BIRZEIT UNIVERSITY

Electrical and Computer Engineering Department

-**SIGNALS AND SYSTEMS** -

ENEE2312

-MATLAB Assignment-

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Introduction

Four questions will be implemented using MATLAB software in this paper, and each question will be explored theoretically by answering it (plotting, generating, and sketching the question).

Question I: Generate and plot the following signals using MATLAB:

1. X1(t) = u(t+3)- u(t-4)

Explanation:

In the code for the first part, we cleared all variables for acquiring accurate results and closed all workspaces. To generate this function, first we created a time vector (starts from -7 to 7, increases by 0.01 each time). Then the required signal was then generated, then we plotted function, The signal in this section was created using the built-in heaviside() function.

Code:

```
clear all
close all
clc

t = -7:0.01:7;
X1 = heaviside(t+3)-heaviside(t-4);
figure (1)
plot (t, X1)
title('X1(t)= u(t+3)-u(t-4)')
```

Output:

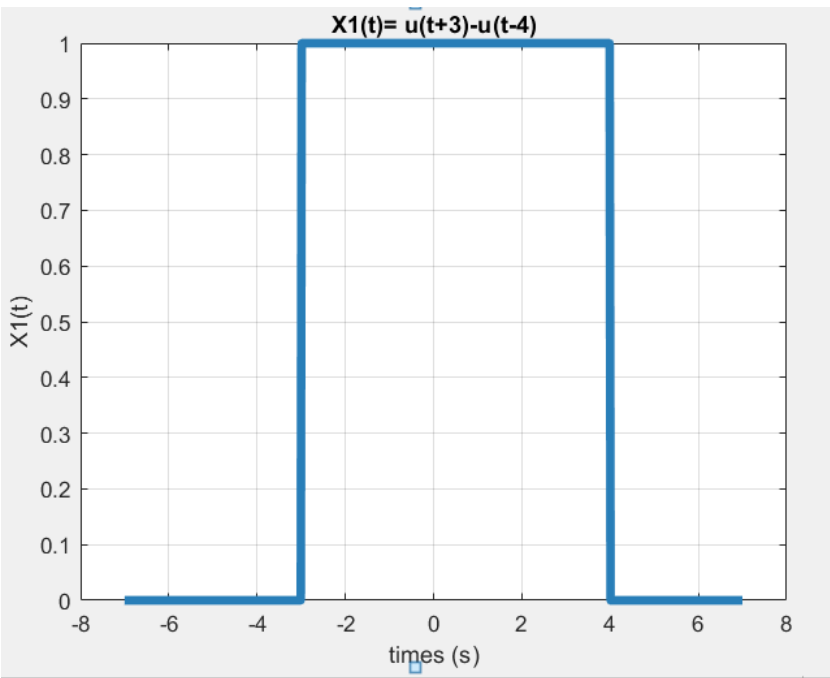


Fig 1.1: sketch of function in MATLAB

2- A finite pulse $\sum_{n=-\infty}^{\infty} \prod(\frac{t-3n}{2})$

Explanation:

In the code for the first part, we cleared all variables for acquiring accurate results and closed all workspaces. To generate this function, we create a variable dynamically (t and n) Then the required signal was then generated by using the built-in rectangularPulse () function, then we plotted function.

Code:

```
clear all
close all
clc

syms t n
x = symsum(rectangularPulse((t-(3.*n))/2),n,-Inf,Inf);
fplot(x)
title('A finite pulse')
xlabel('times (s)')
ylabel('X(t)')
```

Output:

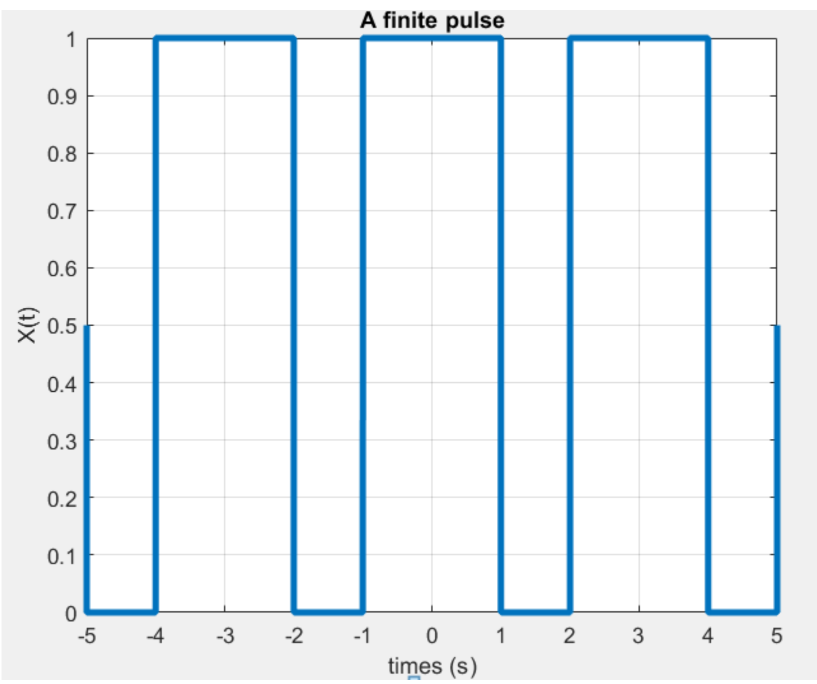


Fig 1.2: sketch of function in MATLAB

3- X2(t)= u(t-4) +r(t-4)-2r(t-7) +r(t-13) in the time interval [0 16]

Explanation:

In the code for the first part, we cleared all variables for acquiring accurate results and closed all workspaces. To generate this function, first we created a time vector (starts from 0 to 16, increases by 0.01 each time). Then the required signal was then generated (Ramp function r1, r2, r3 and unit step function) by using the built-in heaviside () function, then we plotted function.

Code:

```
clear all
close all
clc

t = 0:0.01:16;
r1 = (t-4).*heaviside (t-4);
r2 = (t-7).*heaviside (t-7);
r3 = (t-13).*heaviside (t-13);
X2 = heaviside(t-4) + r1 - 2*r2 + r3;
plot(t,X2)
title('X2(t)= u(t-4) +r(t-4)-2r(t-7) +r(t-13)')
xlabel('times (s)')
ylabel('X2(t)')
```

Output:

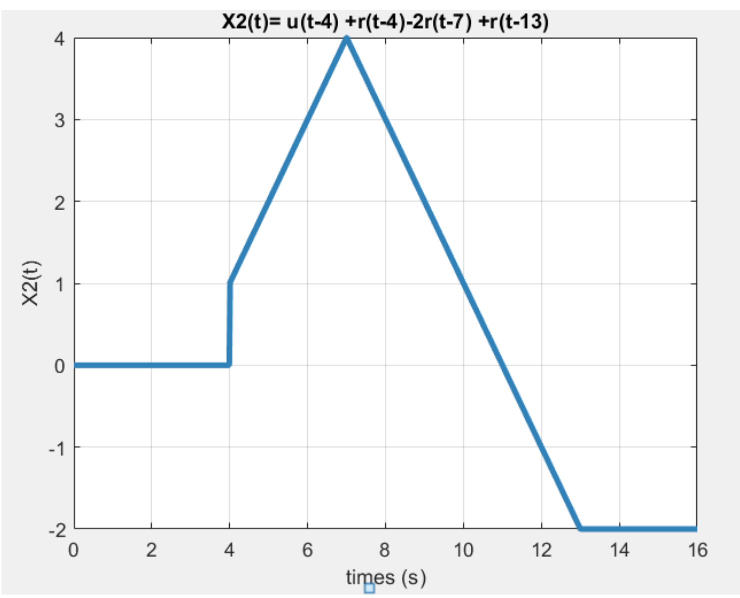


Fig 1.3: sketch of function in MATLAB

Question II:

1 .Generate and plot the signals y1(t)= sin (200πt), y2(t)= cos(500πt), then determine y1 and plot the product of two signals.

2 .Determine, using the MATLAB plots, if the generated signal is periodic. In case a signal is periodic, determine its fundamental frequency.

Part (1)

Explanation:

In the code for the first part, we cleared all variables for acquiring accurate results and closed all workspaces. We create a variable dynamically (t), then the required signal was then generated (y1, y2 and y1*y2), then we plotted function and use subplot divides the current figure into an m -by- n.

Code:

```
clear all
close all
clc

syms t
y1 = sin(200.*pi.*t);
T1 = 1/100;
y2 = cos(500.*pi.*t);
T2 = 1/250;
y = y1.*y2;
subplot(2,2,2)
fplot( t,y1,[-T1,T1] )
title('sin(200.*pi.*t)')
xlabel('time (s)')
ylabel('y1')
subplot(2,2,4)
fplot( t,y2,[-T2,T2] )
title('cos(500.*pi.*t)')
xlabel('time (s)')
ylabel('y2')
subplot(2,2,[1,3])
fplot( t,y,[-2e-2,2e-2])
title('sin(200.*pi.*t) * cos(500.*pi.*t)')
xlabel('time (s)')
ylabel('y1*y2')
```

Output:

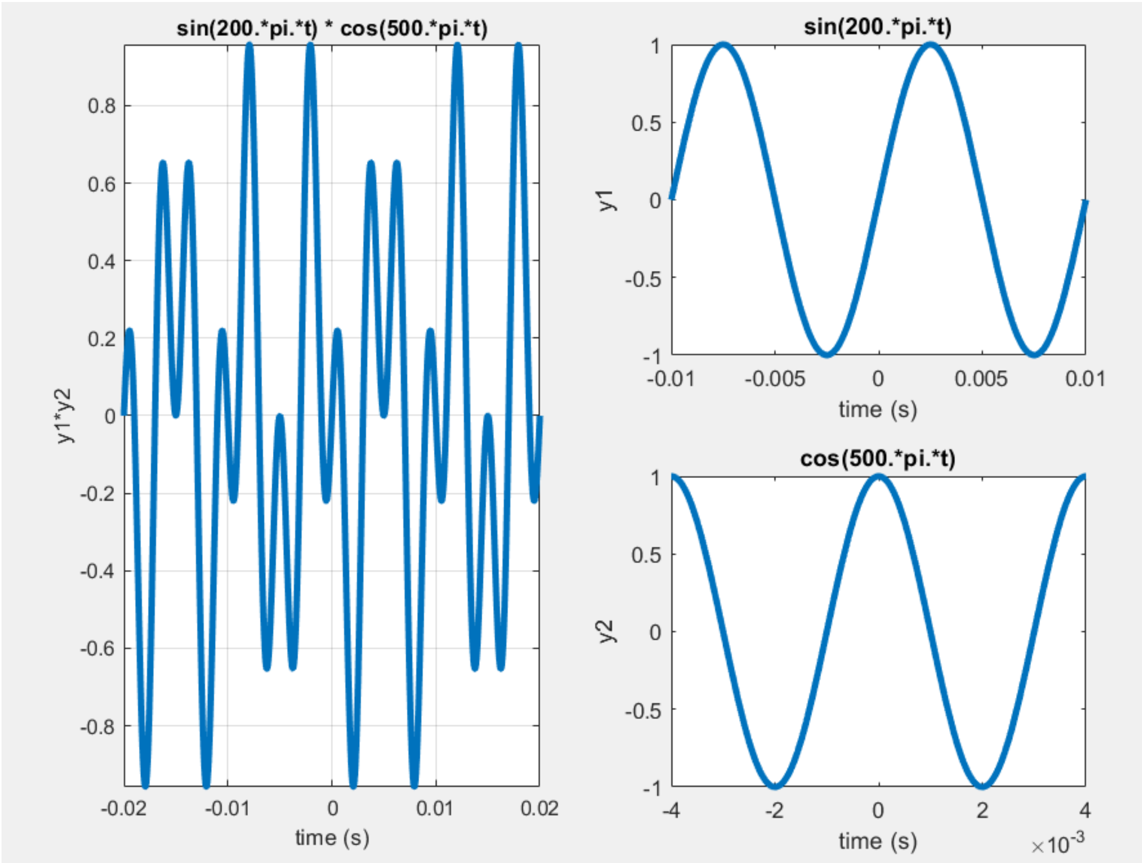


Fig 2.1: sketch of function in MATLAB

Part (2)

Observing the MATLAB charts to check for periodicity:

y1(t) is periodic with a fundamental frequency of 100Hz, as seen in figure y1.
w1=2*pi*f_0 → 2*pi*f_0 = 200*pi → f_0=100 Hz.

y2(t) is periodic with a fundamental frequency of 250Hz, as seen in figure y2.
w2=2*pi*f_0 → 2*pi*f_0 = 500*pi → f_0=250 Hz.

y (t) is periodic with a fundamental frequency of 50Hz, as shown in figure y1*y2.
T_0 = 0.002 + 0.018 = 0.02s.
f_0 = 1 / T_0 = 1/0.02 = 50 Hz.

Question III:

Write For the following differential equation:

$$\frac{dy(t)}{dt} + 30y(t) = 20$$

1. Write the program that solve the following differential equation (for t>0) using zero initial conditions.
2. Evaluate the Fourier Transform of the Transfer Function H(f)=Y(f)/X(f).
3. Plot the magnitude and phase of the Transfer Function H(f).

Explanation:

I'll create a program to solve and plot a differential equation in the third question. For t>0, I'll start with zero starting circumstances (y (0) = 0). In addition, I'll utilize MATLAB to calculate the Fourier Transform and see the Transfer Function's amplitude and phase. Finally, I'll demonstrate the final figure of the code by drawing the signal on the diagram. After that, I finished the whole thing. Following that, I created the whole code for parts two and three, as well as screen images of the output and code.

Part (1)

Code:

```
clear all
close all
clc

syms y(t)
a = diff(y,t) + 30.*y(t) == 20;
c = y(0) == 0;
y(t) = dsolve(a,c)
t = 0:0.01:1;
x = 20.*(t>=0);
y = double(vpa(y(t)));
subplot (3,1,1);
plot(t,y);
grid on;
ylim([0 1])
title('solve ode')
xlabel('time (Sec)')
ylabel('y(t)')
```

Output:

```
Command Window

y(t) =

2/3 - (2*exp(-30*t))/3

fx >>
```

Fig 3.1: The solve differential equation

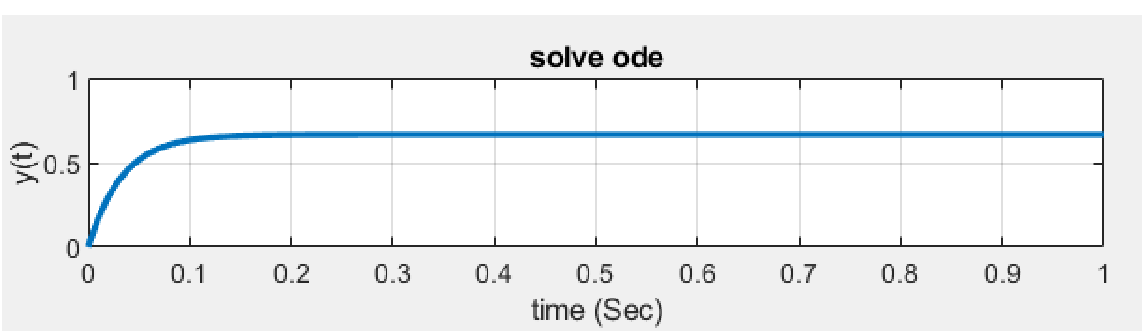


Fig 3.2: sketch solve differential equation

Part (2)

Code:

```
f = -100:1:100;
dt = t(2)-t(1);
for i = 1:length(f)
    X(i) = sum(x.*exp(-2.*1i.*pi.*f(i).*t)).*dt;
    Y(i) = sum(y.*exp(-2.*1i.*pi.*f(i).*t)).*dt;
    H(i) = Y(i)/X(i);
end
```

Part (3)

Code:

```
subplot (3,1,2);
plot(f,abs(H));
grid on;
title("Magnitude Spectrum");
ylabel("abs H(f)");
xlabel("freq");
subplot (3,1,3);
plot(f,angle(H));
grid on;
title("Phase Spectrum");
ylabel(" angle H(f)");
xlabel("freq");
```

Output:

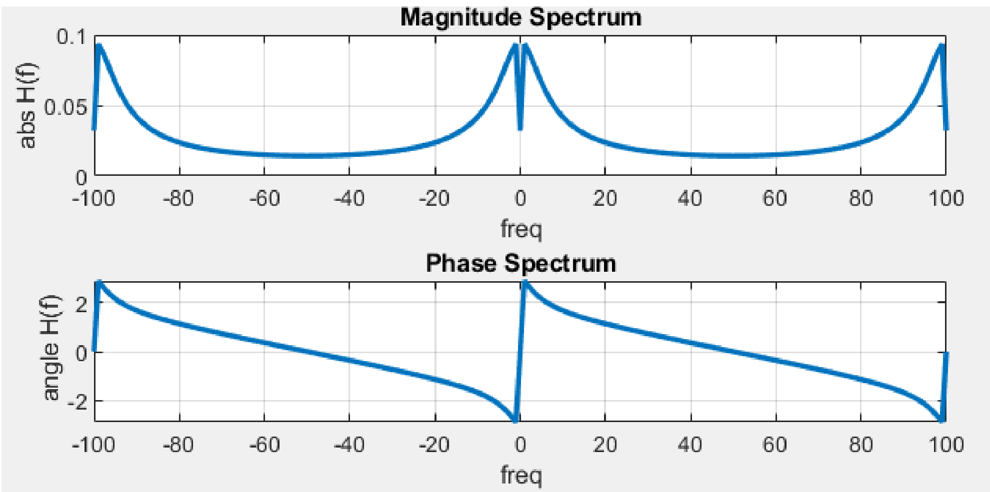


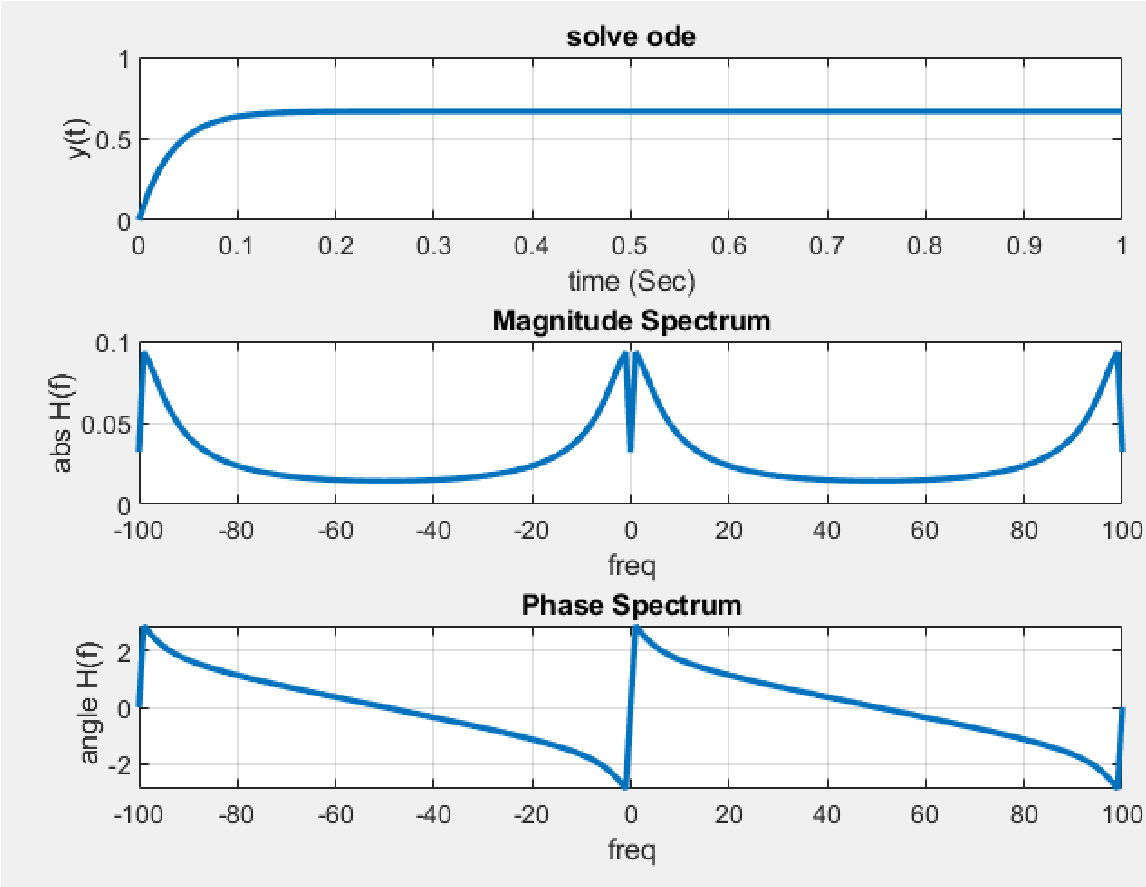
Fig 3.3: sketch of magnitude and phase of the Transfer Function in MATLAB

Full code:

```
clear all
close all
clc

syms y(t)
a = diff(y,t) + 30.*y(t) == 20;
c = y(0) == 0;
y(t) = dsolve(a,c)
t = 0:0.01:1;
x = 20.*(t>=0);
y = double(vpa(y(t)));
subplot (3,1,1);
plot(t,y);
grid on;
ylim([0 1])
title('solve ode')
xlabel('time (Sec)')
ylabel('y(t)')
%************************************************
f = -100:1:100;
dt = t(2)-t(1);
for i = 1:length(f)
    X(i) = sum(x.*exp(-2.*1i.*pi.*f(i).*t)).*dt;
    Y(i) = sum(y.*exp(-2.*1i.*pi.*f(i).*t)).*dt;
    H(i) = Y(i)/X(i);
end
%************************************************
subplot (3,1,2);
plot(f,abs(H));
grid on;
title("Magnitude Spectrum");
ylabel("abs H(f)");
xlabel("freq");
subplot (3,1,3);
plot(f,angle(H));
grid on;
title("Phase Spectrum");
ylabel(" angle H(f)");
xlabel("freq");
```

Full output:



Command Window

```
y(t) =

2/3 - (2*exp(-30*t))/3

fx >>
```

Fig 3.4: sketch solve differential equation and magnitude and phase of the Transfer Function

Question IV:

Write a program that computes and plots the convolution of the functions

$$x(t) = (10\ e\verb|^|(-0.2t)\ )\Pi((t-7)/4), h(t) = (10e\verb|^|(0.2\ t)\ )\Pi((t-1)/2)$$

Explanation:

In the code for the first part, we cleared all variables for acquiring accurate results and closed all workspaces. We created a time vector (starts from 0 to 12). We generated x(t) and h(t) by using rectangularPulse and exp then plot them. After that we computes and plot the convolution of the functions by conv(x,h).

Code:

```
clear all
close all
clc

t = 0:12;
e = 10.*exp(-0.2.*t);
a = rectangularPulse((t-7)/4);
x = e.*a;
subplot(2,2,1)
plot(x)
ylim([0 5])
title('x(t)')
xlabel('time')
ylabel('Amp')

a = 10.*exp(0.2.*t);
b = rectangularPulse((t-1)/2);
h = a.*b;
subplot(2,2,2)
plot(h)
ylim([0 15])
title('h(t)')
xlabel('time')
ylabel('Amp')

y=conv(x,h);
subplot(2,2,[3 4]);
plot(y)
ylim([0 70])
title('convolution')
xlabel('time')
ylabel('Amp')
```

Output:

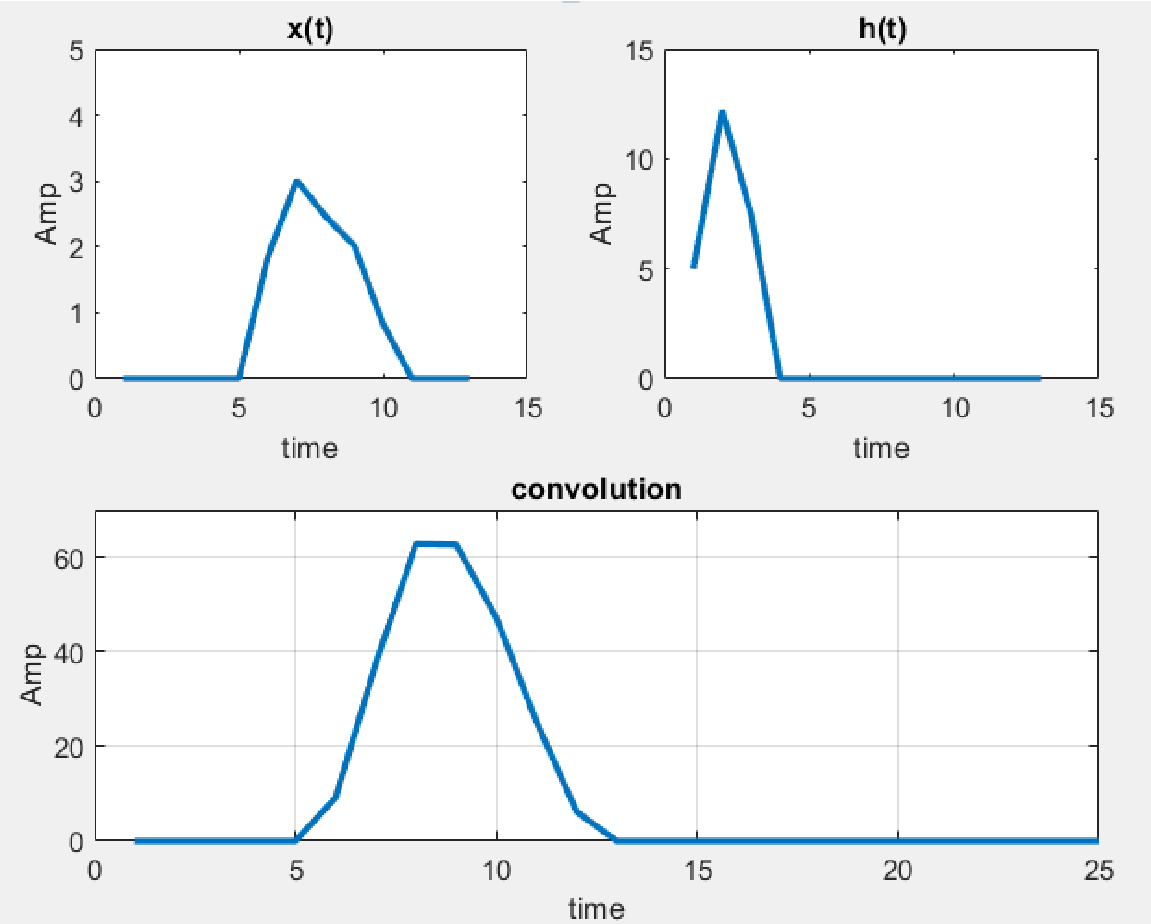


Fig 4.1: sketch of function in MATLAB