LAB 2

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CONTENTS

1 QUESTION 1

1. Generation of signal and its transformation.

a) Write a Matlab function signalx that evaluates the following signal at an arbitrary set of points:

$$x(t) = \begin{cases} 0; -\infty < t \le -2 \\ 2; -2 < t \le 0 \\ 2e^{-t/2}; 0 < t \le \infty \end{cases}$$

b) Plot the signal x(t) versus t, for $-8 \le t \le 8$. Consider enough no. of closely spaced sample points to get a smooth plot.

c) Use the function signalx to plot x(t-3) versus t.

d) Use the function signalx to plot x(3-t) versus t.

e) Use the function signalx to plot x(2t) versus t.

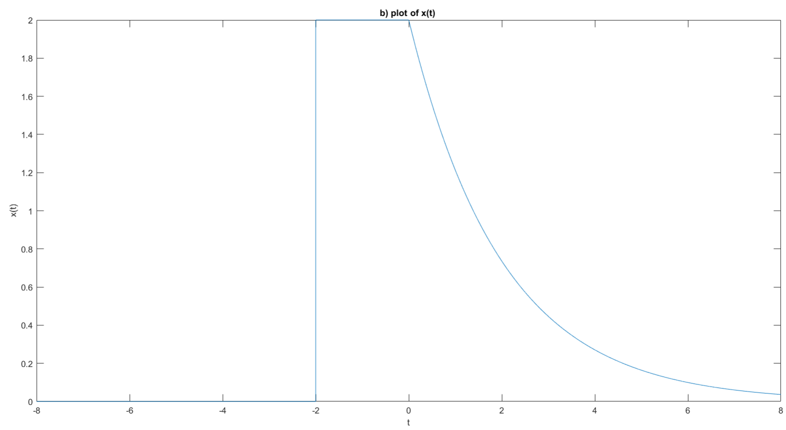
f) Use the function signalx to plot x(t/2) versus t.

1.1 Section A

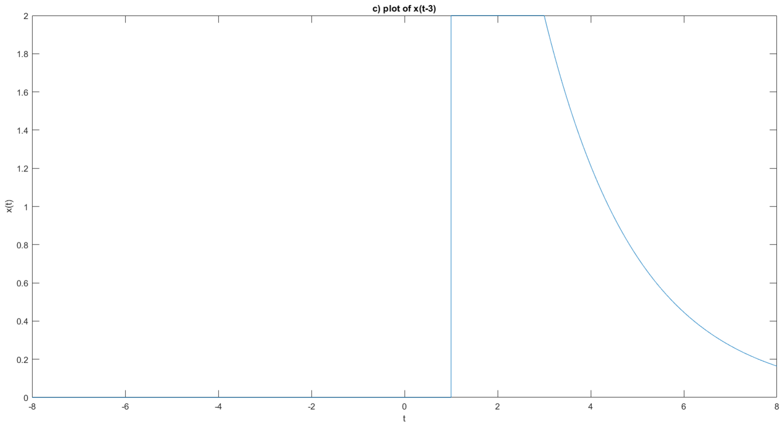
This the MATLAB function for required plot within the range [-8, 8]

```
function out = signalx(x)
out = [];
for a = 1:length(x)
    t = x(a);
    if t > -2 && t <= 0
        out(end+1)= 2;
    elseif t > 0 && t <= 8
        out(end+1) = (2*exp(-t/2));
    else
        out(end+1) = 0;
    end
end
end
```

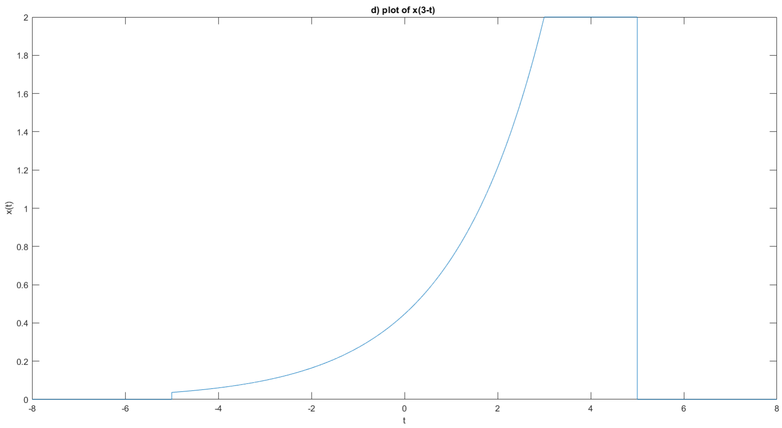
1.2 Section B



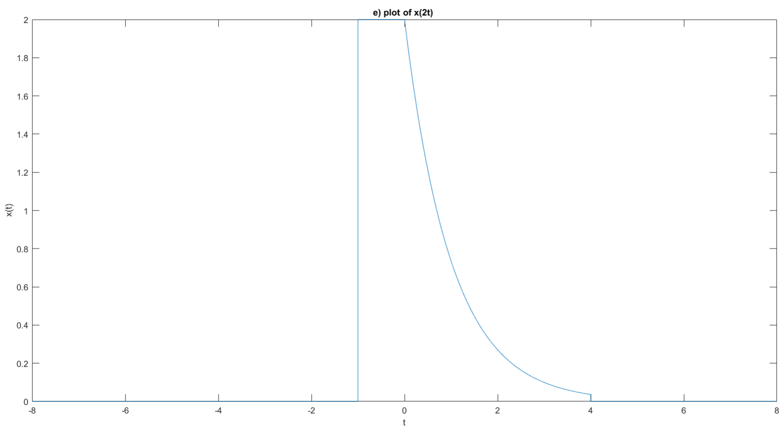
1.3 Section C



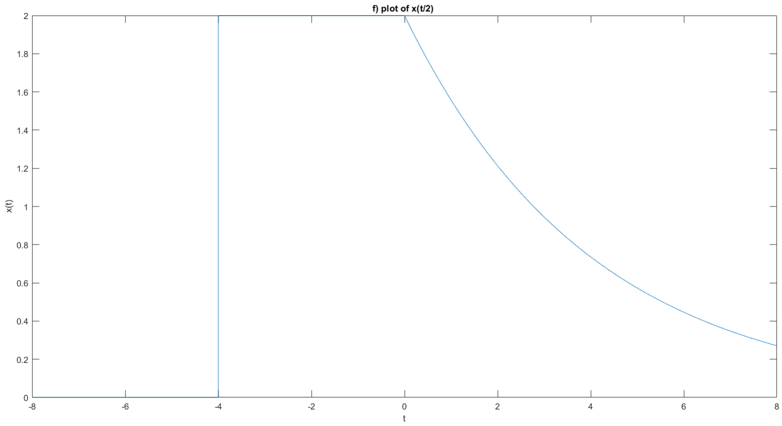
1.4 Section D



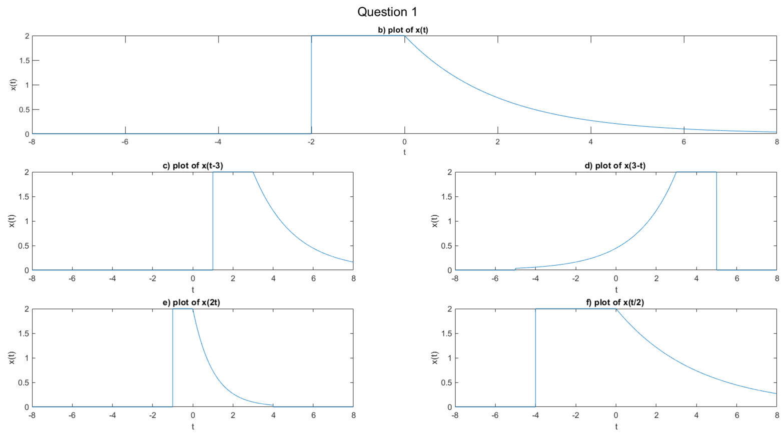
1.5 Section E



1.6 Section F



1.7 Output of Code



1.8 Code

```
close all, clc
sgtitle('Question 1')

fs = 10000;
time = -8:1/fs:8;

%plot of x(t)
subplot(3,2,1:2)
plot(time,signalx(time))
xlabel("t")
ylabel(" x(t) ")
title("b) plot of x(t) ")

%plot of x(t-3)
subplot(3,2,3)
plot(time,signalx(time-3))
xlabel("t")
ylabel(" x(t) ")
title("c) plot of x(t-3)")

%plot of x(3-t)
subplot(3,2,4)
plot(time,signalx(3-time))
xlabel("t")
ylabel(" x(t) ")
title("d) plot of x(3-t) ")

%plot of x(2t)
subplot(3,2,5)
plot(time,signalx(2*time))
xlabel("t")
ylabel(" x(t) ")
title("e) plot of x(2t) ")

%plot of x(t/2)
subplot(3,2,6);
plot(time,signalx(time/2))
xlabel("t")
ylabel(" x(t) ")
title("f) plot of x(t/2) ")

function out = signalx(x)
out = [];
for a = 1:length(x)
    t = x(a);
    if t > -2 && t <= 0
        out(end+1)= 2;
    elseif t > 0 && t <= 8
        out(end+1) = (2*exp(-t/2));
    else
        out(end+1) = 0;
    end
end
end
```

1.9 Description & Observations

1.9.1 *Section A*

A function signalx is written which takes input argument time. We can add/ modify this argument and call this function to get the required output. The function written is such that the value of x(t) is defined within the interval [-8, 8].

1.9.2 *Section B*

As observed in the plot, the signal x(t) satisfies the conditions mentioned in question. x(t) takes it values within the ranges as mentioned.

1.9.3 *Section C*

Here x(t-3) is required. Hence the plot has to shift right by 3 units of time. As seen in plots, it can be verified comparing with the original signal x(t).

1.9.4 *Section D*

Here x(3-t) is required. Hence the plot has to flip with y-axis acting like a mirror since the sign of t in function is negative. Also the plot has to shift 3 units right. As seen in plots, it can be verified comparing with the original signal x(t).

1.9.5 *Section E*

Here x(2t) is required. Hence the plot has to compress by 2 times along time scale to hold the validity of original signal. As seen in plots, it can be verified comparing with the original signal x(t).

1.9.6 *Section F*

Here x(t/2) is required. Hence the plot has to expand by 2 times along time scale to hold the validity of original signal. As seen in plots, it can be verified comparing with the original signal x(t).

2 QUESTION 2

2. Convolution of two continuous-time signals

a) Write a Matlab function contconv that computes an approximation to continuous-time convolution for the following signals:

$$x_1(t) = \begin{cases} 1; 0 < t \leq 2 \\ 0; elsewhere \end{cases} \quad \text{and} \quad x_2(t) = \begin{cases} 1; 0 < t \leq 3 \\ 0; elsewhere \end{cases}$$

b) Plot all the three signals $x_1(t)$, $x_2(t)$ and convolved output signal y(t) in the same plot using subplots.

c) Also verify your output plot using in -built matlab command 'conv'. Plot the convolved output obtained in part (b) & (c) i.e. with & without using in -built matlab command 'conv' in the same plot using subplots.

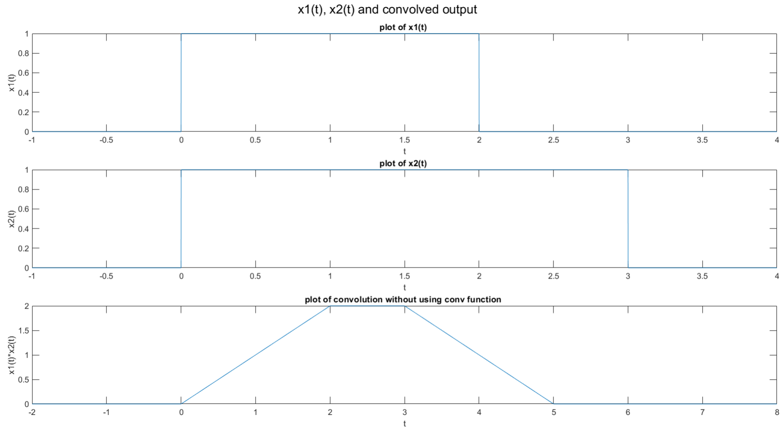
d) Convolve the signal $x_1(t)$ with itself to obtain output signal z(t). Plot the two signals $x_1(t)$ and z(t) in the same plot using subplots.

2.1 Section A

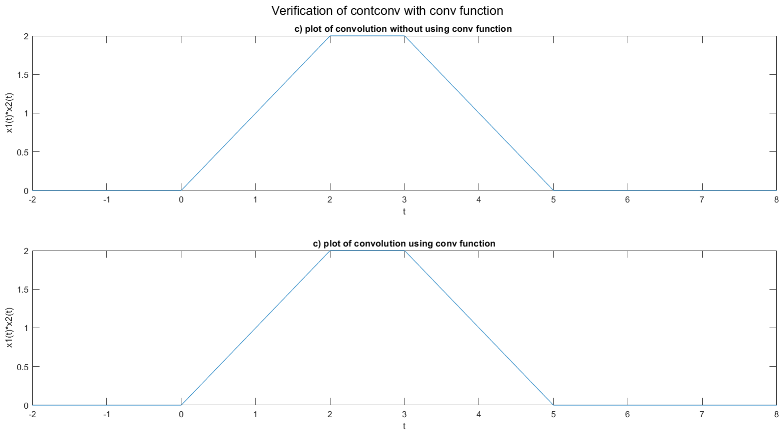
Below is the MATLAB contconv function written to solve the question.

```
%convolution function
function Y = contconv(a, b)
m = length(a);
n = length(b);
X=[a,zeros(1,n)];
H=[b,zeros(1,m)];
for i=1:n+m-1
    Y(i)=0;
    for j=1:m
        if(i-j+1>0)
            Y(i)=Y(i)+X(j)*H(i-j+1);
        else
        end
    end
end
end
```

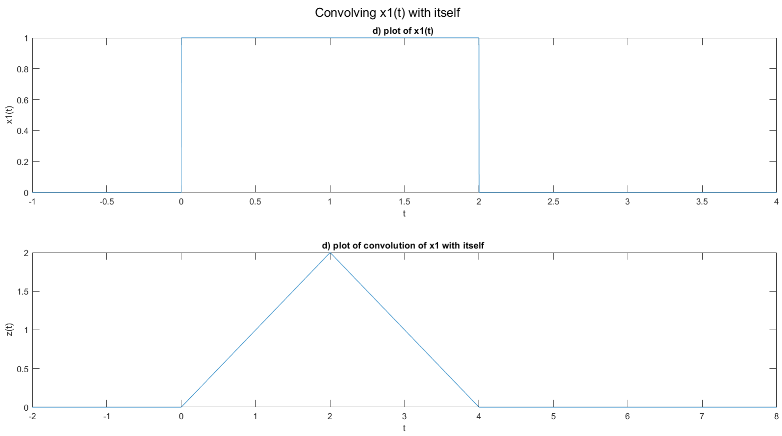
2.2 Section B



2.3 Section C



2.4 Section D

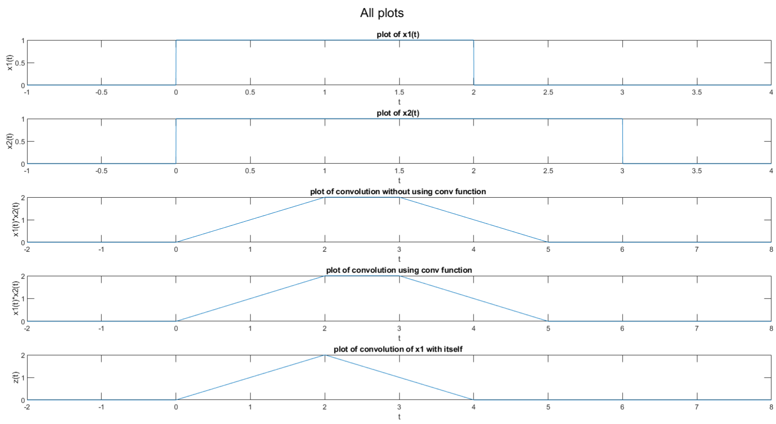


2.5 Code

```
close all, clc
sgtitle('Question 2')

fs = 1000;
time = -1:1/fs:4;
t1 = -2:1/fs:8;

%plot of x1(t)
subplot(5,1,1)
plot(time,X_out1(time))
xlabel("t")
ylabel(" x1(t) ")
title("b) plot of x1(t) ")

%plot of x2(t)
subplot(5,1,2)
plot(time,X_out2(time))
xlabel("t")
ylabel(" x2(t) ")
title("b) plot of x2(t) ")

%plot of convolution without using conv function
Y = contconv(X_out1(time), X_out2(time));
subplot(5,1,3)
plot(t1,Y/fs)
xlabel("t")
ylabel(" x1(t)*x2(t) ")
title("b) plot of convolution without using conv function ")

%plot of convolution using conv function
new = conv(X_out1(time), X_out2(time));
subplot(5,1,4)
plot(t1,new/fs)
xlabel("t")
ylabel(" x1(t)*x2(t) ")
title("b) plot of convolution using conv function")

%plot of convolution of x1 with itself
z = conv(X_out1(time), X_out1(time));
subplot(5,1,5)
plot(t1,z/fs)
xlabel("t")
ylabel(" z(t) ")
title("b) plot of convolution of x1 with itself ")

function out1 = X_out1(x)
out1 = [];
for a = 1:length(x)
    t = x(a);
    if t <= 2 && t > 0
        out1(end+1)= 1;
    else
        out1(end+1) = 0;
    end
```

```
end
end

function out2 = X_out2(x)
out2 = [];
for a = 1:length(x)
    t = x(a);
    if t <= 3 && t > 0
        out2(end+1)= 1;
    else
        out2(end+1) = 0;
    end
end
end

%convolution function
function Y = contconv(a, b)
m = length(a);
n = length(b);
X=[a,zeros(1,n)];
H=[b,zeros(1,m)];
for i=1:n+m-1
    Y(i)=0;
    for j=1:m
        if(i-j+1>0)
            Y(i)=Y(i)+X(j)*H(i-j+1);
        else
        end
    end
end
end
```

2.6 Output of Code



2.7 Description & Observations

2.7.1 *Section A*

As asked in question, I've created a function contconv which takes signals for input and convolves them to give output. The function is written at last and we call it whenever we need to use it.

2.7.2 *Section B*

The subplot function is used here. The output shows both the input signals and the convolved signal.

2.7.3 *Section C*

Here we've plotted 2 graphs. One is the convolution of the signals found by using contconv function, The other is the output using in-built conv function. As seen both are the same, Hence my contconv function works good. Again subplot function is used to plot these

2.7.4 *Section D*

As mentioned, here I've convolved signal x1(t) with itself. We can notice that there is only a single peak value. This is because during convolution the whole signal overlaps with itself only once. Hence a single peak.

3 REFERENCES

1. https://www.overleaf.com/learn/latex/lists
2. https://in.mathworks.com/help/matlab/ref/exp.html
3. https://in.mathworks.com/matlabcentral/answers/76446-how-to-time-shift-a-signal
4. https://in.mathworks.com/help/matlab/ref/function.html
5. http://matlab.izmiran.ru/help/techdoc/ref/end.html
6. https://in.mathworks.com/help/matlabmobile/ug/accessing-array-elements.html
7. https://www.youtube.com/watch?v=E3633vp0CGQ