<<< Only Problem 1, 4 and 9 will be graded >>>

In [ ]:
```
import matplotlib.pyplot as plt
import numpy as np
%matplotlib inline
import IPython.display as ipd
import os
from scipy import signal,fftpack
from skimage.io import imread
import cv2
```

Problem 1

Sketch the following signals

1.$x(t) = \sin\left(\frac{\pi}{4}t + 20^\circ\right)$

2.$x(t) = \begin{cases} t+2, t \leq -2 \\ 0, -2 \leq t \leq 2 \\ t-2, t \geq 2 \end{cases}$

3.$x(t) = 2e^{-t}, 0 \leq t < 1$ and $x(t+1) = x(t)$ for all t

4.$x(t) = u(t) + 5u(t-1) - 2u(t-2)$

5.$x(t) = r(t) - r(t-1) - u(t-2)$

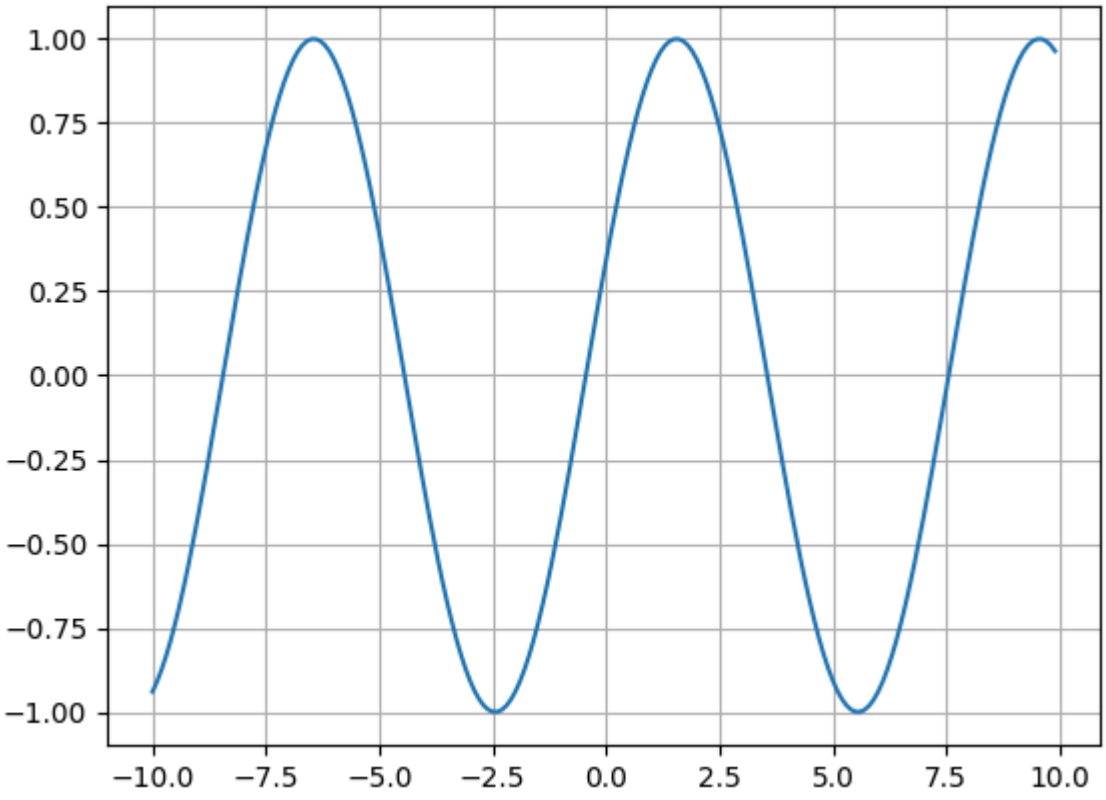
In [ ]:
```
def u(t):
  if(t>0):
    return 1
  else:
    return 0

def r(t):
  return max(t,0)

def x1(t):
  return np.sin(np.pi*t/4+np.pi/9)

def x2(t):
  if(t<=-2):
    return t+2
  elif(-2<=t<=2):
    return 0
  else:
    return t-2

def x3(t):
  return 2*np.e**(-(t%1))

def x4(t):
```

```
  return u(t)+5*u(t-1)-2*u(t-2)

def x5(t):
  return r(t)-r(t-1)-u(t-2)
```

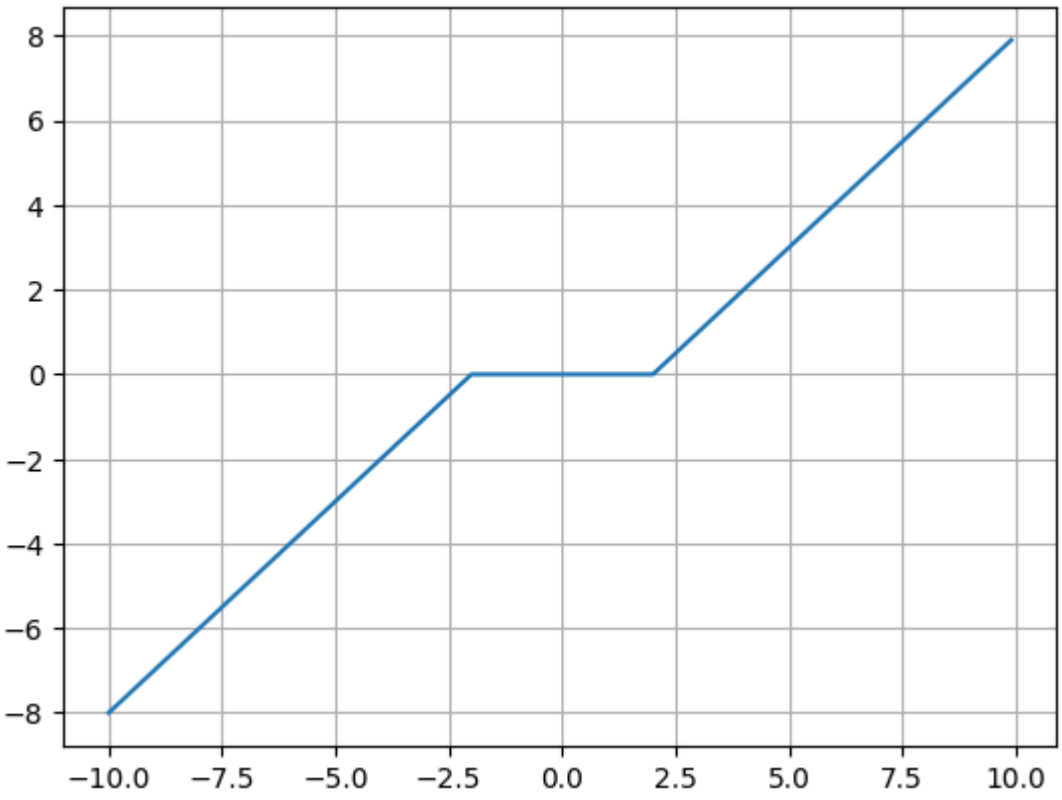
In [ ]:

```
print(1)
x=np.arange(-10,10,0.1)
y1=x1(x)
plt.plot(x,y1,"-")
plt.grid(True)
plt.show()

print(2)
x=np.arange(-10,10,0.1)
y2=[]
for i in x:
    y2.append(x2(i))
plt.plot(x,y2,"-")
plt.grid(True)
plt.show()

print(3)
x=np.arange(0,10,0.01)
y3=x3(x)
plt.plot(x,y3,"-")
plt.grid(True)
plt.show()

print(4)
x=np.arange(-5,5,0.0001)
y4=[]
for i in x:
    y4.append(x4(i))
plt.plot(x,y4,"-")
plt.grid(True)
plt.show()

print(5)
x=np.arange(-5,5,0.001)
y5=[]
for i in x:
    y5.append(x5(i))
plt.plot(x,y5,"-")
plt.grid(True)
plt.show()
```

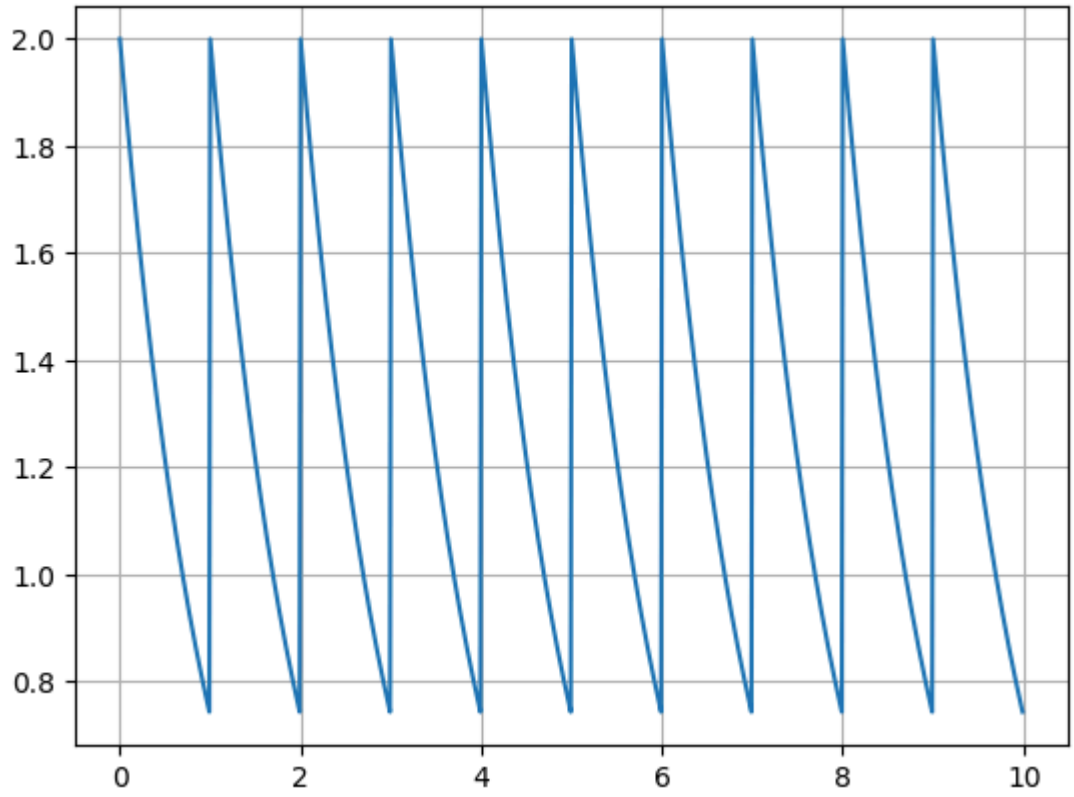
1


1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−10.0
−7.5
−5.0
−2.5
0.0
2.5
5.0
7.5
10.0

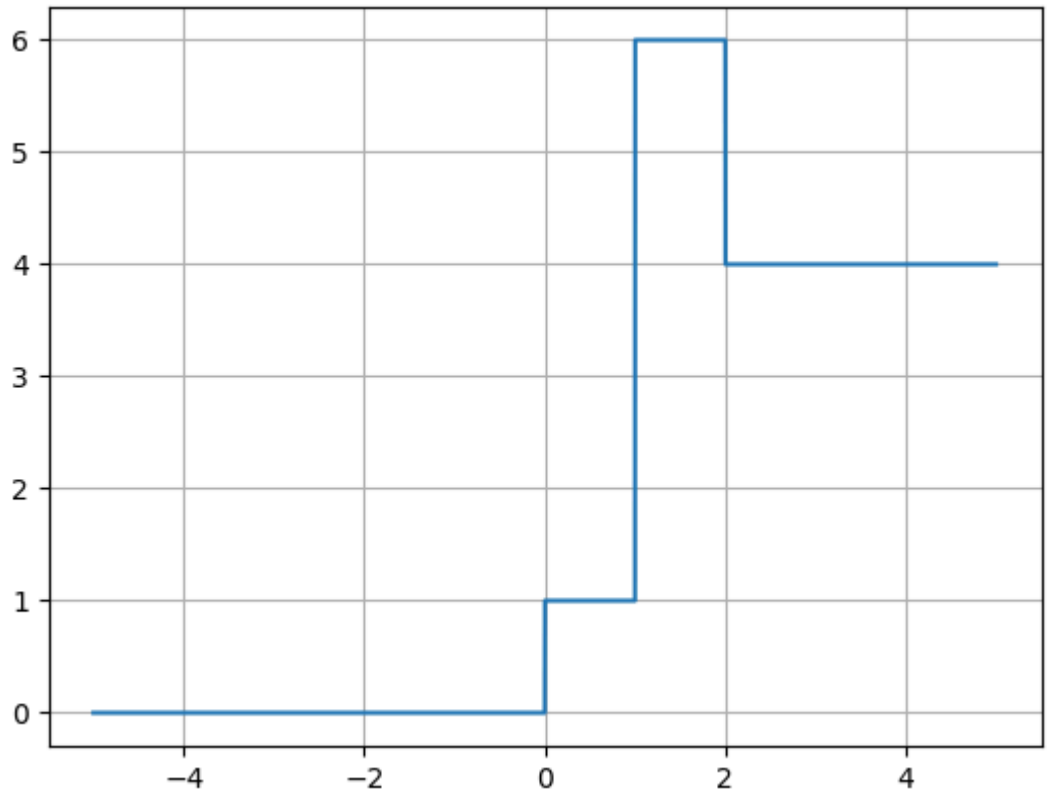
2


8
6
4
2
0
−2
−4
−6
−8
−10.0
−7.5
−5.0
−2.5
0.0
2.5
5.0
7.5
10.0

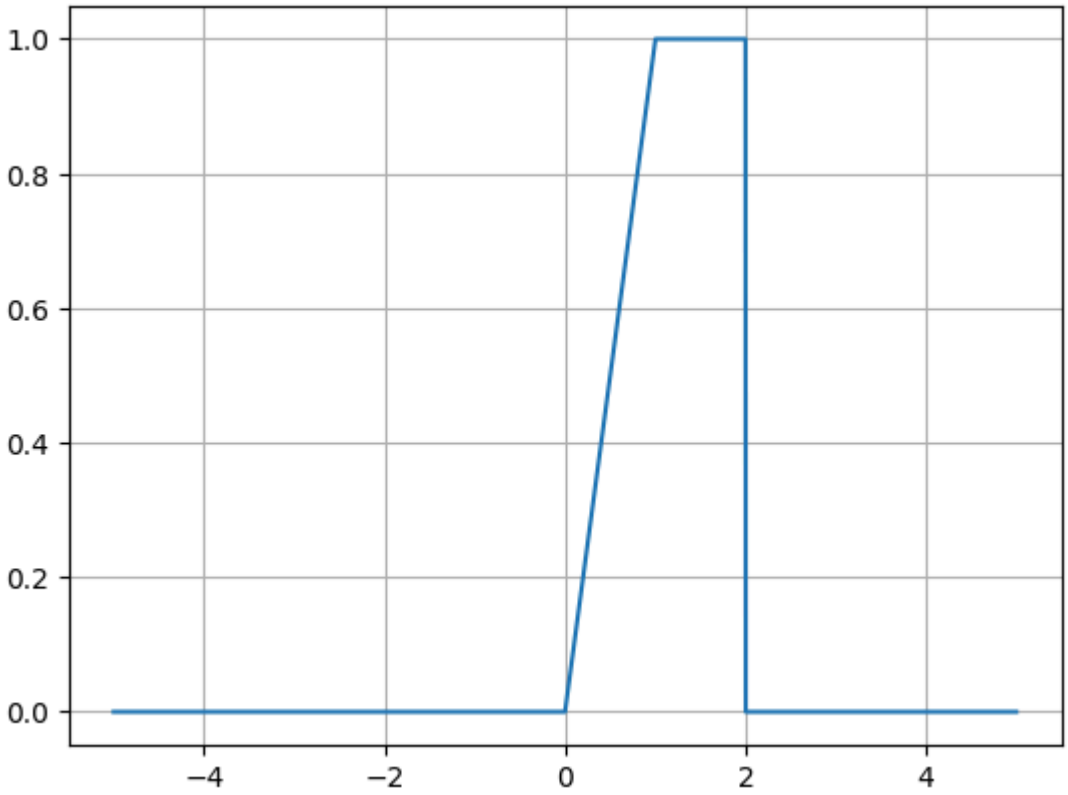
3



4



5



Problem 2

Determine whether each of following signals is periodic, and if so, find its period.

1.$x(t) = \sin\left(\frac{\pi}{3}t\right) + \cos\left(\frac{8\pi}{3}t\right)$

2.$x(t) = \exp\left(j\frac{7\pi}{6}t\right) + \exp\left(j\frac{5\pi}{6}t\right)$

3.$x(t) = \exp\left(j\frac{7\pi}{6}t\right) + \exp\left(\frac{5\pi}{6}t\right)$

Ans

1.periodic with T=6

2.periodic with T=12

3.aperiodic

Problem 3 (ยังไม่ได้ทำ)

Determine whether the following signals are power or energy signals or neither. Justify your answers

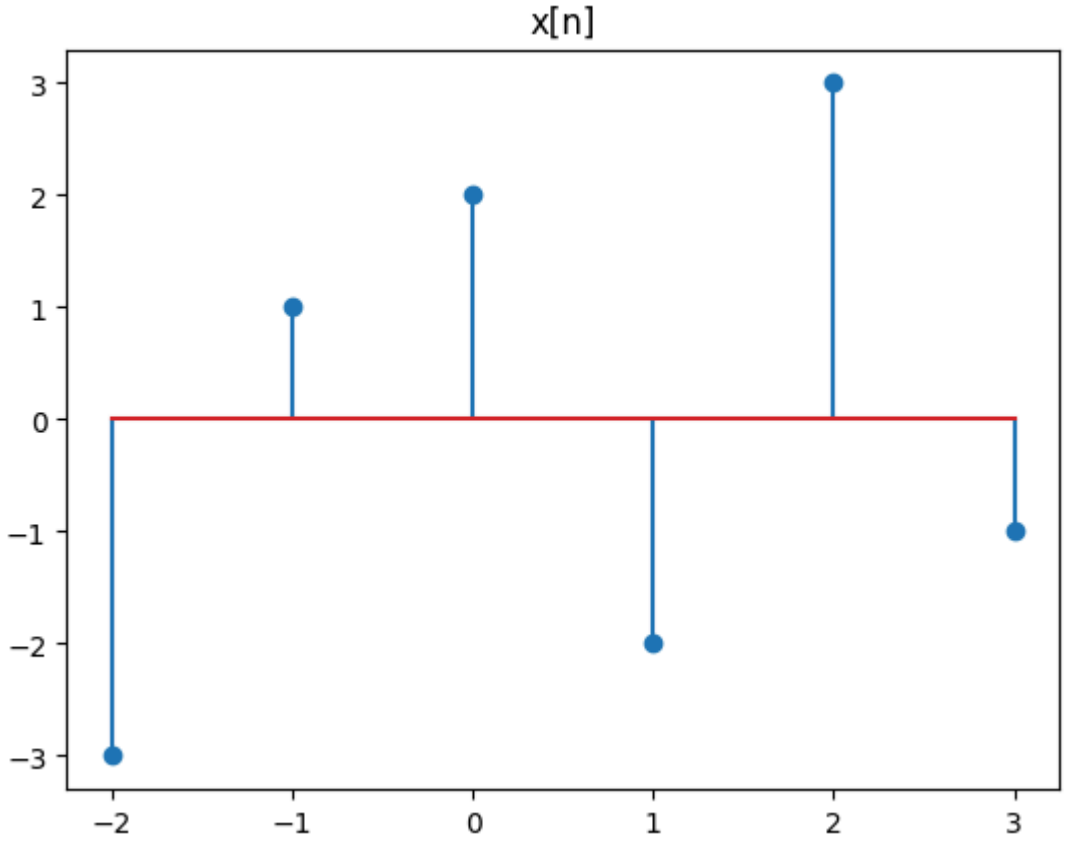
1. $x(t) = A\sin(t), -\infty < t < \infty$
2. $x(t) = A(u(t-a) - u(t+a)),\ a > 0$
3. $x(t) = \exp(-at)u(t),\ a > 0$
4. $x(t) = A\exp(bt)u(t),\ b > 0$

Problem 4

For the discrete time signal x[n] shown in Figure below, sketch each of the following

1. $x[2-n]$
2. $x[3n-4]$
3. $x\left[\frac{2}{3}n+1\right]$
4. $x\left[-\frac{n+8}{4}\right]$
5. $x[n^3]$
6. $x[2-n] + x[3n-4]$

In [ ]:
```
# x[n]
t = np.arange(-2,4)
x_t = np.array([-3,1,2,-2,3,-1])
plt.stem(t, x_t)
plt.title('x[n]')
plt.show()
```



In [ ]:

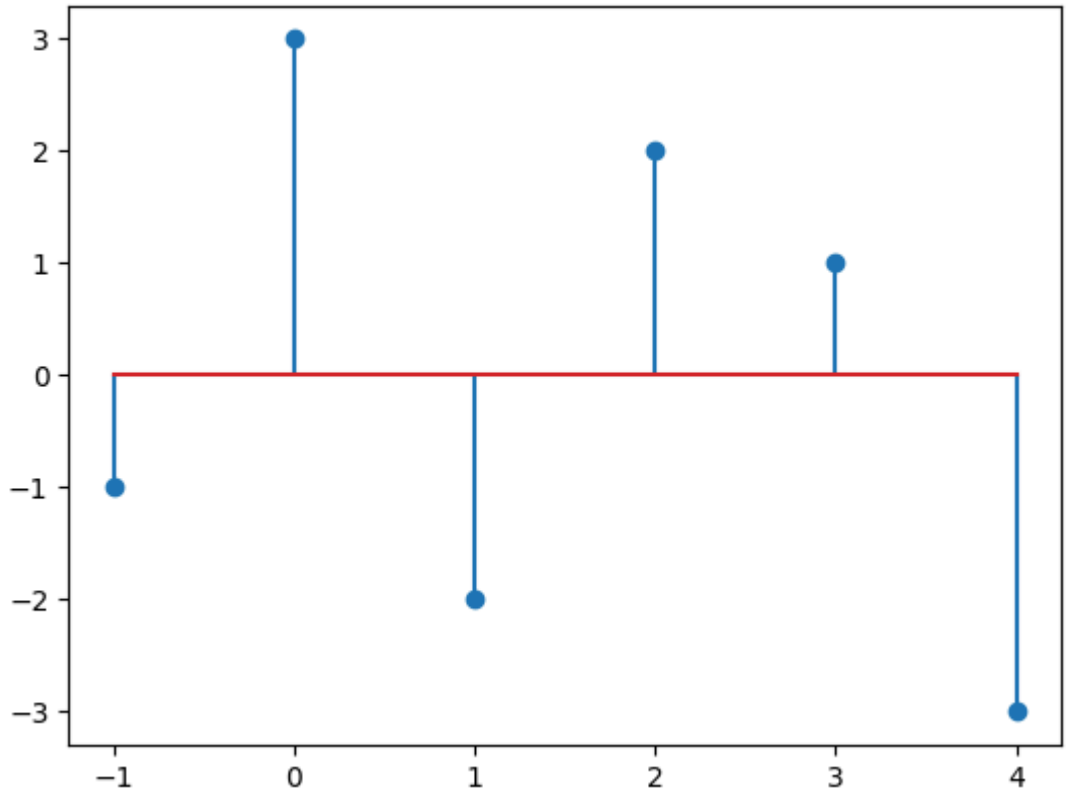
```
def x1(t,x):
    rt=np.flip(t)
    rt*=-1
    rt=rt+2
    rx=np.flip(x)
    return rt,rx

def x2(t,x):
    rt=t+4
    rt=rt/3
    return rt,x

def x3(t,x):
    rt=t-1
    rt*=3
    rt=rt/2
    return rt,x

def x4(t,x):
    rt=t+2
    rt=np.flip(rt)
    rx=np.flip(x)
    rt*=-1
    rt*=4
    return rt,rx

def x5(t,x):
    rt=np.cbrt(t)
    return rt,x

def x6(t,x):
    rt,rx=x1(t,x)
    t_2,x_2=x2(-t,x)
```

```
    for i in range(len(t_2)):
        idxs=np.where(rt == t_2[i])
        if(len(idxs[0])==0):
            rt=np.append(rt,np.array([t_2[i]]))
            rx=np.append(rx,np.array([x_2[i]]))
        else:
            rx[idxs[0][0]]+=x_2[i]
    return rt,rx
```

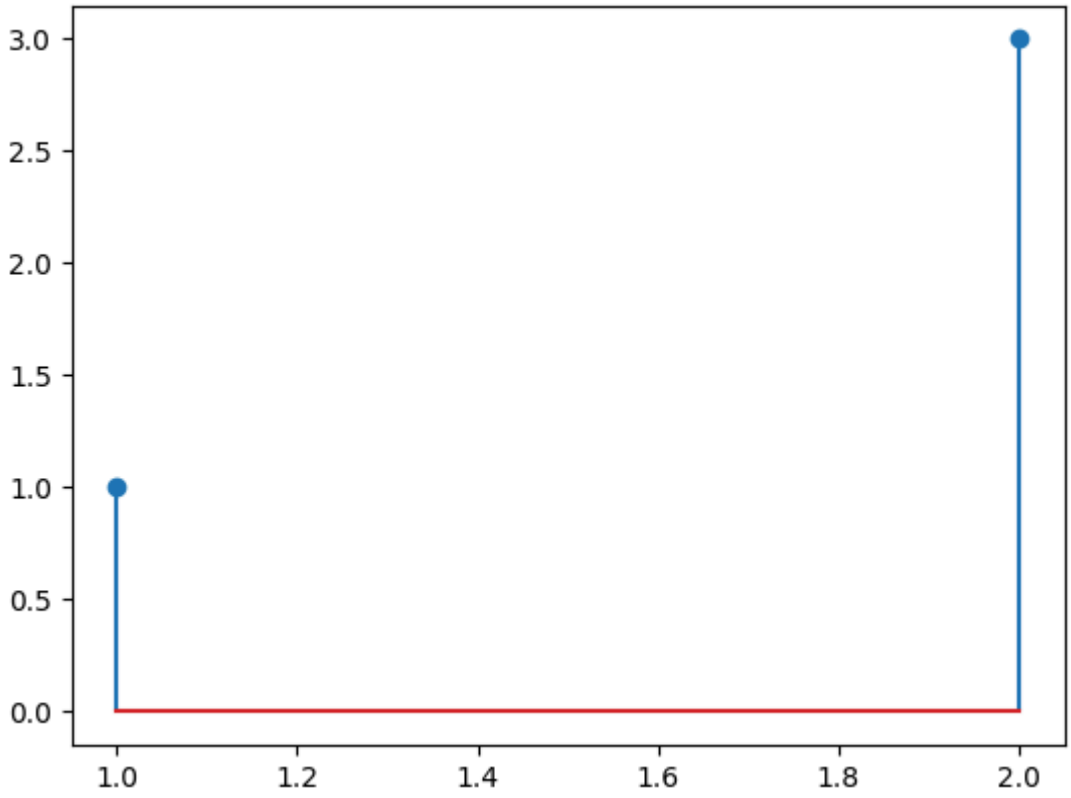
In [ ]:
```
def filterInt(t,x):
    idx = [(i%1==0) for i in t]
    return t[idx],x[idx]

def display(t,x,i):
    print(i)
    print(t,x)
    plt.stem(t, x)
    plt.show()
```

In [ ]:
```
t=np.arange(-2,4)
t_1,x_1=x1(t,x_t)
t_1,x_1=filterInt(t_1,x_1)
display(t_1, x_1, 1)

t=np.arange(-2,4)
t_2,x_2=x2(t,x_t)
t_2,x_2=filterInt(t_2,x_2)
display(t_2, x_2, 2)

t=np.arange(-2,4)
t_3,x_3=x3(t,x_t)
t_3,x_3=filterInt(t_3,x_3)
display(t_3, x_3, 3)

t=np.arange(-2,4)
t_4,x_4=x4(t,x_t)
t_4,x_4=filterInt(t_4,x_4)
display(t_4, x_4, 4)

t=np.arange(-2,4)
t_5,x_5=x5(t,x_t)
t_5,x_5=filterInt(t_5,x_5)
display(t_5, x_5, 5)

t=np.arange(-2,4)
t_6,x_6=x6(t,x_t)
t_6,x_6=filterInt(t_6,x_6)
display(t_6, x_6, 6)
```

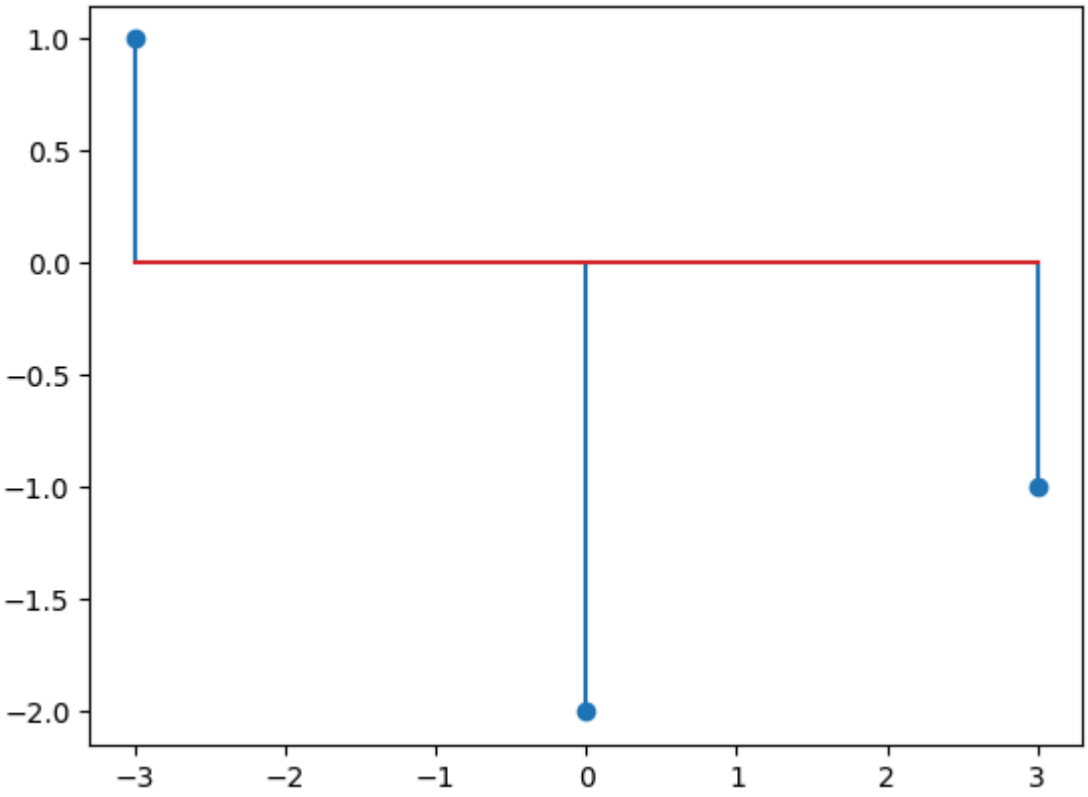
```
1
[-1  0  1  2  3  4] [-1  3 -2  2  1 -3]
```



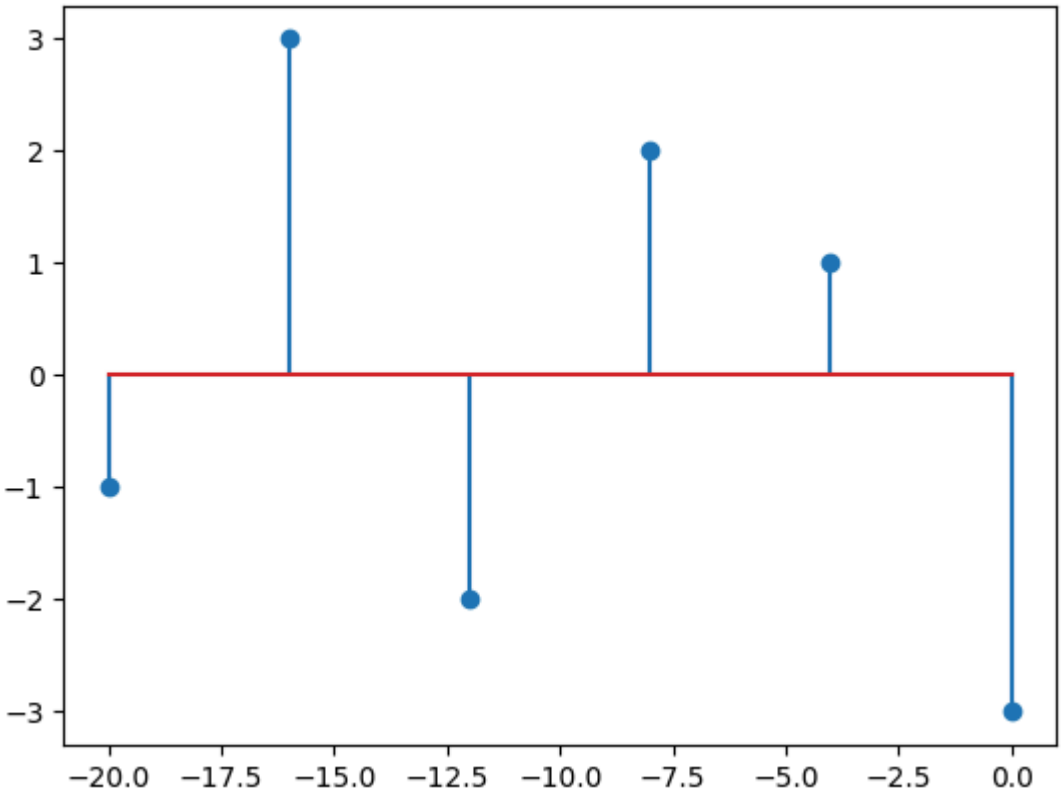

```
2
[1. 2.] [1 3]
```



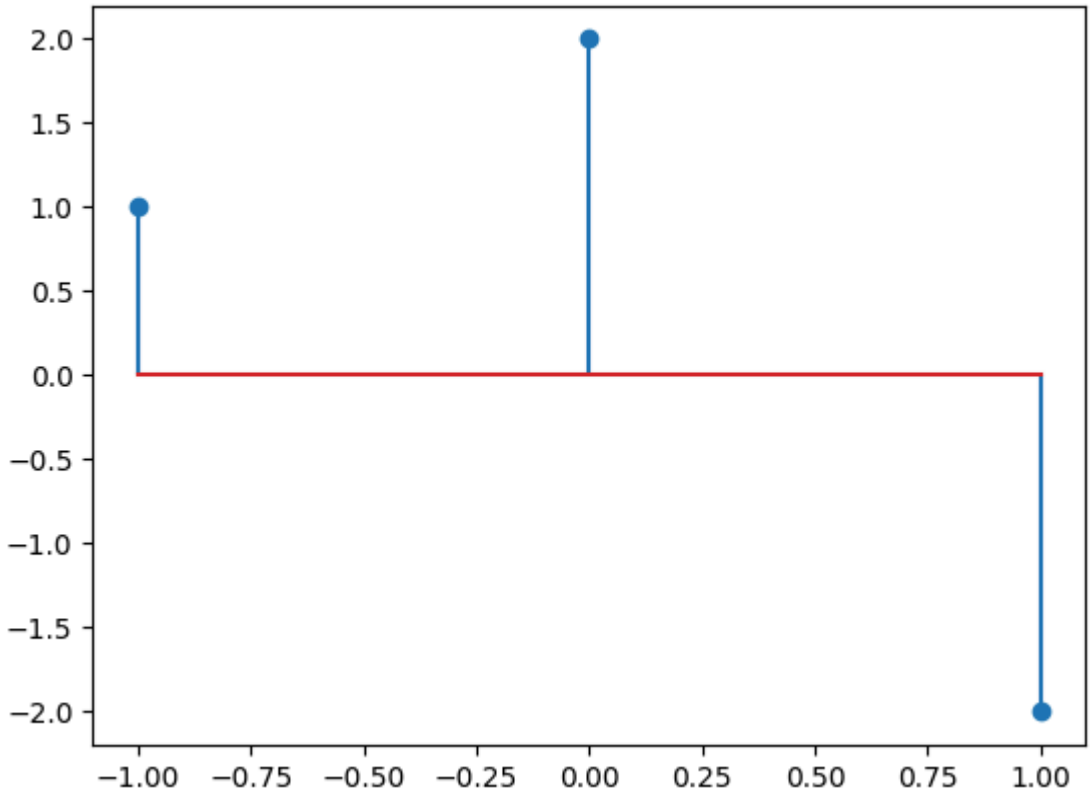

```
3
[-3.  0.  3.] [ 1 -2 -1]
```



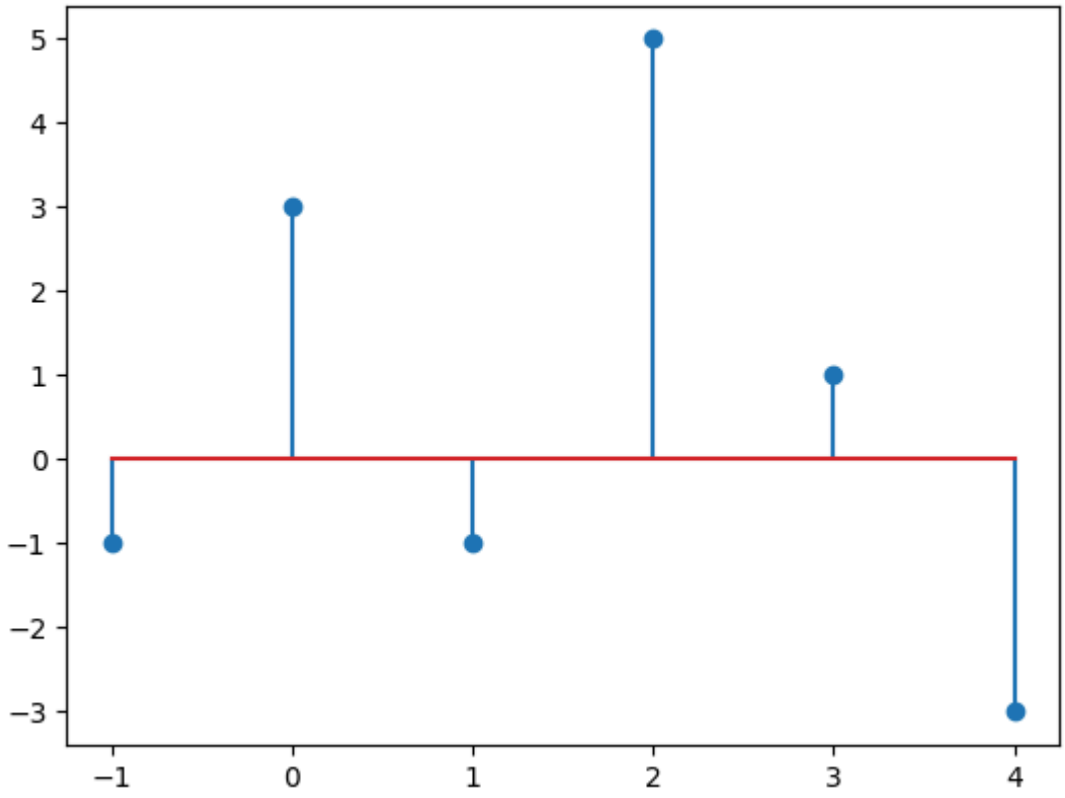
4
[-20 -16 -12 -8 -4   0] [-1 3 -2 2 1 -3]



5
[-1. 0. 1.] [1 2 -2]



6
[-1. 0. 1. 2. 3. 4.] [-1 3 -1 5 1 -3]



Problem 5 (ยังไม่ได้ทำ)

Determine whether each of following signals is periodic, and if so, find its period.

1.$x[n] = \sin\left(\frac{\pi n}{4} + \frac{\pi}{8}\right)$

2.$x[n] = \sin\left(\frac{3\pi n}{4}\right) + \sin\left(\frac{\pi}{3}n\right)$

3.$x[n] = \sin\left(\frac{3\pi n}{4}\right)\sin\left(\frac{\pi}{3}n\right)$

4.$x[n] = \exp\left(\frac{6\pi}{5}n\right)$

5.$x[n] = \exp\left(j\frac{5\pi}{6}n\right)$

6.$x[n] = \sum_{m=-\infty}^{\infty}[\delta[n-2m] + 2\delta[n-3m]]$

Problem 6 (ยังไม่ได้ทำ)

[python] Signal transformations : Study the sawtooth function in the figure below. Apply reflection, scaling, shifting operations to the signal and plot the transformed signals compared with the original sawtooth signal.

In [ ]:
```
import numpy as np
from scipy import signal
import matplotlib.pyplot as plt
%matplotlib inline
```

In [ ]:
```
# t = np.linspace(-1, 1, 500)
# plt.plot(t, signal.sawtooth(2 * np.pi * 5 * t))
# plt.show()
```

In [ ]:
```
# t = np.linspace(-1, 1, 500)
# plt.plot(t, signal.sawtooth(2 * np.pi * 5 * t))

# scaling factor = 3 and 1/3
## TODO : writing code for time scaling
```

In [ ]:
```
# t = np.linspace(-1, 1, 500)
# plt.plot(t, signal.sawtooth(2 * np.pi * 5 * t))

# shifting t to the left and right 0.05 units

## TODO : writing code for time shifting
```

In [ ]:
```
# plt.plot(t, signal.sawtooth(2 * np.pi * 5 * t))

## TODO : writing code for time Reflection
```

Problem 7 (ยังไม่ได้ทำ)

[python] Elementary signals: study the ramp signal plotted in the example below. \ TODO : plot these signals

1. Unit step function
2. Unit impulse function

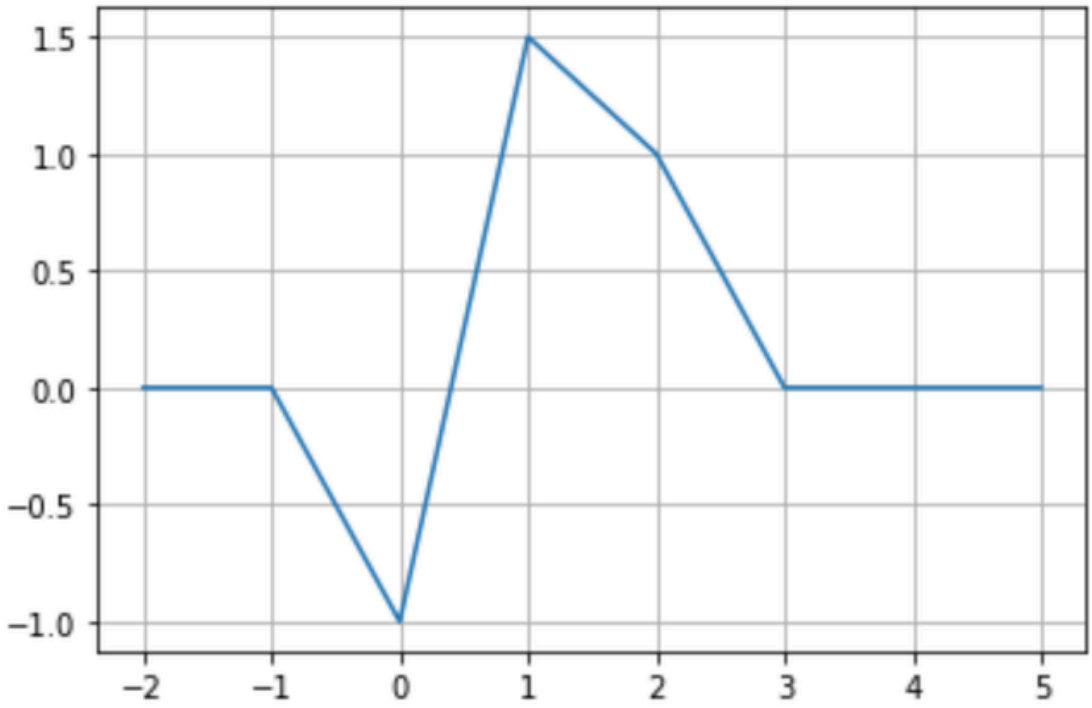
In [ ]:
```
# t = np.linspace(-1, 1, 500)
# ramp_t = t.copy()
# ramp_t[ramp_t < 0 ] = 0
# plt.plot(t, ramp_t)
# plt.show()
```

In [ ]:
```
## TODO : writing code for plotting unit step function
```

In [ ]:
```
## TODO : writing code for plotting unit impulse function
```

Problem 8 (ยังไม่ได้ทำ)

Express the signal that shown in Figure below using Unit-ramp functions



Problem 9

Evaluate the following integrals

1. $\int_{-\infty}^{\infty} \left(\frac{2}{3}t - \frac{3}{2}\right) \delta(t-1)\, dt = -\frac{5}{6}$
2. $\int_{-\infty}^{\infty} (t-1)\delta\left(\frac{2}{3}t - \frac{3}{2}\right)\, dt = \frac{15}{8}$
3. $\int_{-3}^{-2} \left[e^{(-t+1)} + \sin\left(\frac{2\pi t}{3}\right)\right] \delta\left(t - \frac{3}{2}\right)\, dt = 0$
4. $\int_{-3}^{2} \left[e^{(-t+1)} + \sin\left(\frac{2\pi t}{3}\right)\right] \delta\left(t - \frac{3}{2}\right)\, dt = e^{-\frac{1}{2}}$

Problem 9

1) $\int_{-\infty}^{\infty} \left(\frac{2t}{3} - \frac{3}{2}\right) \delta(t-1)\, dt = \frac{2(1)}{3} - \frac{3}{2} = \frac{-5}{6}$

2) $\int_{-\infty}^{\infty} (t-1)\, \delta\left(\frac{2t}{3} - \frac{3}{2}\right) dt = \int_{-\infty}^{\infty} (t-1)\, \frac{3}{2}\, \delta\left(t - \frac{9}{4}\right) = \frac{3}{2}\left(\frac{9}{4} - 4\right) = \frac{15}{8}$

3) $\int_{-3}^{-2} \left[e^{(-t+1)} + \sin\left(\frac{2\pi t}{3}\right)\right] \delta\left(t - \frac{3}{2}\right) dt = 0$

4) $\int_{-3}^{-2} \left[e^{(-t+1)} + \sin\left(\frac{2\pi t}{3}\right)\right] \delta\left(t - \frac{3}{2}\right) dt = e^{\left(-\frac{3}{2}+1\right)} + \sin(\pi) = e^{-1/2}$