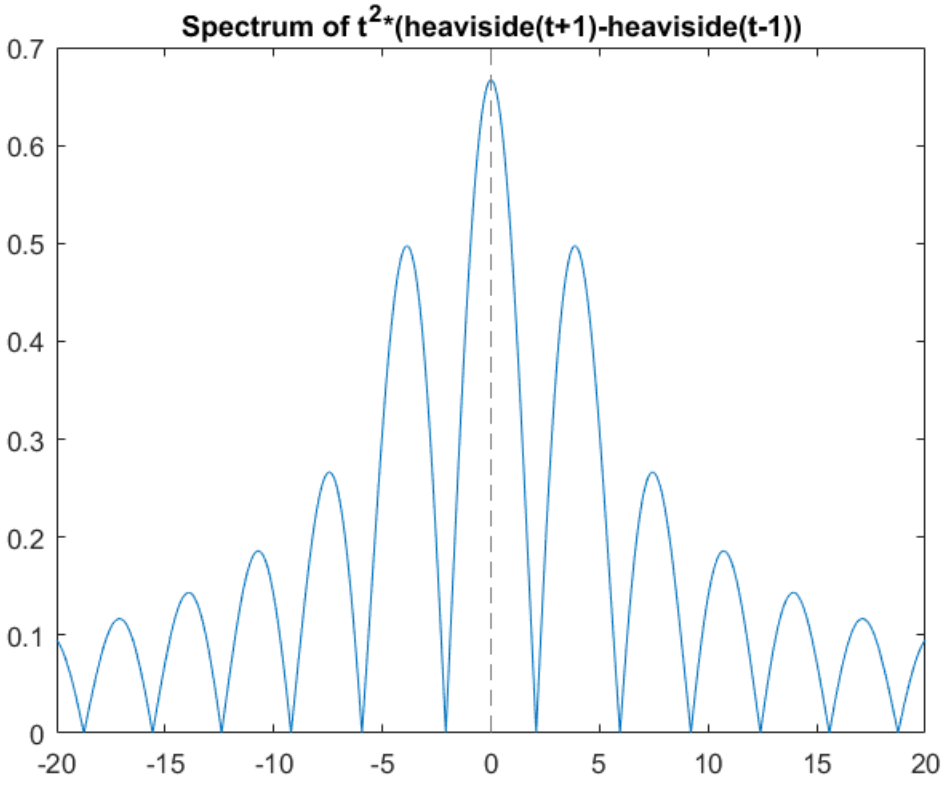
```
fs = 5;
T = 1/fs;
x4 = symsum(x(n*T).*sinc((t-n*T)/T),n,-10,10);
fplot(x4)
xlim([-.2 .2]), ylim([-1.5 2.5])
legend('Original', 'fs = 40Hz', 'fs = 20Hz', 'fs = 10Hz', 'fs = 5Hz')
hold off;

% Note: The n-values should be -inf to inf when summing. However,
% -10:10 n-values were chosen to run the code smoothly without
% crashing. Lower n-vals cause a lack in accuracy as the plot
% extends from the y-axis, however the x-lims were adjusted
% closely to view a more accurate graph of the reconstructed plots.
```

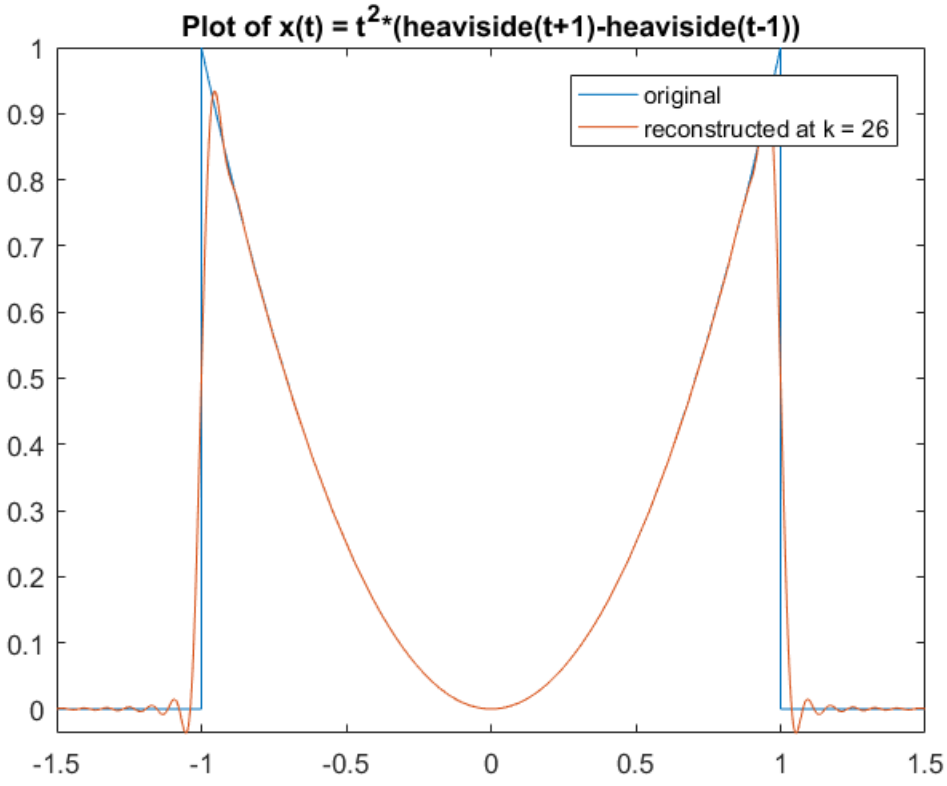


Problem 3

```
syms t w
% w = -10:.1:10;

x = t.^2*(heaviside(t+1)-heaviside(t-1));
xf = fourier(x);
figure;
fplot(abs(xf))
xlim([-20 20]), ylim([0 .7])
title('Spectrum of t^2*(heaviside(t+1)-heaviside(t-1))')
% non band limited since there is no cut-off frequency for zero value.
```

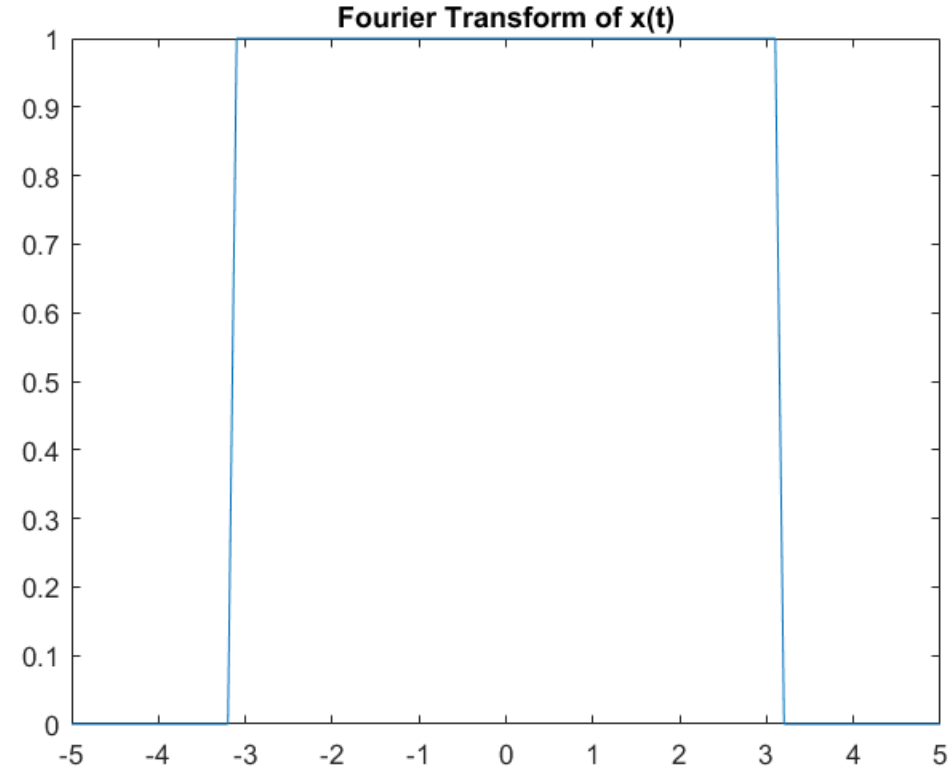
```
fun = @(t) abs(t.^2.*(heaviside(t+1)-heaviside(t-1))).^2;
ex = integral(fun,-inf,inf);
exmin = ex*.98;

fun = (1/(2*pi))*abs(xf).^2;

k = 20;
while 1
    exf = int(fun,w,-k*pi,k*pi);
    exf = vpa(exf,4);
    if exf > exmin
        break
    end
    k = k+1;
end

% At k = 26, the energy signal > .3920

figure;
fplot(x);
hold on;
x = @(t) t.^2*(heaviside(t+1)-heaviside(t-1));

fs = k;
T = 1/fs;
x1 = symsum(x(n*T).*sinc((t-n*T)/T),n,-50,50);
fplot(x1)

hold off;
title('Plot of x(t) = t^2*(heaviside(t+1)-heaviside(t-1))')
legend('original','reconstructed at k = 26')
xlim([-1.5 1.5])

% N-vals of -50:50 were chosen, in theory the values should be -
inf:inf.
```

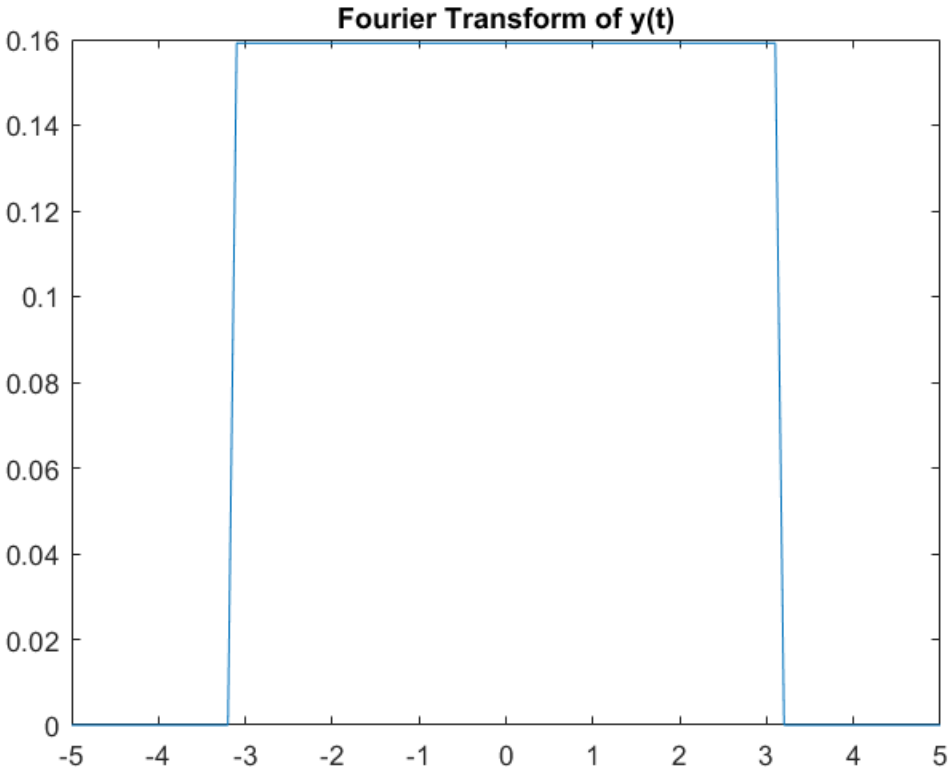

Spectrum of t^2*(heaviside(t+1)-heaviside(t-1))
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-20
-15
-10
-5
0
5
10
15
20

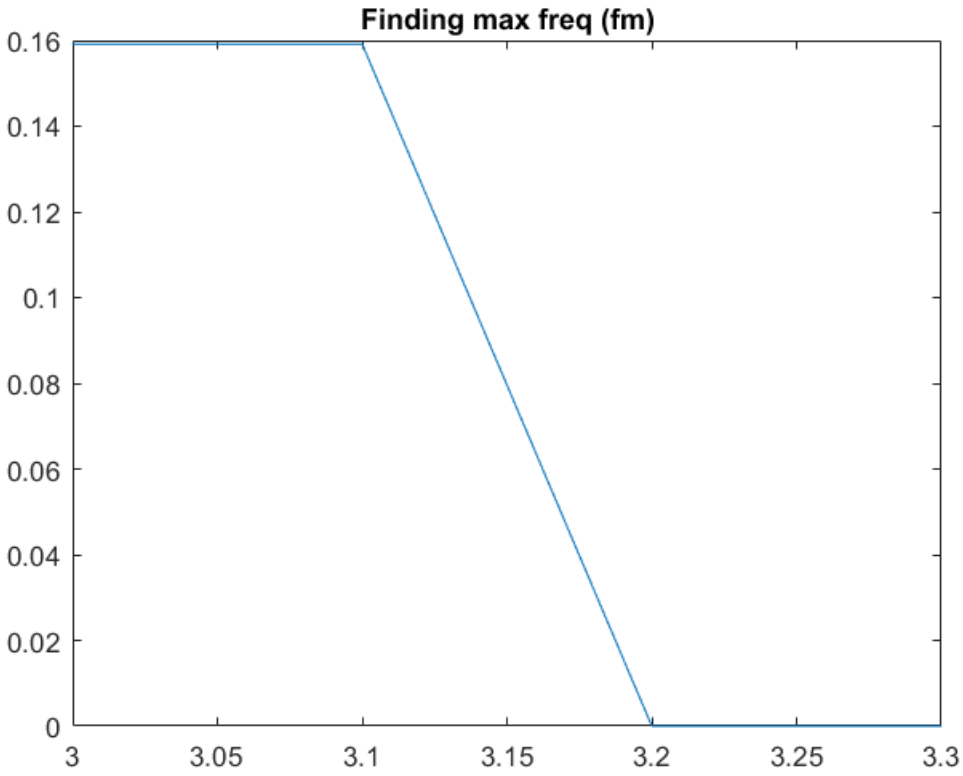

Plot of x(t) = t^2*(heaviside(t+1)-heaviside(t-1))
original
reconstructed at k = 26
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-1.5
-1
-0.5
0
0.5
1
1.5

Problem 4

```
syms t w
w1 = -5:.1:5;

x = sinc(t);
y = x.^2;

%4.1
xf = fourier(x);
xf = subs(xf,w,w1);
figure;
plot(w1,xf)
title('Fourier Transform of x(t)')

%4.2
xef = xf.*xf.*(1./(2.*pi));
figure;
plot(w1,xef);
title('Fourier Transform of y(t)')

%4.3
figure;
plot(w1,xef);
xlim([3 3.3])
title('Finding max freq (fm)')
% y(t) is band limited, the max frequency is w = pi
```


Fourier Transform of x(t)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-5
-4
-3
-2
-1
0
1
2
3
4
5


Fourier Transform of y(t)
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
-5
-4
-3
-2
-1
0
1
2
3
4
5



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