EXP. 4: GENERATION, WINDOWING & TIME OPERATIONS OF SIGNALS

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Objective(s):

(i) Generation of different Continuous time signals used in signals and systems course

(ii) Generation of even & odd components of a given signal

(iii) Understanding windowing effect

(iv) Draw the given signal and perform time operations

(v) Determine the power and energy of a given signal

Note:

(1) *While writing the Matlab code in **Editor window** follow the below instructions :*

(i) (a) use only built-in Matlab functions (if available) otherwise (b) use logical/relational operators

&

(ii) avoid using control loops, as they take more time in running the program

*(2) Use **HELP** option / search documentation of Matlab*

Run #01: Signals.

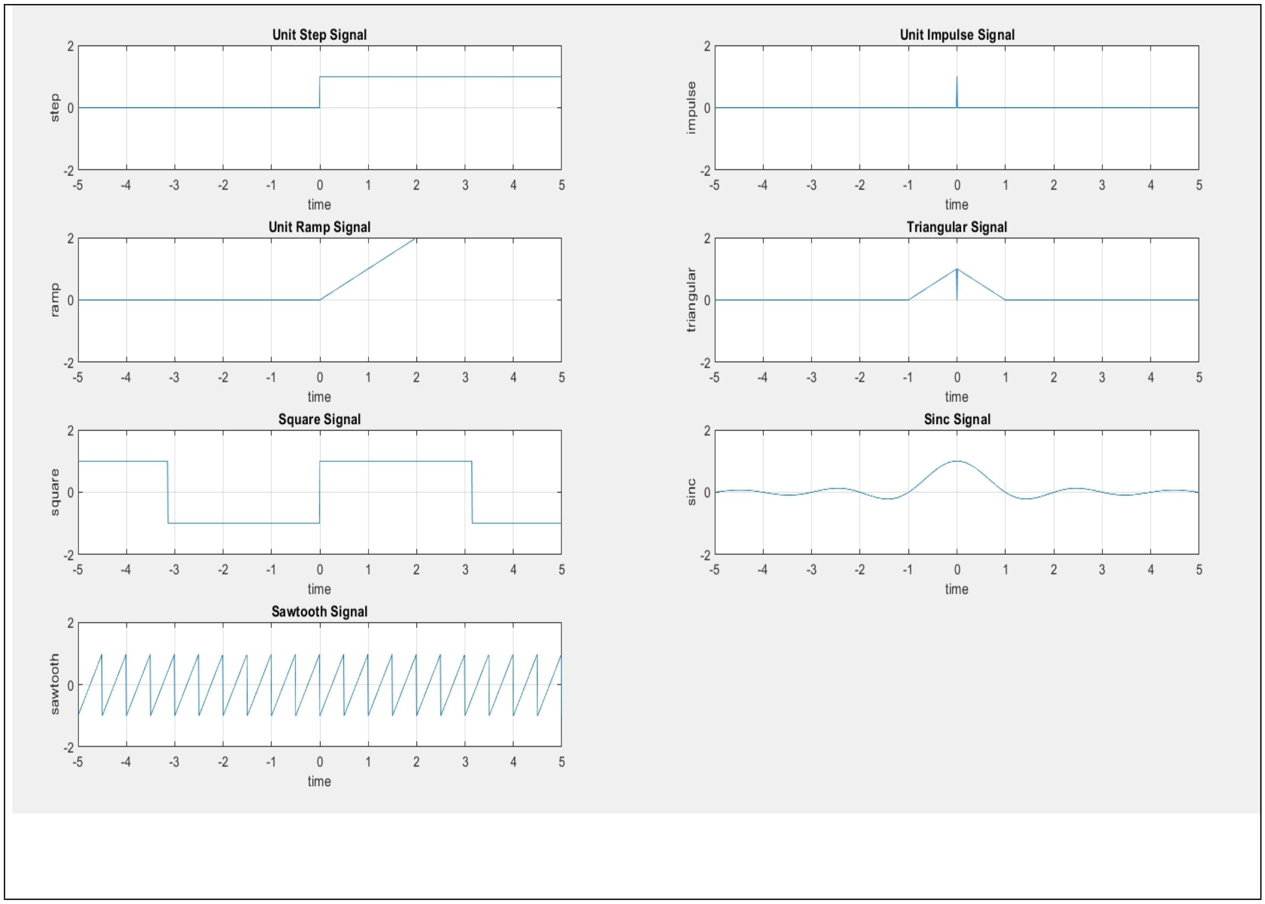
Q1. Write a MATLAB code to generate the following signals. Plot the signals using subplot / axis / grid / x-label, y-label/ title of the plot

(i)	Unit step	(ii) Unit impulse	(iii) Unit ramp
(iv)	Triangular	(v) Square signal	(vi) Sinc signal
(vii)	Sawtooth signal with amplitude = 1 and time period = 0.5		

Answer:

```
clc;
clear all;
close all;
t=-5:0.01:5;
x1=1;
x2=0;

%unit step signal
ustep=x1.*(t>=0) + x2.*(t<0);
subplot(4,2,1);
plot(t,ustep);
axis([-5 5 -2 2]);
grid on;
ylabel('step');
xlabel('time');
title('Unit Step Signal');

%impulse signal
imp=x1.*(t==0)+x2.*(t<0 & t>0);
subplot(4,2,2);
plot(t,imp);
axis([-5 5 -2 2]);
grid on;
ylabel('impulse');
xlabel('time');
title('Unit Impulse Signal');

%ramp signal
rmp=t.*(t>0)+x2.*(t<0);
subplot(4,2,3);
plot(t,rmp);
axis([-5 5 -2 2]);
grid on;
ylabel('ramp');
xlabel('time');
title('Unit Ramp Signal');

%triangular signal
tri=(t+1).*(t>-1 & t<0)+x2.*(t<-1)+x2.*(t>1)+(-t+1).*(t>0 &
t<1);
subplot(4,2,4);
```

```
plot(t,tri);
axis([-5 5 -2 2]);
grid on;
ylabel('triangular');
xlabel('time');
title('Triangular Signal');

%square signal
sq=square(t);
subplot(4,2,5);
plot(t,sq);
axis([-5 5 -2 2]);
grid on;
ylabel('square');
xlabel('time');
title('Square Signal');

%sinc signal
sincsignal=sinc(t);
subplot(4,2,6);
plot(t,sincsignal);
axis([-5 5 -2 2]);
grid on;
ylabel('sinc');
xlabel('time');
title('Sinc Signal');

%sawtooth signal
sawt=sawtooth(2*pi*2*t);
subplot(4,2,7);
plot(t,sawt);
axis([-5 5 -2 2]);
grid on;
ylabel('sawtooth');
xlabel('time');
title('Sawtooth Signal');
```



Q2. Write a MATLAB code to plot the following signals.

(i) $\sin(2\pi t)$

(ii) $\sin(2\pi t)+\cos(10\pi t)$

(iii) $\exp(j2\pi t)$

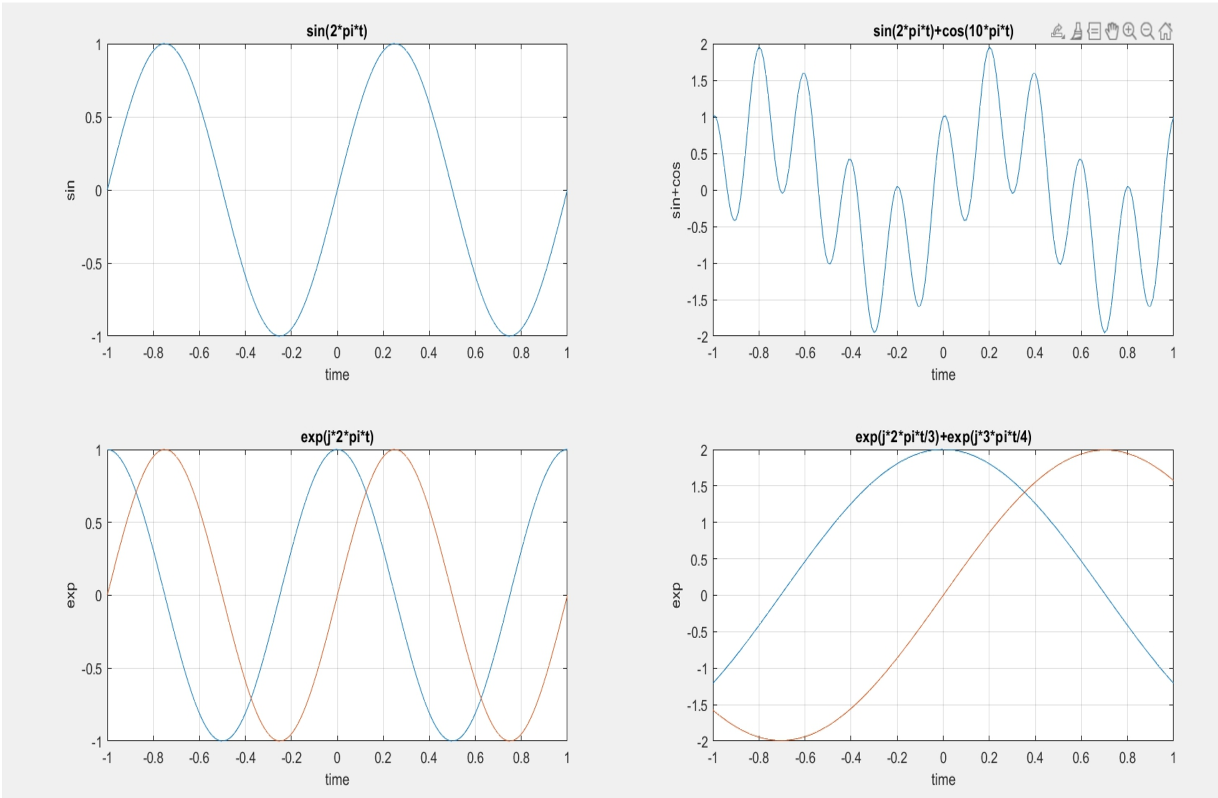
(iv) $\exp(j2\pi t/3) + \exp(j3\pi t/4)$

Display the fundamental time period of these signals.

Answer:

```
clc;
clear all;
close all;
t=-1:0.01:1;

%sin(2*pi*t)
y1=sin(2*pi*t);
subplot(2,2,1);
```

```
plot(t,y1);
xlabel('time');
ylabel('sin');
grid on;
title('sin(2*pi*t)');

%sin(2*pi*t)+cos(10*pi*t)
y2=sin(2*pi*t)+cos(10*pi*t);
subplot(2,2,2);
plot(t,y2);
xlabel('time');
ylabel('sin+cos');
grid on;
title('sin(2*pi*t)+cos(10*pi*t)');

%exp(j*2*pi*t)
y3=exp(j*2*pi*t);
subplot(2,2,3);
plot(t,real(y3), t, imag(y3));
xlabel('time');
ylabel('exp');
grid on;
title('exp(j*2*pi*t)');

%exp(j*2*pi*t/3)+exp(j*3*pi*t/4)
y4=exp(j*2*pi*t/3)+exp(j*3*pi*t/4);
subplot(2,2,4);
plot(t,real(y4), t, imag(y4));
xlabel('time');
ylabel('exp');
grid on;
title('exp(j*2*pi*t/3)+exp(j*3*pi*t/4)');
```



Run #02: Even & odd components of a given signal

Q3. Write a MATLAB code to generate the even and odd components of the following signals

Note : Use ***heaviside*** built-in function available in Matlab for plotting signals related to step function

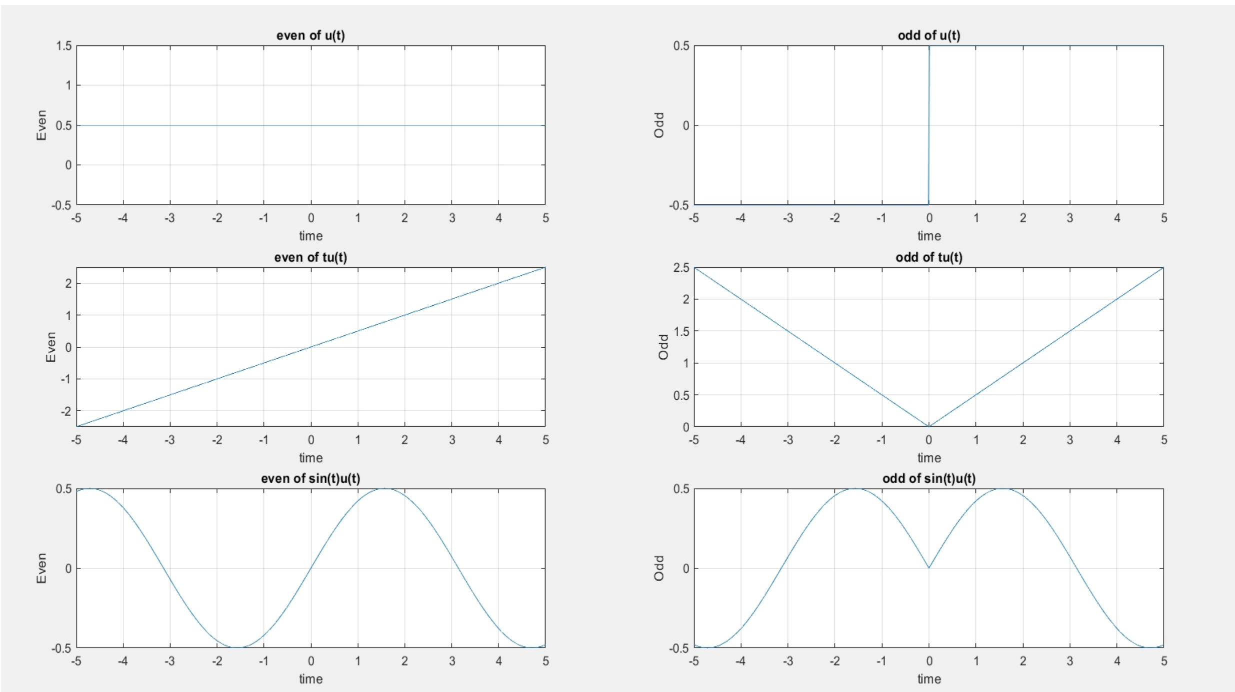
(i) u(t) (ii) t u(t) (iii) $\sin(\omega_0 t)\, u(t)$

Answer

```
clc;
clear all;
close all;
t=-5:0.01:5;
```

```
%u(t)
y1=heaviside(t);
y2=heaviside(-t);
y1even=(y1+y2)/2;
subplot(3,2,1);
plot(t,y1even);
xlabel('time');
ylabel('Even');
title("even of u(t)");
grid on;
y1odd=(y1-y2)/2;
subplot(3,2,2);
plot(t,y1odd);
xlabel('time');
ylabel('Odd');
title("odd of u(t)");
grid on;

%tu(t)
y3=t.*heaviside(t);
y4=t.*heaviside(-t);
y3even=(y3+y4)/2;
subplot(3,2,3);
plot(t,y3even);
xlabel('time');
ylabel('Even');
title("even of tu(t)");
grid on;
y3odd=(y3-y4)/2;
subplot(3,2,4);
plot(t,y3odd);
xlabel('time');
ylabel('Odd');
title("odd of tu(t)");
grid on;

%sin(t)u(t)
y5=sin(t).*heaviside(t);
y6=sin(t).*heaviside(-t);
y5even=(y5+y6)/2;
subplot(3,2,5);
plot(t,y5even);
xlabel('time');
```

```
ylabel('Even');
title("even of sin(t)u(t)");
grid on;
y5odd=(y5-y6)/2;
subplot(3,2,6);
plot(t,y5odd);
xlabel('time');
ylabel('Odd');
title("odd of sin(t)u(t)");
grid on;
```



Run #03 : Windowing effect on a given signal

Q4. (i) Write the expression x(t) for a sine wave signal of frequency 0.5 Hz, starting at time = -5 sec and ending at time = 10 seconds and reaching a maximum value of 4 volts peak to peak.

(ii) Generate the same sine wave signal using matlab code and plot, showing the time and amplitude scales and give the title as “signal x(t)”.

(iii) Write Matlab code to generate a rectangular windowed signal y(t) for time t = -2 sec to t = 2 sec plot it in same figure of x(t) using *subplot* command (as shown in below figure 1). Show the time scale and labels. Index the plots using “text” command and draw grid.

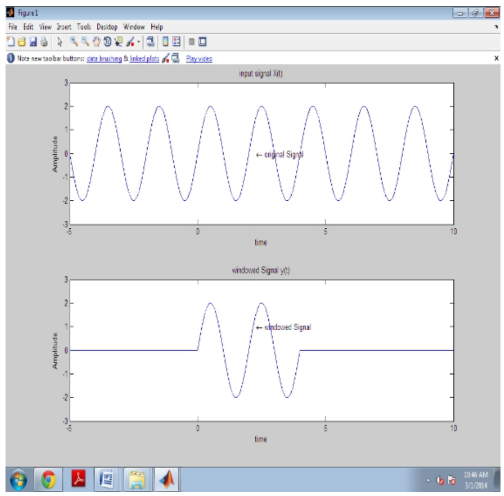


Figure 1

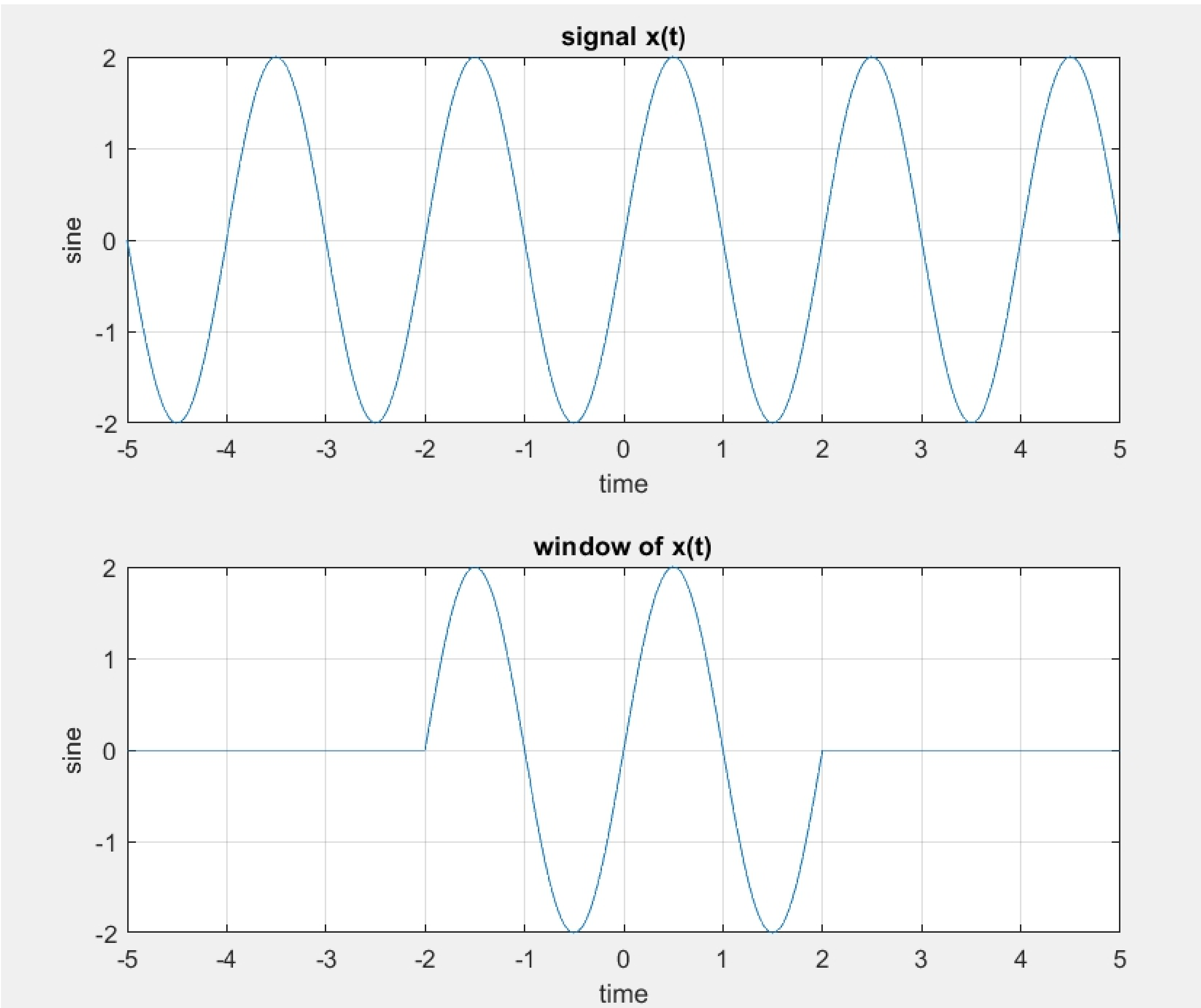
Answer (paste the written code and plots):

(i)y1=2*sin(2*pi*0.5*t);

(ii),(iii)

```
clc;
clear all;
close all;
t=-5:0.01:10;

%sine signal generation
y1=2*sin(2*pi*0.5*t);
subplot(2,1,1);
plot(t,y1);
axis([-5 5 -2 2]);
xticks(-5 :1: 5);
yticks(-2 :1: 2);
grid on;
```

```
xlabel('time');
ylabel('sine');
title('signal x(t)');
y2=y1.*(t>=-2 & t<=2);
subplot(2,1,2);
plot(t,y2);
xlabel('time');
ylabel('sine');
title('window of x(t)');
axis([-5 5 -2 2]);
xticks(-5 :1: 5);
yticks(-2 :1: 2);
grid on;
```



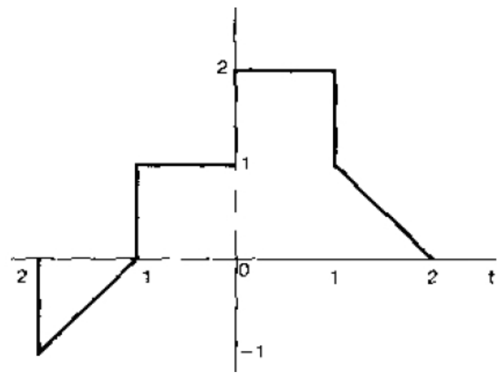
Run #04: Signal operations

Q5. Write the matlab code and

(i) obtain the expression x(t) for the given continuous-time signal (shown below) using relational / logical operators and plot it

(ii) Perform the given operations on obtained signal x(t)

(i) x(t - 1) (ii) x(2 - t) (iii) x(2t + 1) (iv) x(4 - t/2)

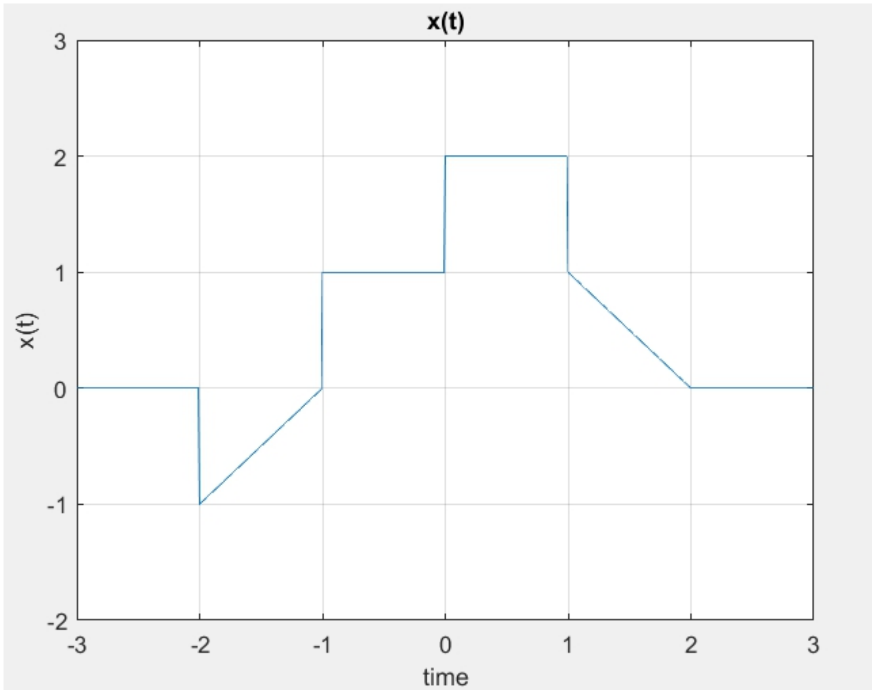


Answer (paste the written code and plots):

(i)

```
clc;
clear all;
close all;
t=-4:0.01:4;
x1=(t+1);
x2=1;
x3=2;
x4=(2-t);
y1=x1.*(t>=-2 & t<-1)+x2.*(t>=-1 & t<0)+x3.*(t>=0 &
t<1)+x4.*(t>=1 & t<2);
plot(t,y1);
axis([-3 3 -2 3]);
xticks(-3:1:3);
yticks(-2:1:3);
xlabel('time');
ylabel('x(t)');
```

```
title('x(t)');
grid on;
```



(ii)

```
clc;
clear all;
close all;
t=-4:0.01:4;
x1=(t+1);
x2=1;
x3=2;
x4=(2-t);

%x(t)
y=x1.*(t>=-2 & t<-1)+x2.*(t>=-1 & t<0)+x3.*(t>=0 &
t<1)+x4.*(t>=1 & t<2);
subplot(3,2,1);
plot(t,y);
axis([-5 5 -3 3]);
xticks(-5:1:5);
yticks(-3:1:3);
xlabel('time');
ylabel('x(t)');
```

```
title('x(t)');
grid on;

%x(t-1)
t1=t-1;
y1=(t1+1).*(t1>=-2 & t1<-1)+x2.*(t1>=-1 & t1<0)+x3.*(t1>=0
& t1<1)+(2-t1).*(t1>=1 & t1<2);
subplot(3,2,3);
plot(t,y1);
axis([-5 5 -3 3]);
xticks(-5:1:5);
yticks(-3:1:3);
xlabel('time');
ylabel('x(t-1)');
title('x(t-1)');
grid on;

%x(2-t)
t2=2-t;
y2=(t2+1).*(t2>=-2 & t2<-1)+x2.*(t2>=-1 & t2<0)+x3.*(t2>=0
& t2<1)+(2-t2).*(t2>=1 & t2<2);
subplot(3,2,4);
plot(t,y2);
axis([-5 5 -3 3]);
xticks(-5:1:5);
yticks(-3:1:3);
xlabel('time');
ylabel('x(2-t)');
title('x(2-t)');
grid on;

%x(2t+1)
t3=2*t+1;
y3=(t3+1).*(t3>=-2 & t3<-1)+x2.*(t3>=-1 & t3<0)+x3.*(t3>=0
& t3<1)+(2-t3).*(t3>=1 & t3<2);
subplot(3,2,5);
plot(t,y3);
axis([-5 5 -3 3]);
xticks(-5:1:5);
yticks(-3:1:3);
xlabel('time');
ylabel('x(2t+1)');
title('x(2t+1)');
grid on;
```

```
%x(4-(t/2))
t4=4-(t/2);
y4=(t4+1).*(t4>=-2 & t4<-1)+x2.*(t4>=-1 & t4<0)+x3.*(t4>=0
& t4<1)+(2-t4).*(t4>=1 & t4<2);
subplot(3,2,6);
plot(t,y4);
axis([-5 5 -3 3]);
xticks(-5:1:5);
yticks(-3:1:3);
xlabel('time');
ylabel('x(4-(t/2))');
title('x(4-(t/2))');
grid on;
```