EXPERIMENT – 7

18BIS0043

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ECE1018

L21+L22

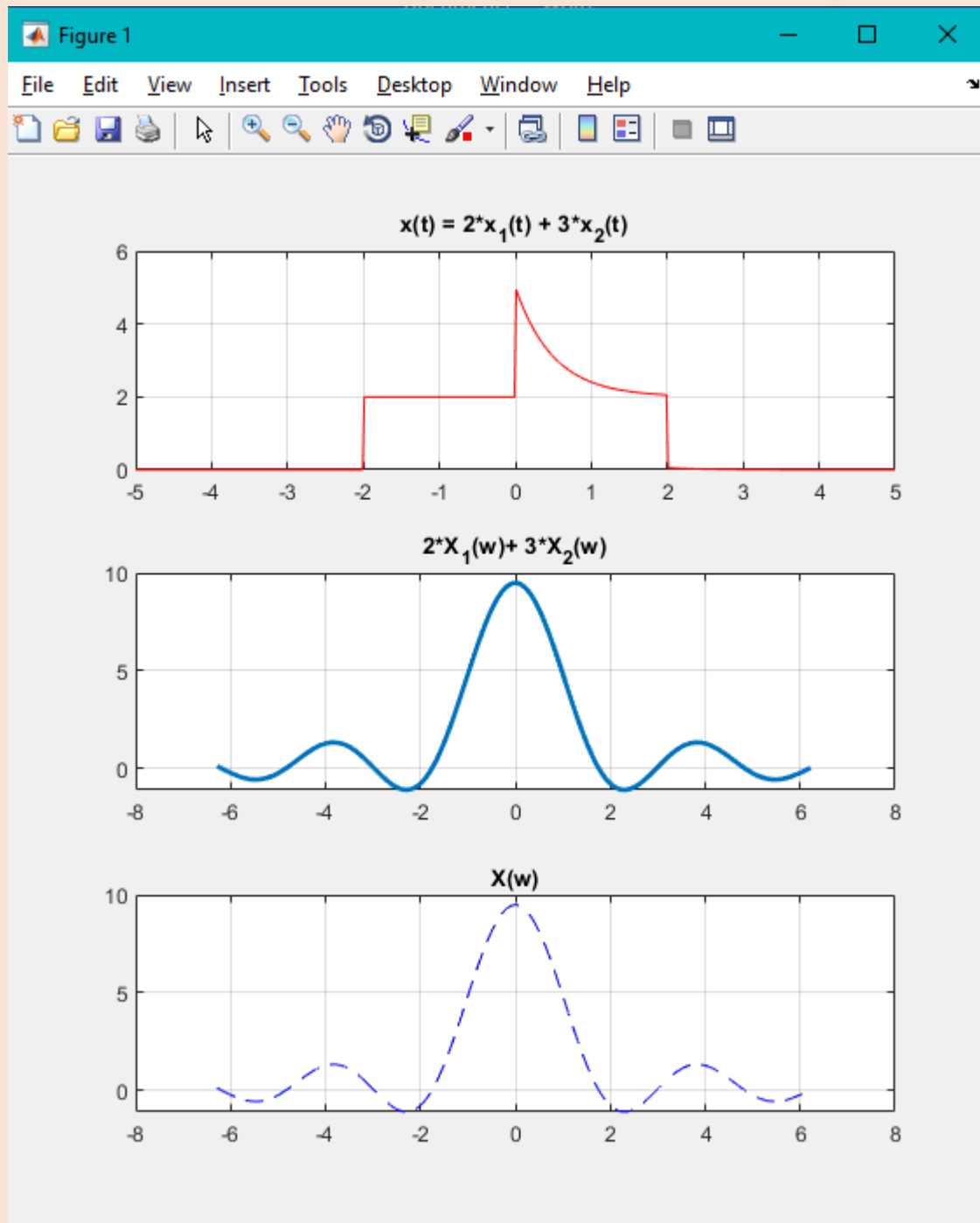## 1. Linearity – a:

```
Editor - C:\Users\allen\Documents\MATLAB\T1.m
  E8_1.m  ×   E7a_1.m  ×   E7b_1.m  ×   Labcat.m  ×   T1.m  ×
 1 -     clear all
 2 -     clc
 3
 4 -     syms t
 5 -     x1 = heaviside(t+2)-heaviside(t-2);
 6 -     x2 = exp(-t*2)*heaviside(t);
 7 -     x = 2*x1+3*x2; % alpha = 2, beta = 3
 8
 9 -     X1 = fourier(x1);
10 -     X2 = fourier(x2);
11 -     X = fourier(x);
12 -     t = [-5:0.01:5];
13 -     w = [-2*pi:.1:2*pi];
14
15 -     x1 = heaviside(t+2) - heaviside(t-2);
16 -     x2 = exp(-t*2).*heaviside(t);
17 -     x = 2*x1+3*x2;
18 -     X1 = 2./w.*sin(2*w);
19 -     X2 = 1./(2+i*w);
20 -     X = 4./w.*sin(2*w)+3./(2+i*w);
21
22 -     subplot(3,1,1)
23 -     plot(t,x,'r');
24 -     grid on;
25 -     title('x(t) = 2*x_1(t) + 3*x_2(t)');
26
```

```
26
27 -     subplot(3,1,2)
28 -     plot(w,(2*X1+3*X2),'linewidth',2);
29 -     grid on;
30 -     title('2*X_1(w)+ 3*X_2(w)');
31
32 -     subplot(3,1,3)
33 -     plot(w,(X),'b--');
34 -     grid on;
35 -     title('X(w)');
36
```

Figure 1

File   Edit   View   Insert   Tools   Desktop   Window   Help

$x(t) = 2*x_1(t) + 3*x_2(t)$

$2*X_1(w) + 3*X_2(w)$

$X(w)$

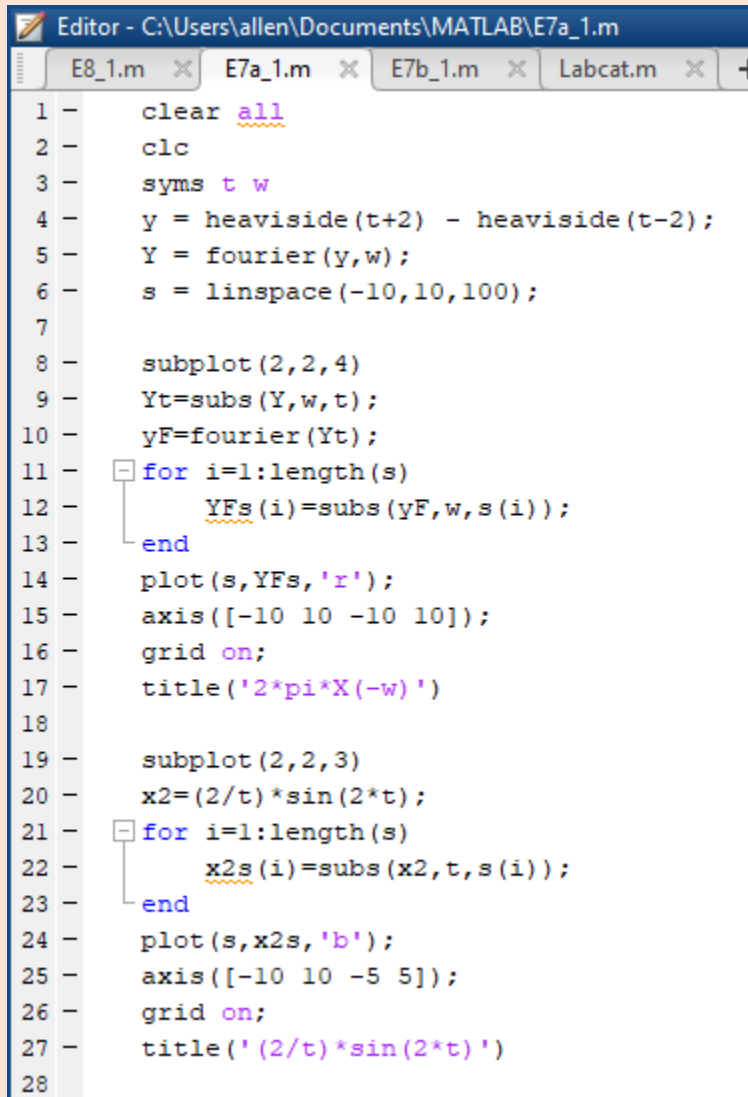## *2. Linearity - b*

```
Editor - C:\Users\allen\Documents\MATLAB\T2.m
  E8_1.m  ×   E7a_1.m  ×   E7b_1.m  ×   Labcat.m  ×   T1.
 1 -      clear all
 2 -      clc
 3
 4 -      syms t
 5 -      x1 = heaviside(t+2)-heaviside(t-2);
 6 -      x2 = exp(-t*2)*heaviside(t);
 7 -      x = 2*x1+3*x2; % alpha = 2, beta = 3
 8
 9 -      X1 = fourier(x1);
10 -      X2 = fourier(x2);
11 -      X = fourier(x);
12 -      t = [-5:0.01:5];
13 -      w = [-2*pi:.1:2*pi];
14
15 -      x1 = heaviside(t+2) - heaviside(t-2);
16 -      x2 = exp(-t*2).*heaviside(t);
17 -      x = 2*x1+3*x2;
18 -      X1 = 2./w.*sin(2*w);
19 -      X2 = 1./(2+i*w);
20 -      X = 4./w.*sin(2*w)+3./(2+i*w);
21
```

```
26
27 -      subplot(2,2,2)
28 -      plot(w,abs(X),'r');
29 -      grid on;
30 -      title('X(w)');
31
32 -      subplot(2,2,3)
33 -      plot(w,angle(2*X1+3*X2),'linewidth',1);
34 -      grid on;
35 -      title('2*X_1(w)+ 3*X_2(w)');
36
37 -      subplot(2,2,4)
38 -      plot(w,angle(X),'r');
39 -      grid on;
40 -      title('X(w)');
41
```
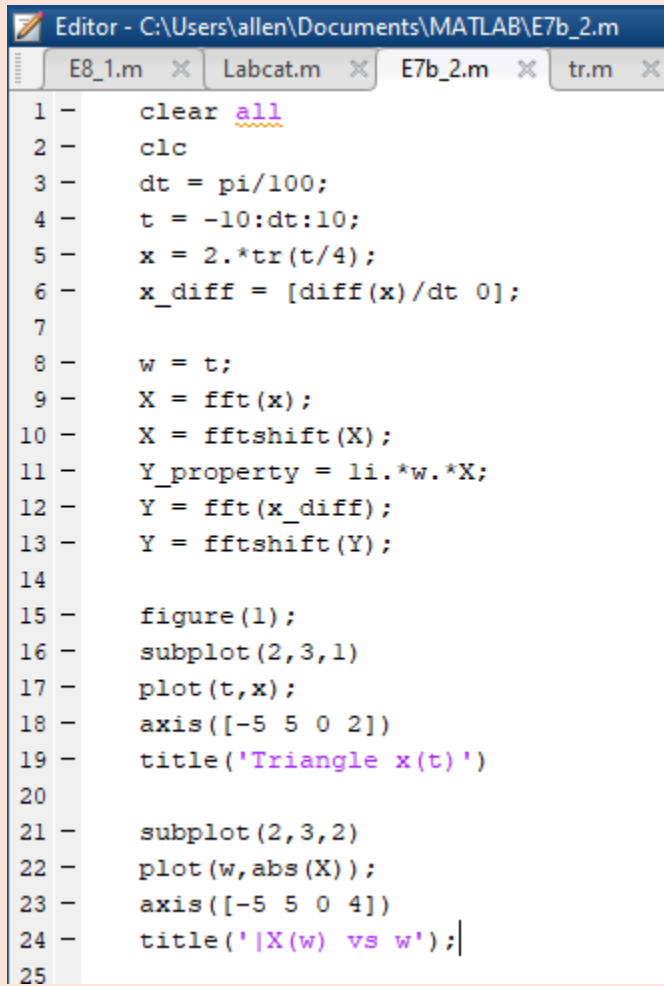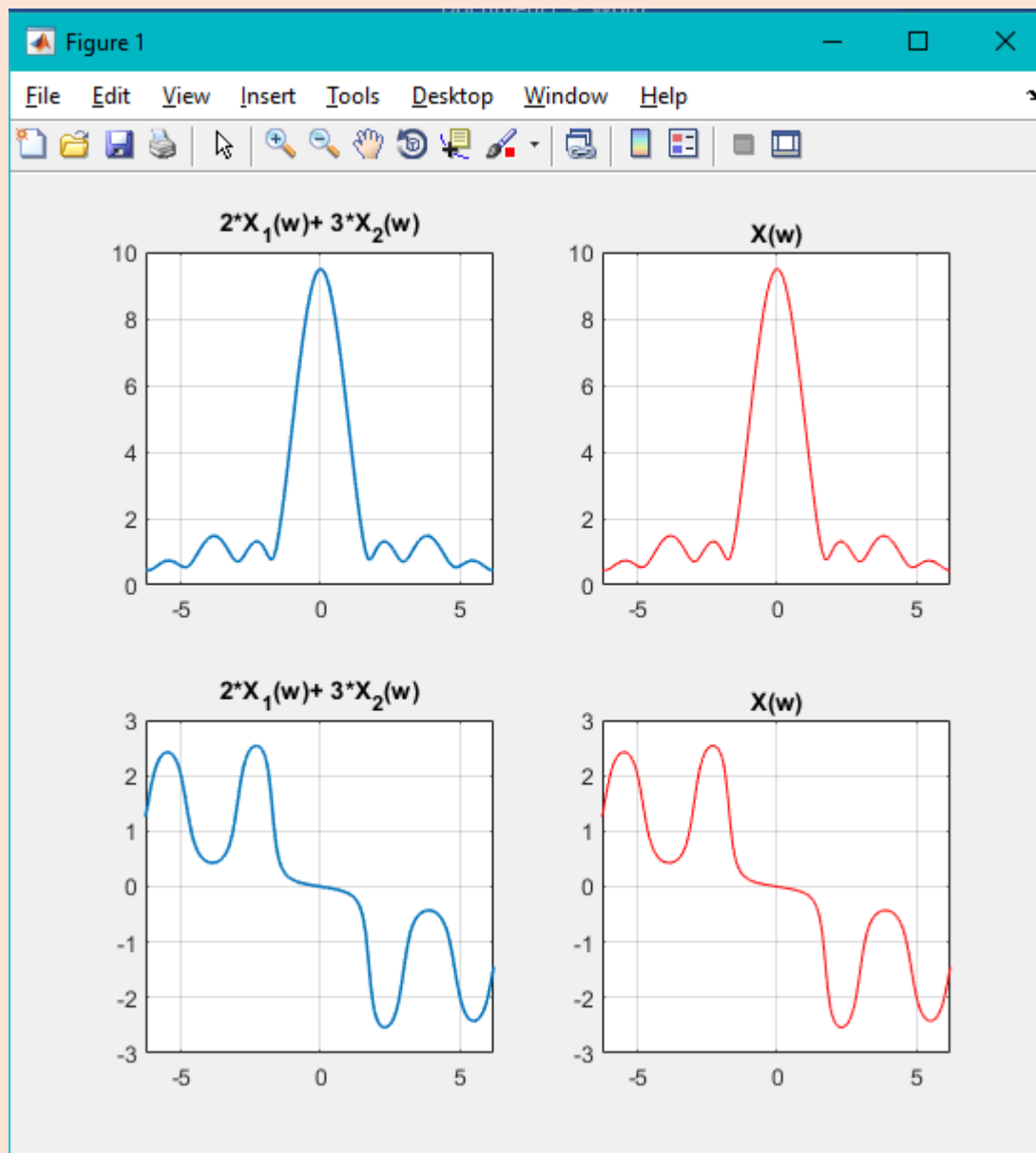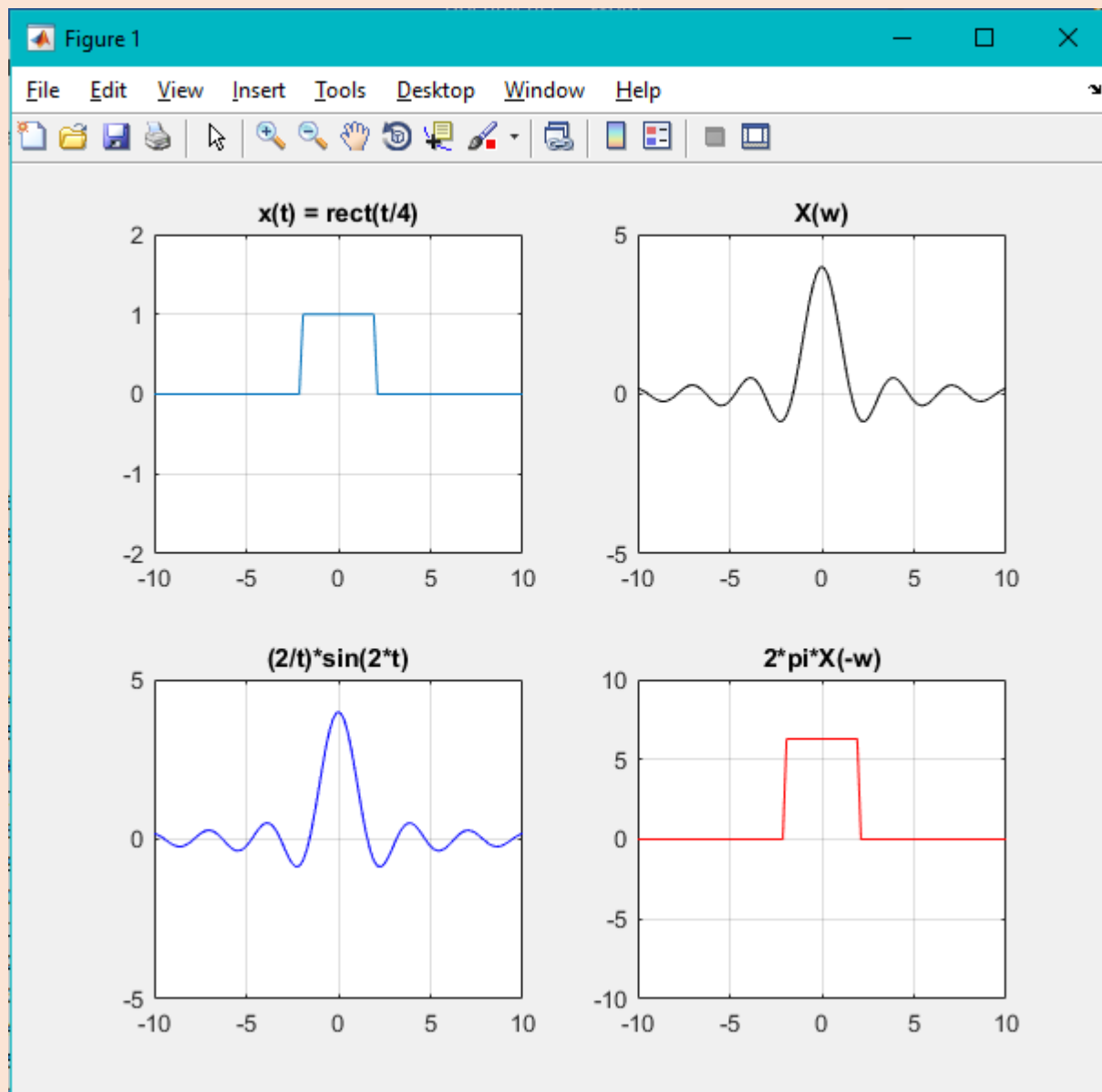
3. Duality

```
Editor - C:\Users\allen\Documents\MATLAB\E7a_1.m
  E8_1.m  ×   E7a_1.m  ×   E7b_1.m  ×   Labcat.m  ×   +
 1 -      clear all
 2 -      clc
 3 -      syms t w
 4 -      y = heaviside(t+2) - heaviside(t-2);
 5 -      Y = fourier(y,w);
 6 -      s = linspace(-10,10,100);
 7
 8 -      subplot(2,2,4)
 9 -      Yt=subs(Y,w,t);
10 -      yF=fourier(Yt);
11 -      for i=1:length(s)
12 -          YFs(i)=subs(yF,w,s(i));
13 -      end
14 -      plot(s,YFs,'r');
15 -      axis([-10 10 -10 10]);
16 -      grid on;
17 -      title('2*pi*X(-w)')
18
19 -      subplot(2,2,3)
20 -      x2=(2/t)*sin(2*t);
21 -      for i=1:length(s)
22 -          x2s(i)=subs(x2,t,s(i));
23 -      end
24 -      plot(s,x2s,'b');
25 -      axis([-10 10 -5 5]);
26 -      grid on;
27 -      title('(2/t)*sin(2*t)')
28
```

```
28
29 -     subplot(2,2,2)
30 -     for i=1:length(s)
31 -         Ys(i)=subs(Y,w,s(i));
32 -     end
33 -     plot(s,Ys,'k');
34 -     axis([-10 10 -5 5]);
35 -     grid on;
36 -     title('X(w)');
37
38
39 -     subplot(2,2,1)
40 -     for i=1:length(s)
41 -         ys(i)=subs(y,t,s(i));
42 -     end
43 -     plot(s,ys);
44 -     xlim([-10,10]);
45 -     ylim([-2,2]);
46 -     grid on;
47 -     title('x(t) = rect(t/4)');
48
```
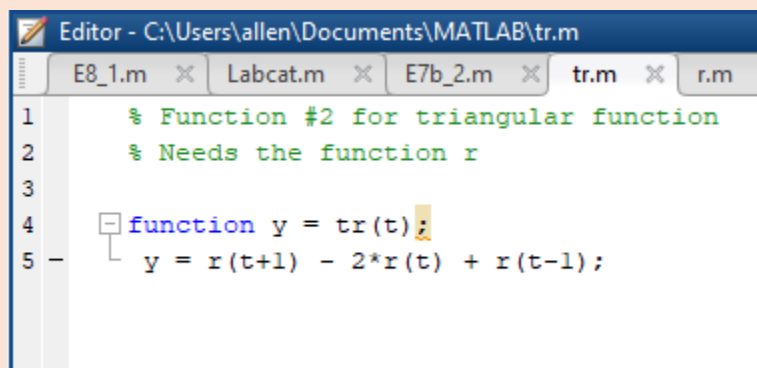
4. Differentiation property

```
Editor - C:\Users\allen\Documents\MATLAB\E7b_2.m
  E8_1.m  ✕   Labcat.m  ✕   E7b_2.m  ✕   tr.m  ✕
 1 -    clear all
 2 -    clc
 3 -    dt = pi/100;
 4 -    t = -10:dt:10;
 5 -    x = 2.*tr(t/4);
 6 -    x_diff = [diff(x)/dt 0];
 7
 8 -    w = t;
 9 -    X = fft(x);
10 -    X = fftshift(X);
11 -    Y_property = 1i.*w.*X;
12 -    Y = fft(x_diff);
13 -    Y = fftshift(Y);
14
15 -    figure(1);
16 -    subplot(2,3,1)
17 -    plot(t,x);
18 -    axis([-5 5 0 2])
19 -    title('Triangle x(t)')
20
21 -    subplot(2,3,2)
22 -    plot(w,abs(X));
23 -    axis([-5 5 0 4])
24 -    title('|X(w) vs w');
25
```

```
20
21 -     subplot(2,3,2)
22 -     plot(w,abs(X));
23 -     axis([-5 5 0 4])
24 -     title('|X(w) vs w');
25
26 -     subplot(2,3,3)
27 -     plot(w,angle(X));
28 -     axis([-5 5 -1 1])
29 -     title('<X(w) vs w');
30
31 -     subplot(2,3,4)
32 -     plot(t,x_diff);
33 -     axis([-5 5 -1.5 1.5])
34 -     title('y(t) = d(x(t)/dt');
35
36 -     subplot(2,3,5)
37 -     plot(w,abs(Y_property));
38 -     axis([ -5 5 0 3])
39 -     title('|Y(w)| vs w');
40
41 -     subplot(2,3,6)
42 -     plot(w,angle(Y_property));
43 -     axis([-10 10 -2 2])
44 -     title('<Y(w) vs w')
45
```
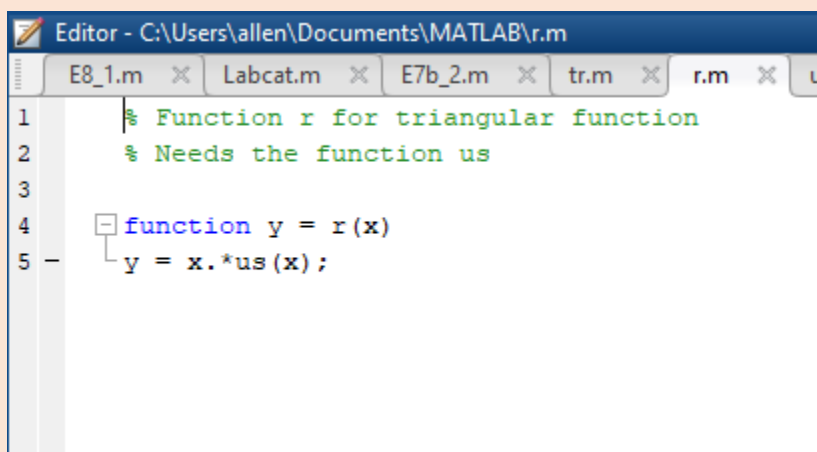
Triangular function:

```
Editor - C:\Users\allen\Documents\MATLAB\tr.m
  E8_1.m  X  Labcat.m  X  E7b_2.m  X  tr.m  X  r.m
1      % Function #2 for triangular function
2      % Needs the function r
3
4    function y = tr(t);
5 -      y = r(t+1) - 2*r(t) + r(t-1);
```

```
45
46 -    figure(2)
47 -    subplot(2,2,1)
48 -    plot(w,abs(Y));
49 -    axis([-5 5 0 4]);
50 -    title('|Y(w)| vs w');
51
52 -    subplot(2,2,2)
53 -    plot(w,angle(Y));
54 -    axis([-5 5 -2 2]);
55 -    title('<Y(w) vs w');
56
57 -    subplot(2,2,3)
58 -    plot(w,abs(Y_property));
59 -    axis([-5 5 0 4]);
60 -    title('|jw*X(w)| vs w');
61
62 -    subplot(2,2,4)
63 -    plot(w,angle(Y_property));
64 -    axis([-5 5 -2 2]);
65 -    title('<jw*X(w) vs w');
66
67
68
```
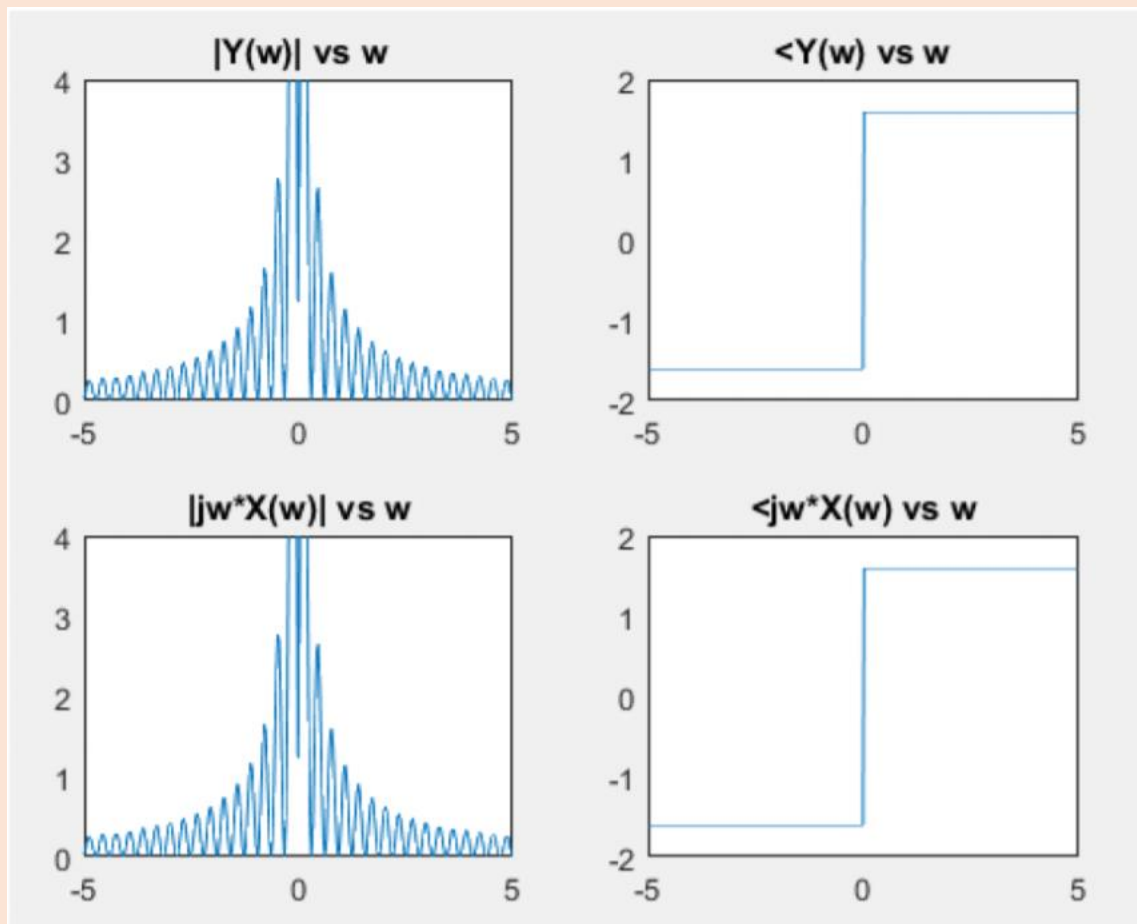
Rectangular function:

```
Editor - C:\Users\allen\Documents\MATLAB\r.m
E8_1.m  ×  Labcat.m  ×  E7b_2.m  ×  tr.m  ×  r.m  ×  u
1       % Function r for triangular function
2       % Needs the function us
3
4       function y = r(x)
5 -     y = x.*us(x);
```
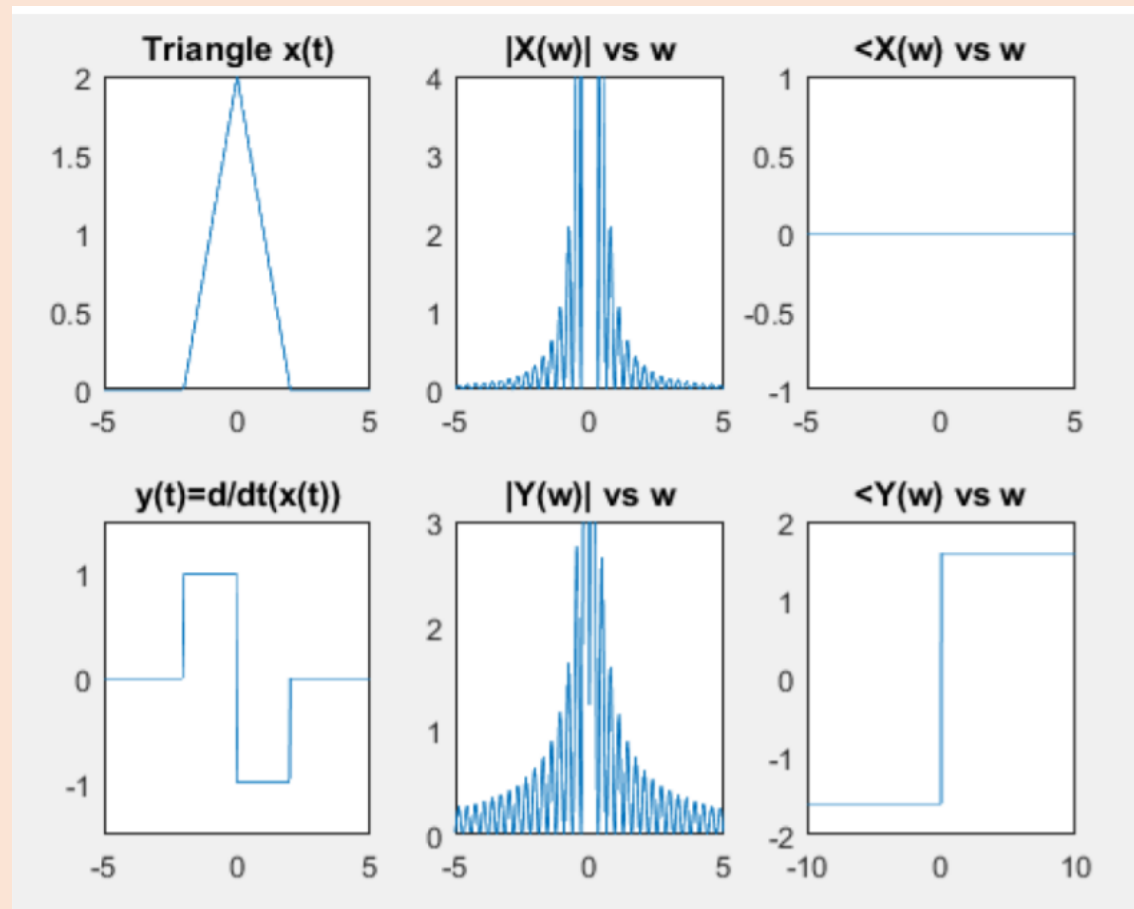
5. Lab – CAT

```
Editor - C:\Users\allen\Documents\MATLAB\Labcat.m
Labcat.m  ⊠  +
1 -    clc
2 -    clear all
3 -    t = linspace(-5,5,1000);
4 -    w = linspace(-3*pi,3*pi,1000);
5 -    x = -(heaviside(t+1) - heaviside(t)) + (heaviside(t) - heaviside(t-1));
6 -    y = tr(4*t)
7 -    Y = fft(y);
8 -    Y = fftshift(Y);
9 -    X = li.*w.*Y;
10
11 -   subplot(3,1,1)
12 -   plot(t,x,'r')
13 -   title('x(t)');
14 -   axis([-5 5 -2 2]);
15 -   grid on;
16
17 -   subplot(3,1,2)
18 -   plot(t,y,'b')
19 -   title('y(t)');
20 -   grid on;
21
22 -   subplot(313)
23 -   plot(w,abs(X),'k');
24 -   title('|X(w)|');
25 -   axis([-5 5 -1 6]);
26 -   grid on;
```