Eric Jiang - 158002948

Table of Contents

Lab 4 - Section C2

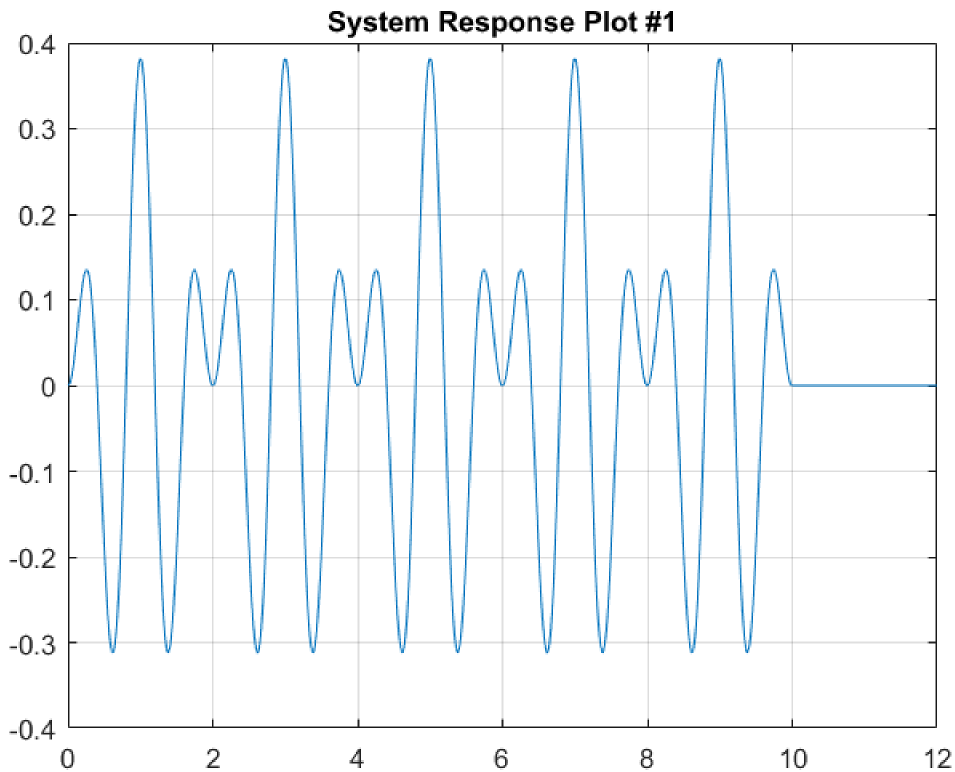
Problem 1

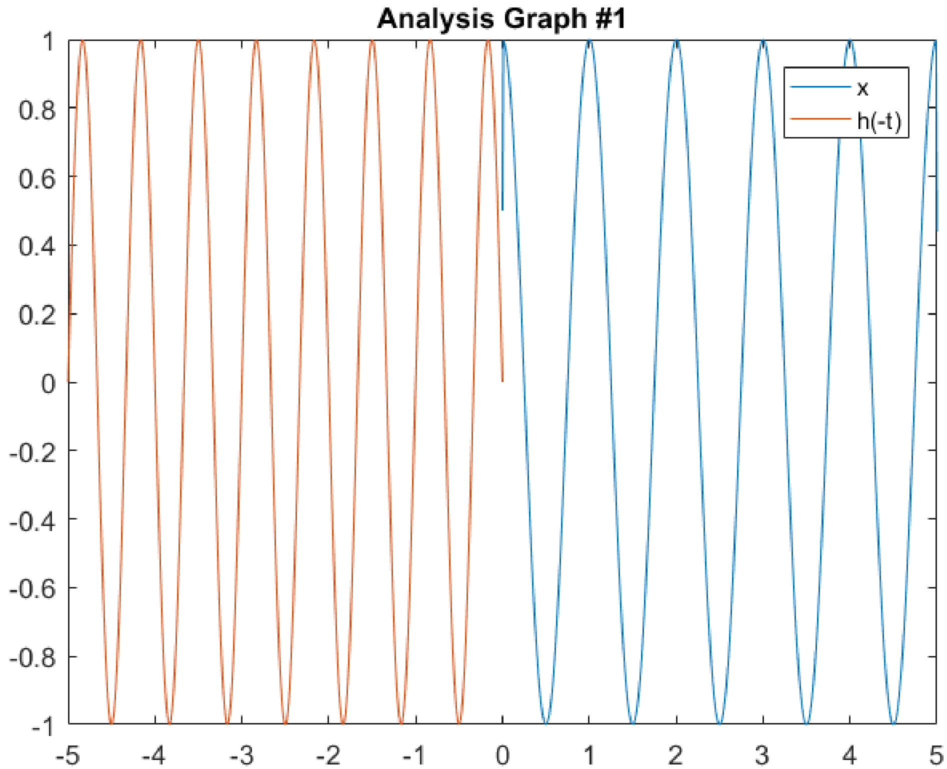
```
close all; clc; clear;
% Conv Method

s = 0.01;
t = 0:s:6;
x = cos(2*pi*t).*(heaviside(t)-heaviside(t-5));
h = sin(3*pi*t).*(heaviside(t)-heaviside(t-5));
y = conv(x,h)*s;
ty = 0:s:12;

figure;
plot(ty,y);
title('System Response Plot #1');
grid on;

figure;
plot(t,x)
hold on;
plot(-t,h)
legend('x','h(-t)')
xlim([-5 5])
title('Analysis Graph #1')

% Use the h(-t) and x(t) graphs to analyze the time boundaries

% 5 Step Method

syms t r
xt = cos(2*pi*r).*(heaviside(r)-heaviside(r-5)); % x(tau)
ht = sin(3*pi*t-r).*(heaviside(t-r)-heaviside(t-r-5)); % h(t - tau)
f = xt.*ht; % x(tau)*h(t-tau)

% step 1 - no overlap 1: t < 0
t0 = [-inf 0];
y0 = 0

% step 2 - Partial overlap entering: 0 < t < 5
t1 = [0:5];
```

```
y1 = int(f,r,0,t)

% step 3 - Full overlap: t = 5
t2 = 5;
y2 = int(f,r,t-5,t)

% step 4 - Partial overlap leaving: 5 < t < 10
t3 = [5:10];
y3 = int(f,r,t-5,5)

% step 5 - no overlap 2: t > 10
t4 = [10 inf];
y4 = 0
```

```
y0 =

    0


y1 =

heaviside(t - 10)*(cos(3*pi*t - 5)/(4*pi - 2) - cos(3*pi*t - 5)/(4*pi
 + 2) - cos(3*pi*t + (2*pi - 1)*(t - 5))/(4*pi - 2) + cos(3*pi*t
 - (2*pi + 1)*(t - 5))/(4*pi + 2)) + heaviside(t)*(cos(3*pi*t)/
(4*pi - 2) - cos(3*pi*t)/(4*pi + 2) - cos(3*pi*t + t*(2*pi - 1))/
(4*pi - 2) + cos(3*pi*t - t*(2*pi + 1))/(4*pi + 2)) - heaviside(t -
 5)*(cos(3*pi*t)/(4*pi - 2) - cos(3*pi*t)/(4*pi + 2) - cos(3*pi*t +
 (2*pi - 1)*(t - 5))/(4*pi - 2) + cos(3*pi*t - (2*pi + 1)*(t - 5))/
(4*pi + 2)) + heaviside(t - 5)*(cos(3*pi*t + t*(2*pi - 1))/(4*pi - 2)
 - cos(3*pi*t - t*(2*pi + 1))/(4*pi + 2) - cos(3*pi*t - 5)/(4*pi - 2)
 + cos(3*pi*t - 5)/(4*pi + 2))


y2 =

piecewise(t == 5, (2*cos(5) - 2)/(8*pi^2 - 2), t <= 5, (heaviside(t
 - 5)*(cos(t*(5*pi - 1)) + cos(t*(pi - 1)) - 2*cos(3*pi*t - 5)
 + pi*(2*cos(t*(5*pi - 1)) - 2*cos(t*(pi - 1)))))/(8*pi^2 - 2) -
 (heaviside(t)*(cos(t*(5*pi - 1)) - 2*cos(3*pi*t) + cos(t*(pi - 1))
 + pi*(2*cos(t*(5*pi - 1)) - 2*cos(t*(pi - 1)))))/(8*pi^2 - 2), 10
 <= t, 0, t in Dom::Interval([5], [10]), cos(5*pi*t - t + 5)/(4*pi
 - 2) - cos(pi*t - t + 5)/(4*pi + 2) - cos(t*(5*pi - 1))/(4*pi - 2)
 + cos(t*(pi - 1))/(4*pi + 2) + (heaviside(t - 5)*(cos(t*(5*pi - 1))
 + cos(t*(pi - 1)) - 2*cos(3*pi*t - 5) + pi*(2*cos(t*(5*pi - 1)) -
 2*cos(t*(pi - 1)))))/(8*pi^2 - 2))


y3 =

piecewise(t == 5, (cos(5) - 1)/(4*pi^2 - 1), 5 <= t, -heaviside(10
 - t)*(cos(pi*t - t + 5)/(4*pi + 2) - cos(5*pi*t - t + 5)/(4*pi -
 2) + cos(3*pi*t - 5)/(4*pi - 2) - cos(3*pi*t - 5)/(4*pi + 2)), t <=
 5, ((sign(t)/2 + 1/2)*(2*sin((t*(pi - 1))/2)^2 + 2*sin((t*(5*pi -
```

```
1))/2)^2 - pi*(4*sin((t*(pi - 1))/2)^2 - 4*sin((t*(5*pi - 1))/2)^2) -
4*sin((3*pi*t)/2)^2))/(8*pi^2 - 2))


y4 =

     0
```





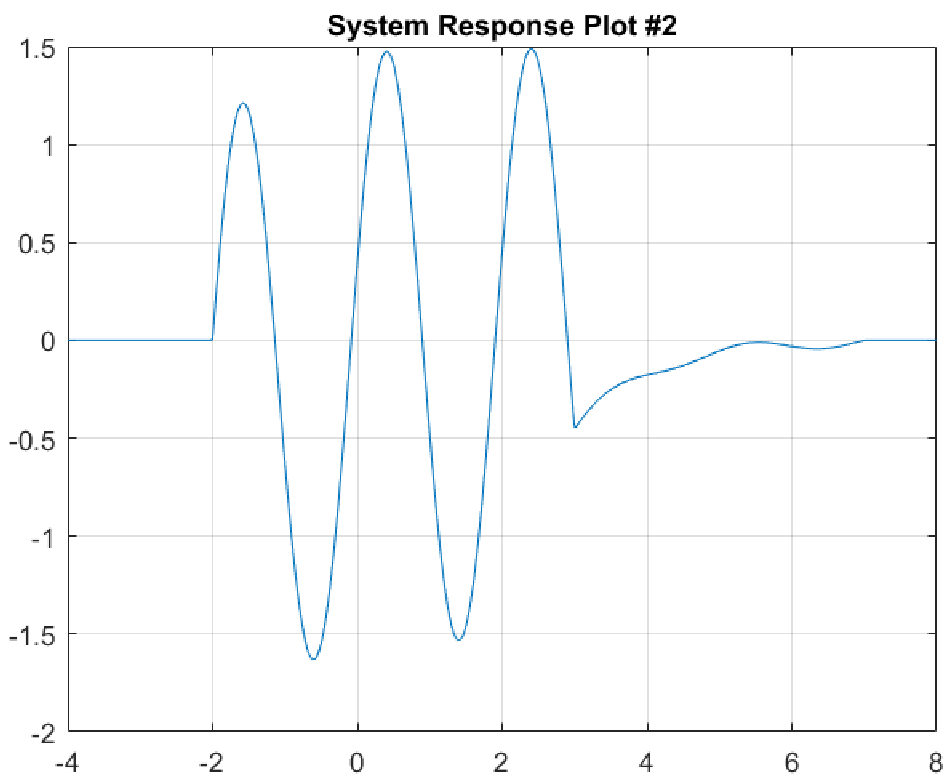
Problem 2

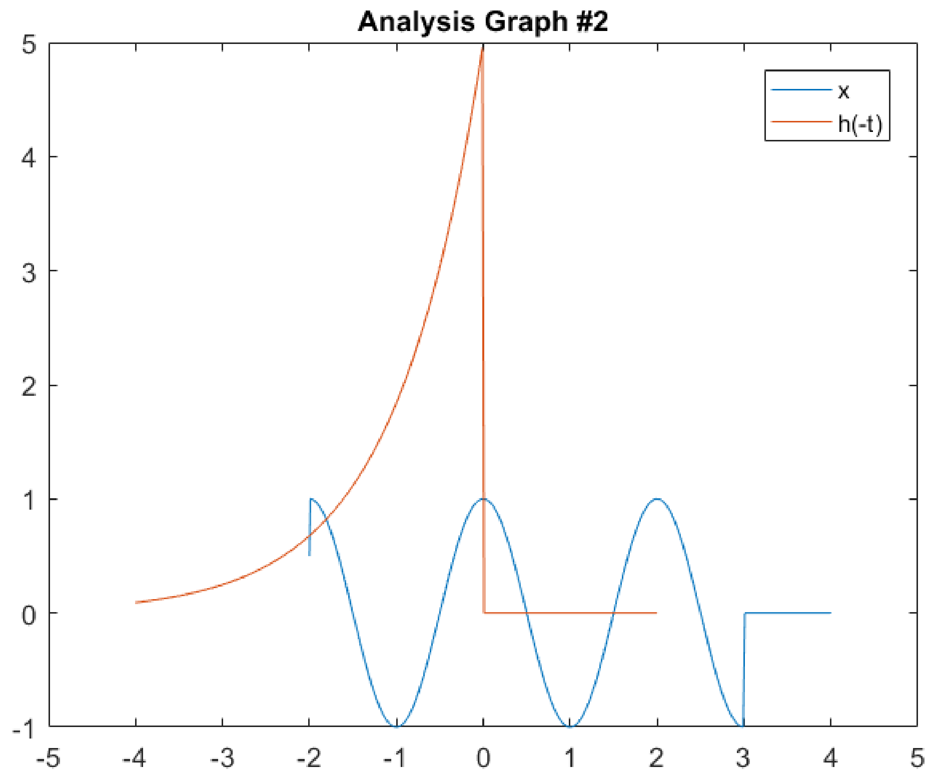
```
% Conv Method

s = 0.01;
t = -2:s:4;

x = cos(pi*t).*(heaviside(t+2)-heaviside(t-3));
h = 5*exp(-t).*heaviside(t);
y = conv(x,h)*s;
ty = -4:s:8;

figure;
plot(ty,y);
title('System Response Plot #2');
grid on;

figure;
plot(t,x)
hold on;
plot(-t,h)
legend('x','h(-t)')
xlim([-5 5])
title('Analysis Graph #2')
```

```
% 5 Step Method

syms t r
xt = cos(pi*r).*(heaviside(r+2)-heaviside(r-3)); % x(tau)
ht = 5*exp(-(t-r)).*heaviside(t-r); % h(t - tau)

f = xt.*ht; % x(tau)*h(t-tau)

% Use the h(-t) and x(t) graphs to analyze the time boundaries

% step 1 - no overlap 1: t < 0
t0 = [-inf -2];
y0 = 0

% step 2 - Partial overlap 1: -2 < t < 3
t1 = [-2:3];
y1 = int(f,r,-2,t)

% step 3 - Full overlap: t = 3
t2 = 3;
y2 = int(f,r,t-5,t)

% step 4 - Partial overlap 2: 3 < t < 8
t3 = [3:8]; % or 3:inf?
y3 = int(f,r,t-5,3)

% step 5 - no overlap 2: t > 8
t4 = [8 inf]; % or inf?
y4 = 0

% Note - Here we assume that the h(t) graph only has an x-length of 5.
% However, if h(t) is assumed to continue to infinity x-length then
% There should be no step 5. In addition, step 4 should be neverending
% stretching from t = 3 to t = inf.
```

```
y0 =

     0


y1 =

- heaviside(t + 2)*((5*exp(- t - 2))/(pi^2 + 1) - (5*(cos(pi*t) +
 pi*sin(pi*t)))/(pi^2 + 1)) - heaviside(t - 3)*((5*exp(3 - t))/(pi^2 +
 1) + (5*(cos(pi*t) + pi*sin(pi*t)))/(pi^2 + 1))


y2 =

piecewise(t == 3, -(5*exp(-5)*(exp(5) + 1))/(pi^2 + 1), t <= 3,
 - heaviside(t + 2)*((5*exp(- t - 2))/(pi^2 + 1) - (5*(cos(pi*t)
 + pi*sin(pi*t)))/(pi^2 + 1)) - heaviside(t - 3)*((5*exp(3 -
 t))/(pi^2 + 1) + (5*(cos(pi*t) + pi*sin(pi*t)))/(pi^2 + 1)), 8
```

```
<= t, 0, t in Dom::Interval([3], [8]), (5*exp(-5)*(cos(pi*t) +
pi*sin(pi*t))*(exp(5) + 1))/(pi^2 + 1) - heaviside(t - 3)*((5*exp(3 -
t))/(pi^2 + 1) + (5*(cos(pi*t) + pi*sin(pi*t)))/(pi^2 + 1)))


y3 =

piecewise(t == 3, -(5*exp(-5)*(exp(5) + 1))/(pi^2 + 1), 3 <= t, -
heaviside(8 - t)*((5*exp(3 - t))/(pi^2 + 1) - (5*exp(-5)*(cos(pi*t)
 + pi*sin(pi*t)))/(pi^2 + 1)), t <= 3, (sign(t + 2)/2 +
 1/2)*((5*cos(pi*t) + 5*pi*sin(pi*t))/(pi^2 + 1) - (5*exp(- t - 2))/
(pi^2 + 1)))


y4 =

     0
```





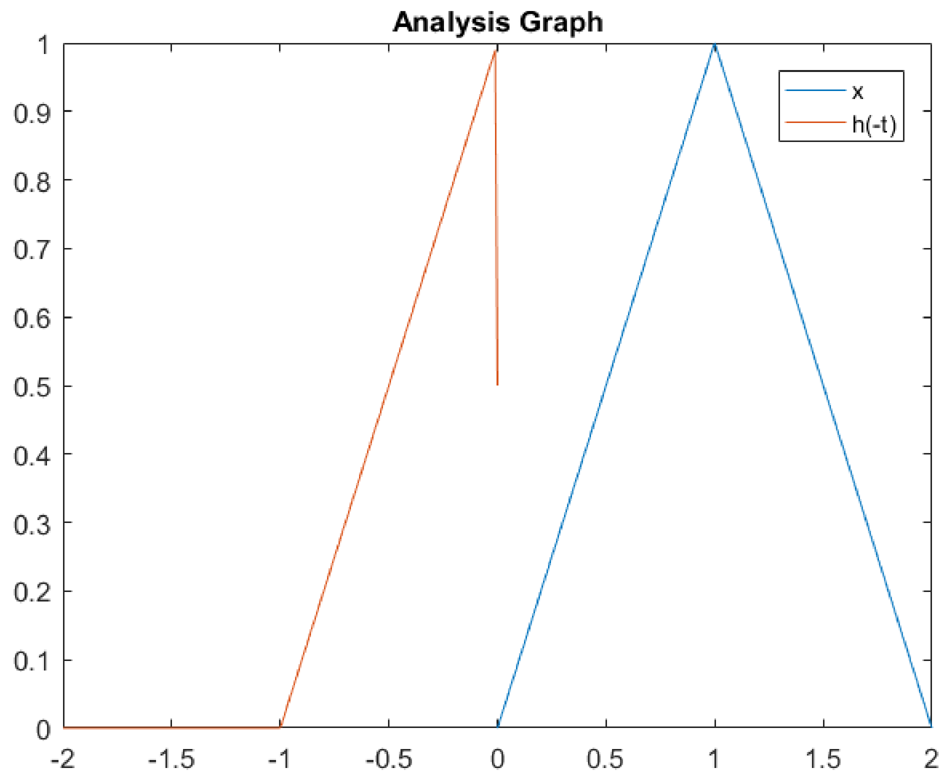
Problem 3

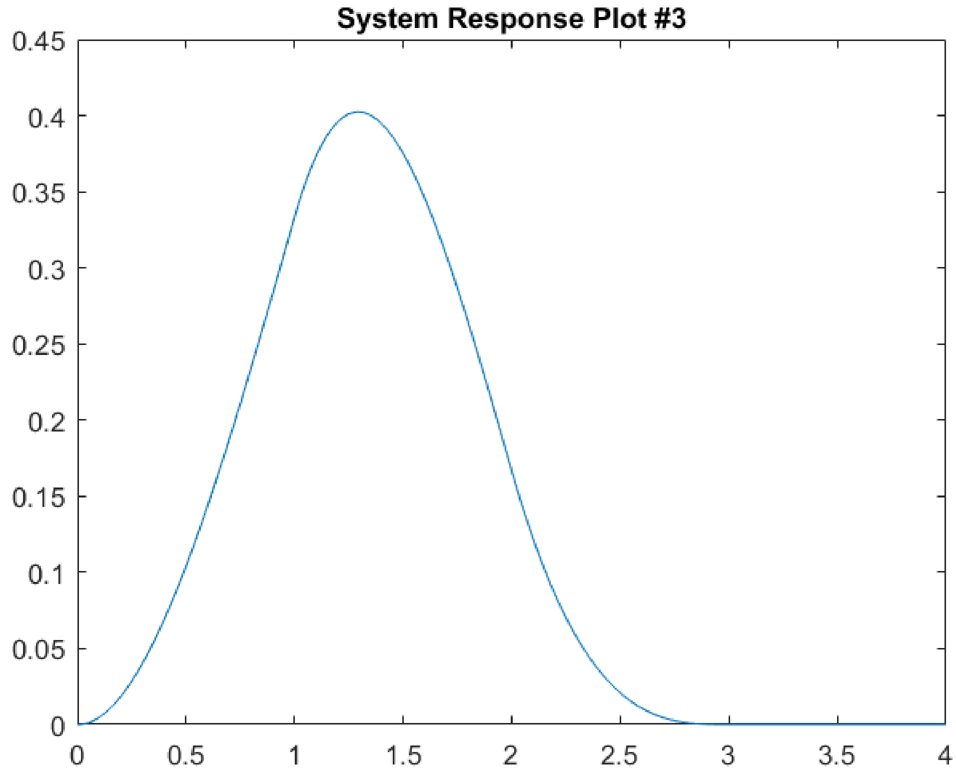
```
s = 0.01;
t = 0:s:2;
x = (t).*(heaviside(t)-heaviside(t-1))+(2-t).*(heaviside(t-1)-
heaviside(t-2));
h = (1-t).*(heaviside(t)-heaviside(t-1));

figure;
plot(t,x)
hold on;
plot(-t,h)
legend('x','h(-t)')
title('Analysis Graph')

figure;
y = conv(x,h)*s;
ty = 0:s:4;
plot(ty,y)
title('System Response Plot #3')

% Use the h(-t) and x(t) graphs to analyze the time boundaries

% 5 Step Method
```

```
syms t r
xt = (r).*(heaviside(r)-heaviside(r-1))+(2-r).*(heaviside(r-1)-
heaviside(r-2)); % x(tau)
ht = (1-(t-r)).*(heaviside(t-r)-heaviside(t-r-1)); % h(t - tau)
f = xt.*ht; % x(tau)*h(t-tau)

% step 1: No Overlap - t < 0
t0 = [-inf 0];
y0 = 0

% step 2: Partial Overlap - 0 < t < 1
t1 = [0:1];
y1 = int(f,r,0,t)

% step 3: Total Overlap - 1 < t < 2
t2 = [1:2];
y2 = int(f,r,t-1,t)

% step 4: Partial Overlap - 2 < t < 3
t3 = [2:3];
y3 = int(f,r,t-1,2)

% step 5: No Overlap - t > 3
t4 = [3 inf];
y4 = 0
```

```
y0 =

     0


y1 =

(heaviside(t - 1)*(t - 1)^3)/6 + (heaviside(t - 3)*(t - 3)^3)/6
 + (heaviside(t - 1)*(t - 1)*(t^2 - 8*t + 13))/6 - (heaviside(t -
 2)*(t + 1)*(t - 2)^2)/6 - (heaviside(t - 2)*(t - 2)^2*(t - 5))/3 -
 (heaviside(t - 1)*(t - 1)*(- t^2 + 2*t + 5))/6 - (t^2*heaviside(t)*(t
 - 3))/6


y2 =

piecewise(t == 1, 1/3, t == 2, 1/6, t <= 1, ((t - 3)*(3*heaviside(t -
 1) - 6*t*heaviside(t - 1) - t^2*heaviside(t) + 3*t^2*heaviside(t -
 1)))/6, 3 <= t, 0, t in Dom::Interval([1], [2]), t/2 + (heaviside(t
 - 3)*(t - 3)^3)/6 + (heaviside(t - 1)*(t - 1)*(t^2 - 8*t + 13))/6
 - (heaviside(t - 2)*(t + 1)*(t - 2)^2)/6 - (heaviside(t - 2)*(t -
 2)^2*(t - 5))/3 - (heaviside(t - 1)*(t - 1)*(- t^2 + 2*t + 5))/6 -
 1/6, t in Dom::Interval([2], [3]), (heaviside(t - 3)*(t - 3)^3)/6 -
 t/2 - (heaviside(t - 2)*(t - 2)^2*(t - 5))/6 + 7/6)


y3 =
```

```
piecewise(t == 1, 1/3, t == 2, 1/6, t <= 1, ((t - 3)*(3*heaviside(t -
 1) - 6*t*heaviside(t - 1) - t^2*heaviside(t) + 3*t^2*heaviside(t -
 1)))/6, 2 <= t, ((heaviside(t - 3) - heaviside(3 - t))*(t - 3)^3)/6,
 t in Dom::Interval([1], [2]), t/2 + (heaviside(t - 1)*(t - 1)*(t^2 -
 8*t + 13))/6 - (heaviside(t - 2)*(t + 1)*(t - 2)^2)/6 - (heaviside(t
 - 2)*(t - 2)^2*(t - 5))/3 - (heaviside(t - 1)*(t - 1)*(- t^2 + 2*t +
 5))/6 - 1/6)


y4 =

     0
```

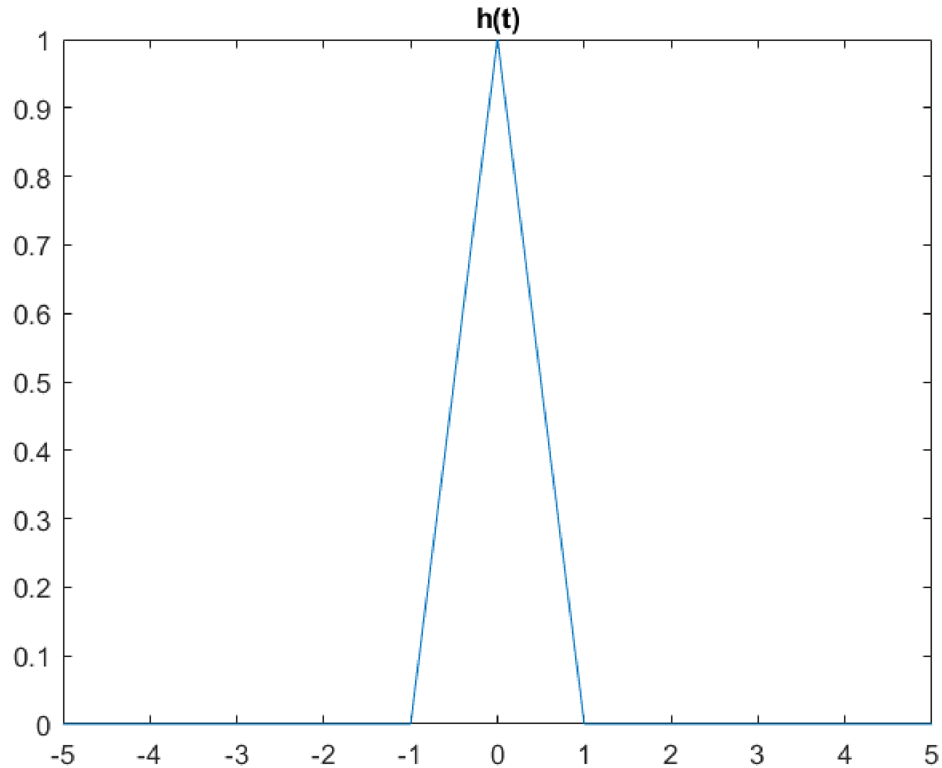


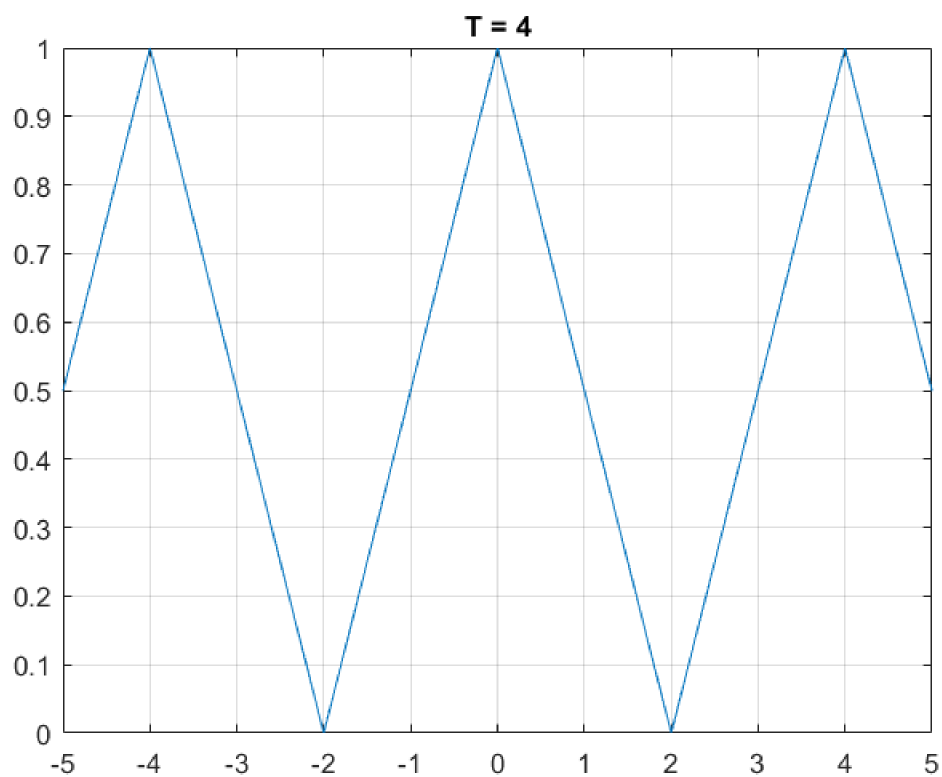


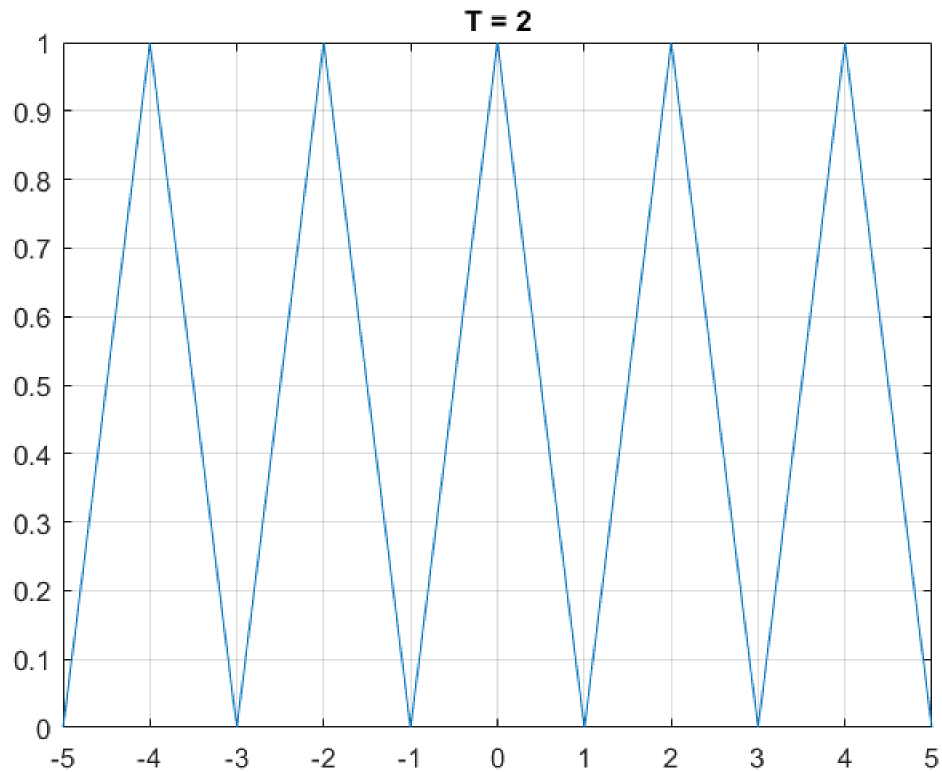
Problem 4

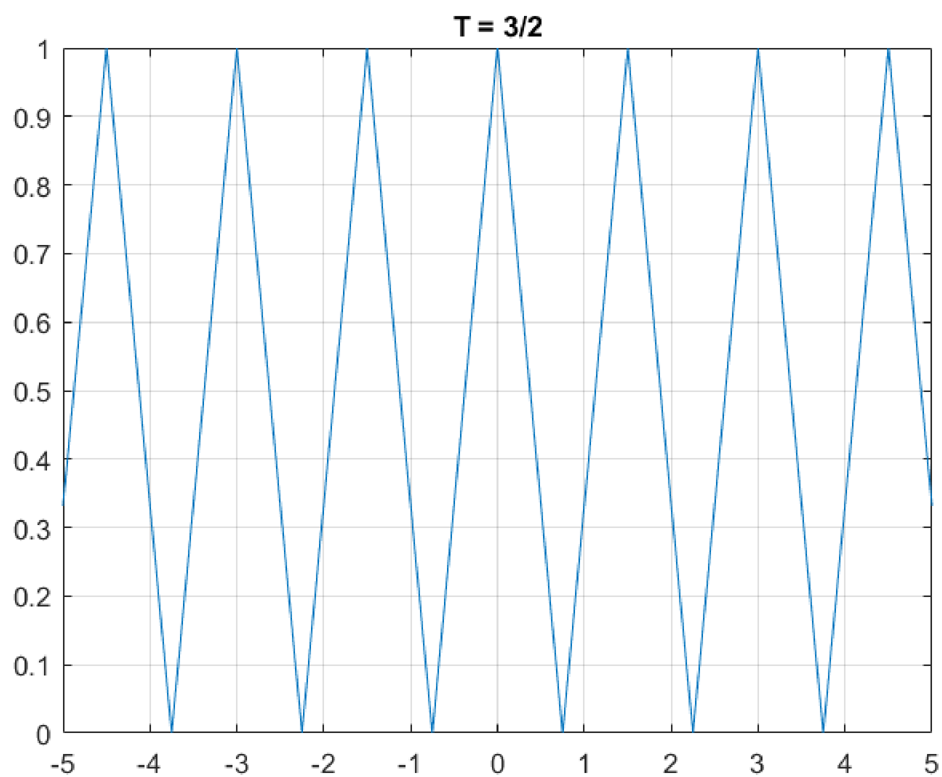
```
syms t k
t = -20 : .01 : 20;
h = (t+1).*(heaviside(t+1)-heaviside(t))+(-t+1).*(heaviside(t)-
heaviside(t-1));
figure;
plot(t,h);
xlim([-5 5])
title('h(t)')

% 4a.
T = 4;
d = -20:T:20;
y = pulstran(t,d,'tripuls',T);
figure;
plot(t,y)
xlim([-5 5])
title('T = 4')
grid on;

% 4b.
T = 2;
d = -20:T:20;
y = pulstran(t,d,'tripuls',T);
```

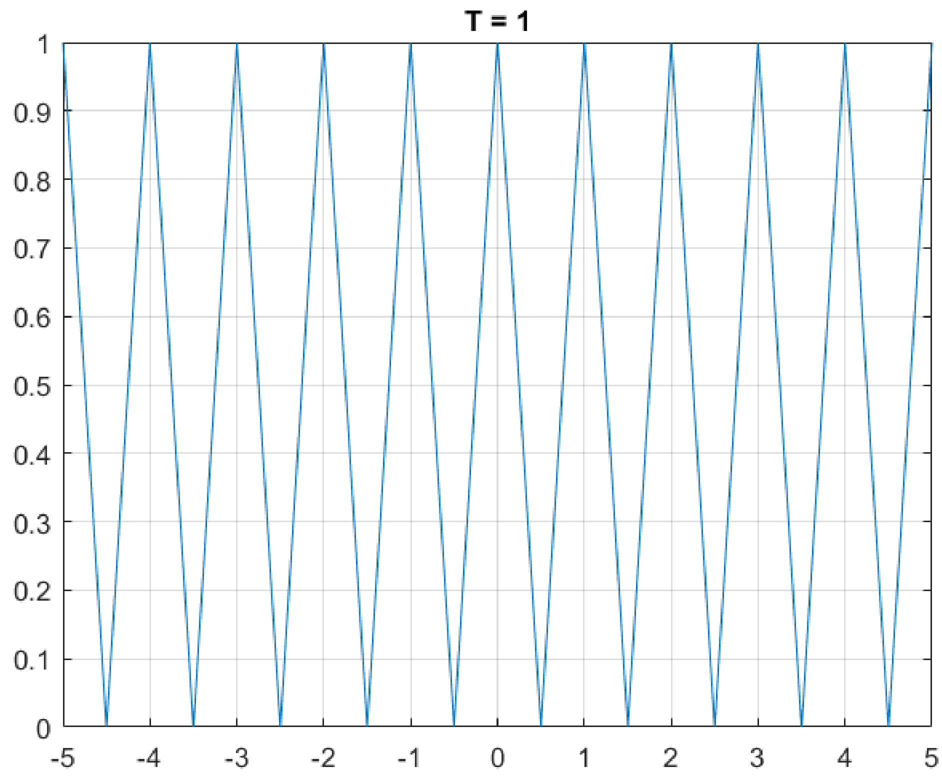
```
figure;
plot(t,y)
xlim([-5 5])
title('T = 2')
grid on;

% 4c.
T = 1.5;
d = -15:T:15;
y = pulstran(t,d,'tripuls',T);
figure;
plot(t,y)
xlim([-5 5])
title('T = 3/2')
grid on;

% 4c.
T = 1;
d = -20:T:20;
y = pulstran(t,d,'tripuls',T);
figure;
plot(t,y)
xlim([-5 5])
title('T = 1')
grid on;

% The convolution of the single triangular pulse h(t) with a unit
 pulse
% train x(t) results in a triangular pulse train. Since x(t) has
 varying
% periods (T), then the convolution will have its peak amplitude
% signal during every multiple of T (k*T k = [-inf inf]). The varying
% T values for the convolutions are shown in the graphs via pulstran.
```


h(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


T = 4
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


T = 2
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


T = 3/2
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



Published with MATLAB® R2016b