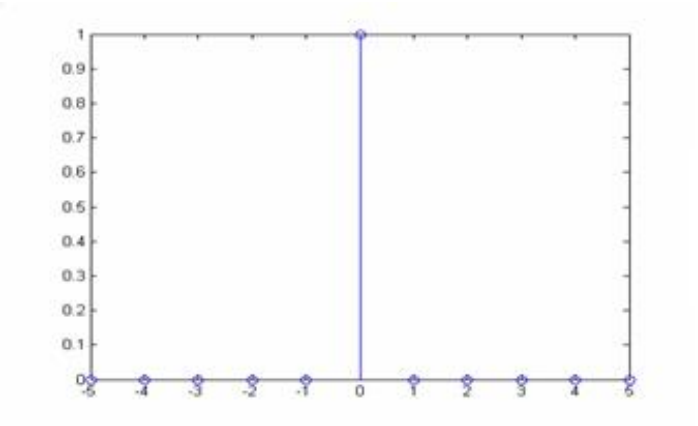
MatLab representations of Discrete-time Signals

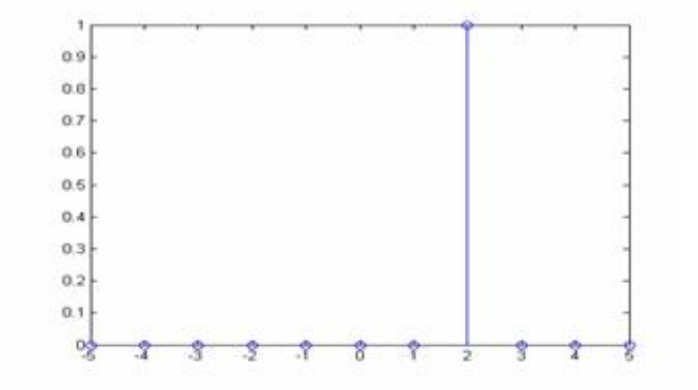
1. Unit sample signal

$$\delta(n)=\begin{cases}1, & n=0\\ 0 & n\neq 0\end{cases}$$



```
>> n=-5:5;
>> x=[n==0];
>> stem (n,x)
```

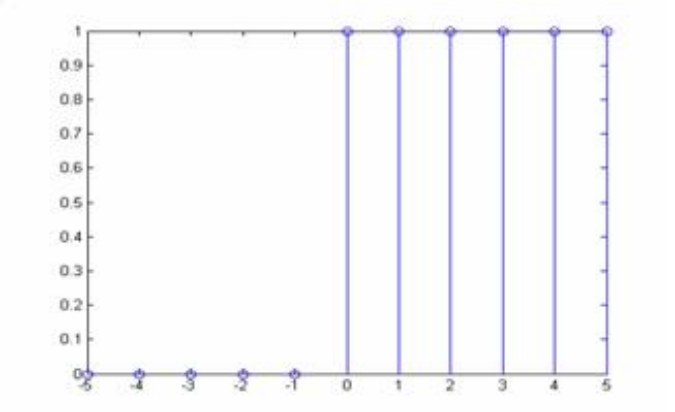
$$\delta(n-2)=\begin{cases}1, & n=2\\ 0 & n\neq 2\end{cases}$$



```
>> n=-5:5;
>> x=[(n-2)==0];
>> stem (n,x)
```

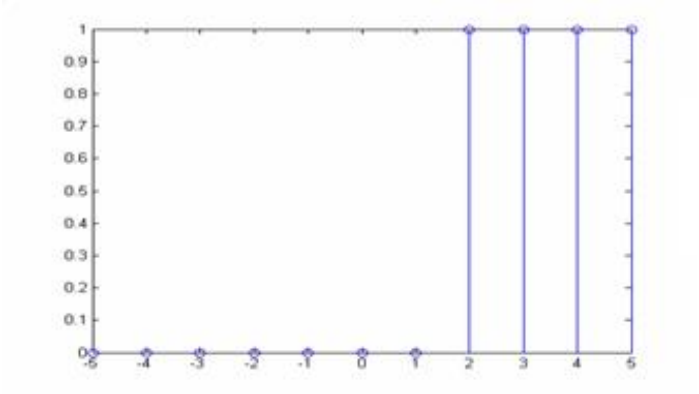
2. Unit step signal

$$u(n)=\begin{cases}1, & n\geq 0\\ 0 & n<0\end{cases}$$



```
>> n=-5:5;
>> x=[n>=0];
>> stem (n,x)
```

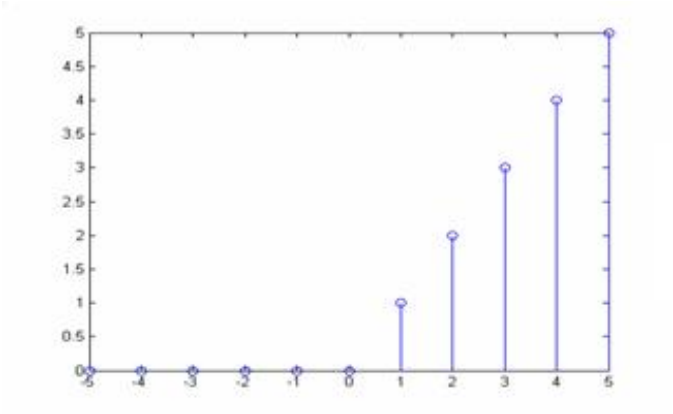
$$u(n-2)=\begin{cases}1, & n\geq 2\\ 0 & n<2\end{cases}$$



```
>> n=-5:5;
>> x=[(n-
2)>=0];
>> stem (n,x)
```

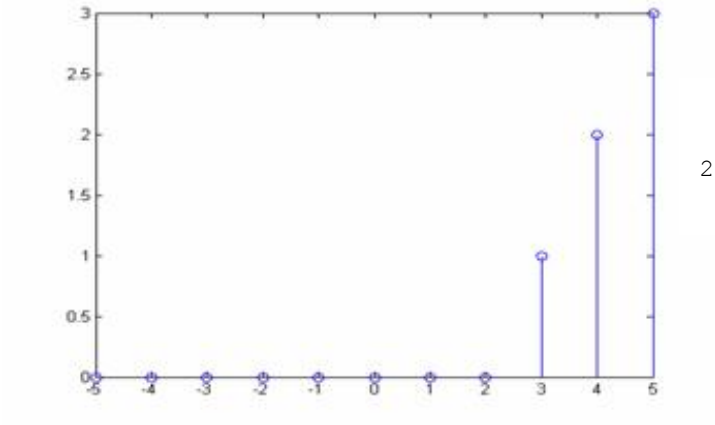
3. Unit ramp signal

$$u_r(n)=\begin{cases} n, & n\geq 0 \\ 0 & n<0 \end{cases}$$



```
>> n=-5:5;
>> x=n.*
[n>=0];
>> stem (n,x)
```

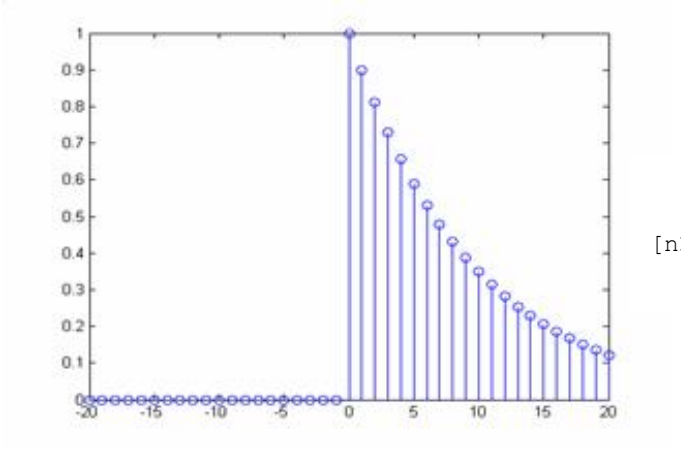
$$u_r(n-2)=\begin{cases} n-2, & n\geq 2 \\ 0 & n<2 \end{cases}$$



```
>> n=-5:5;
>> x=(n-2).*[(n-
2)>=0];
>> stem (n,x)
```

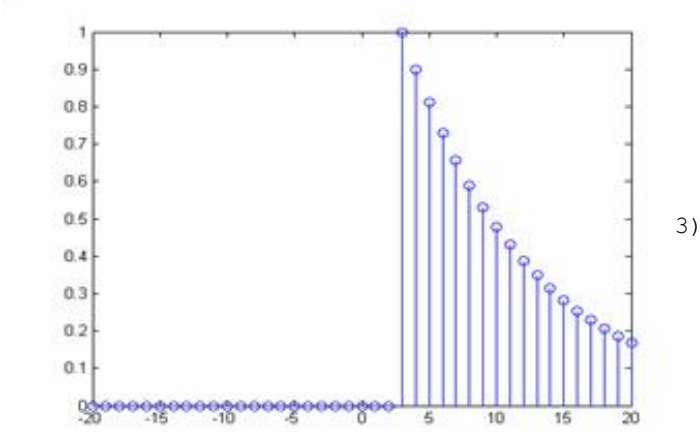
4. Real valued exponential signal

$$x(n)=\begin{cases} 0.9^n, & n\geq 0 \\ 0 & n<0 \end{cases}$$



```
>> n=-20:20;
>> x=(0.9.^n).*
[n>=0];
>> stem (n,x)
```

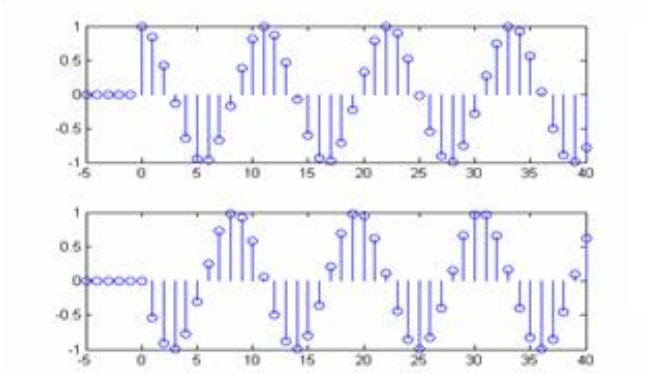
$$x(n-3)=\begin{cases}0.9^{n-3}, & n\geq 3\\ 0 & n<3\end{cases}$$



```
>> n=-20:20;
>> x=(0.9.^(n-3)).*[(n-
3)>=0];
>> stem (n,x)
```

5. Complex-valued exponential signal

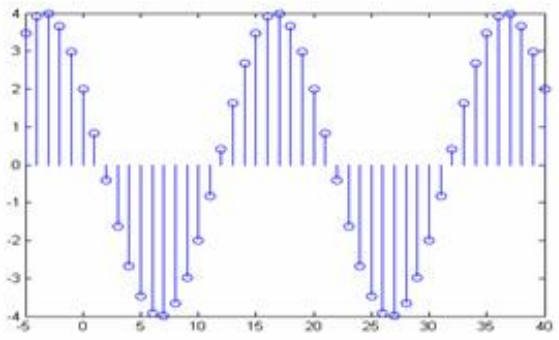
$x(n)=e^{(a+j\theta)n}$ for n>=0



```
>> n=-5:40;
>> x=(exp((3*4j)*n)).*[n>=0];
>> y=real(x);
>> subplot(2,1,1);
>> stem (n,y)
>> z=imag(x);
>> subplot(2,1,2);
>> stem (n,z)
```

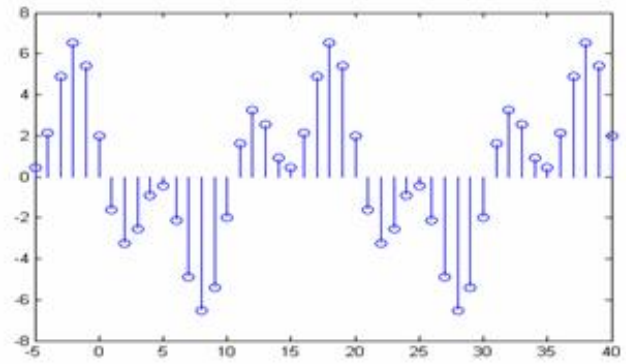
6. Sinusoidal signal:

$$x(n)=4*\cos(0.1\pi n+\frac{\pi}{3})$$



```
>> n=-5:40;
>> x=4*cos(0.1*pi*n+pi/3);
>> stem(n,x)
```

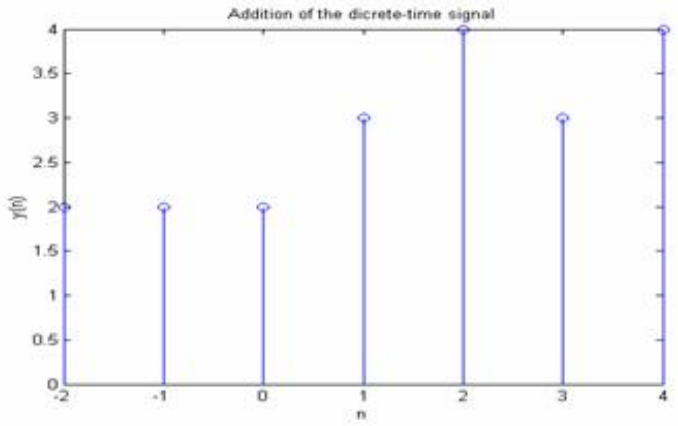
$$x(n) = 4*\cos(0.1\pi n + \frac{\pi}{3}) + 3\sin(0.3\pi n + \pi)$$



```
>> stem(n,x)
>> x=4*cos(0.1*pi*n+pi/3)+3*sin(0.3*pi*n+pi);
>> stem(n,x)
```

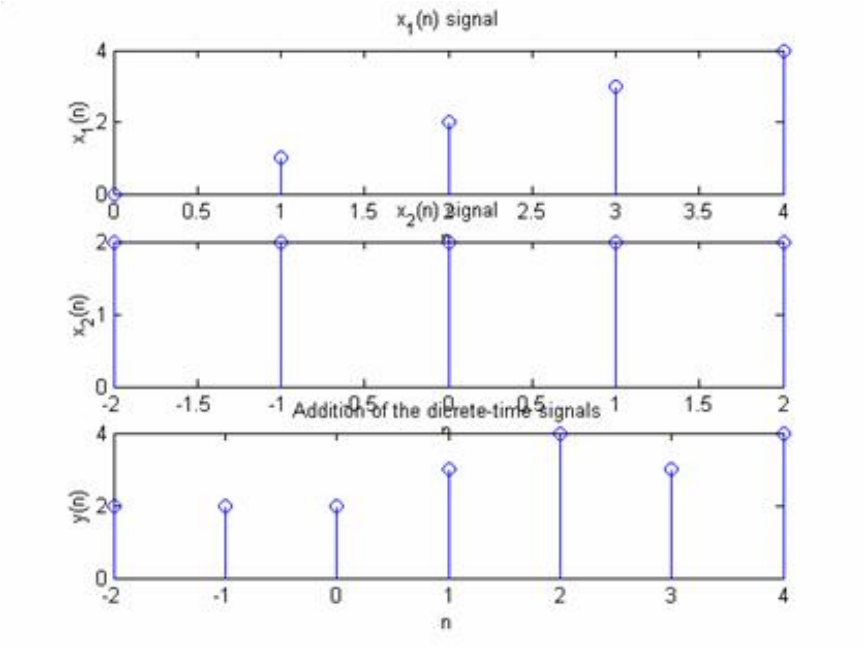
Signal Addition:

$$y(n) = x_1(n) + x_2(n)$$




```
n1 = 0:4;
x1 = [0 1 2 3 4];
n2 = -2:2;
x2 = [2 2 2 2 2];
n = min(min(n1),min(n2)):max(max(n1),max(n2)); % duration of y(n)
y1 = zeros(1,length(n)); y2 = y1;               % initialization
y1(find((n>=min(n1))&(n<=max(n1))==1))=x1;      % x1 with duration of y
y2(find((n>=min(n2))&(n<=max(n2))==1))=x2;      % x2 with duration of y
y = y1+y2;                                      % sequence
addition                                       % addition
stem(n,y)
```

we can represent $x_1(n)$, $x_2(n)$, and $y(n) = x_1(n) + x_2(n)$ signals as follow.

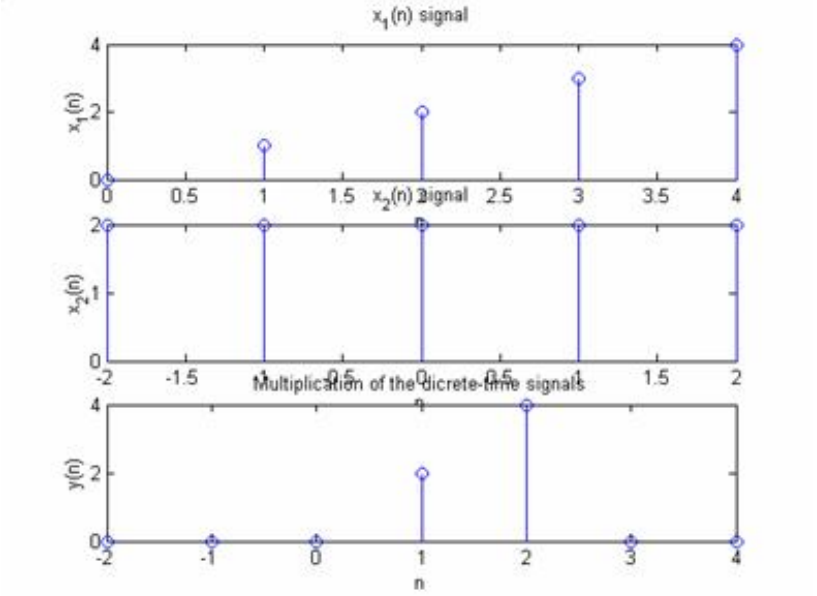


m-file

```
%Discrete-time addition y(n)=x1(n)+x2(n)
n1 = 0:4;
x1 = [0 1 2 3 4];
subplot(3,1,1);stem(n1,x1); title('x_1(n) signal');
xlabel('n'); ylabel('x_1(n)');

n2 = -2:2;
x2 = [2 2 2 2 2];
subplot(3,1,2);stem(n2,x2); title('x_2(n) signal');
xlabel('n'); ylabel('x_2(n)');

n = min(min(n1),min(n2)):max(max(n1),max(n2)); % duration of y(n)
y1 = zeros(1,length(n)); y2 = y1;              % initialization
y1(find((n>=min(n1))&(n<=max(n1))==1))=x1;     % x1 with duration of y
y2(find((n>=min(n2))&(n<=max(n2))==1))=x2;     % x2 with duration of y
y = y1+y2;                                     % sequence addition
% addition
subplot(3,1,3); stem(n,y); title('Addition of the discrete-time signals');
xlabel('n'); ylabel('y(n)');
```



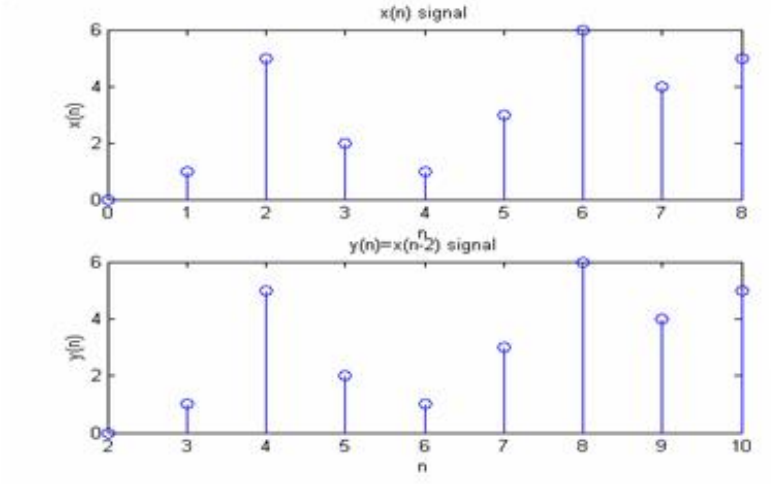
m-file

```
% implements y(n) = x1(n)*x2(n)
n1 = 0:4;
x1 = [0 1 2 3 4];
subplot(3,1,1);stem(n1,x1); title('x_1(n) signal');
xlabel('n'); ylabel('x_1(n)');

n2 = -2:2;
x2 = [2 2 2 2 2];
subplot(3,1,2);stem(n2,x2); title('x_2(n) signal');
xlabel('n'); ylabel('x_2(n)');

n = min(min(n1),min(n2)):max(max(n1),max(n2)); % duration of y(n)
y1 = zeros(1,length(n)); y2 = y1;              % initialization
y1(find((n>=min(n1))&(n<=max(n1))==1))=x1;     % x1 with duration of y
y2(find((n>=min(n2))&(n<=max(n2))==1))=x2;     % x2 with duration of y
y = y1 .* y2;                                  % sequence multiplication
subplot(3,1,3); stem(n,y); title('Multiplication of the discrete-time
signals');
xlabel('n'); ylabel('y(n)');
```

Shifting a non-function discrete-time signal

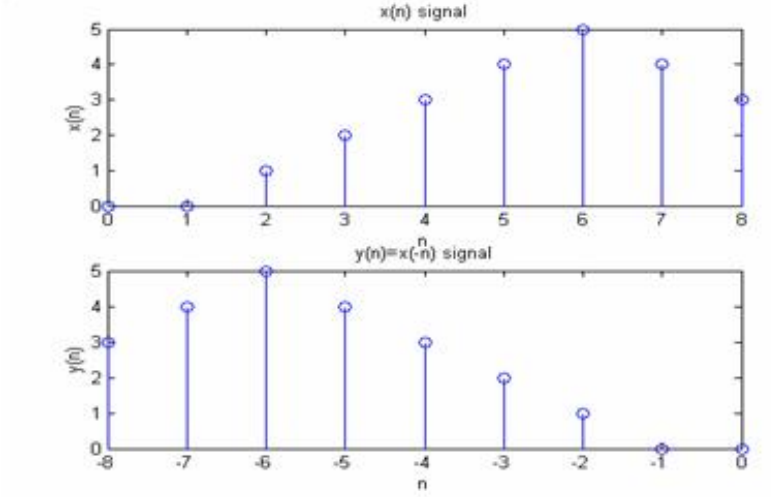


m-file

```
%Shifting a non-function Discrete-time
signal
n = 0:8;
x = [0 1 5 2 1 3 6 4 5];
subplot(2,1,1);stem(n,x); title('
signal');
xlabel('n'); ylabel('x(n)');

m=n+2; y=x;
subplot(2,1,2);stem(m,y); title('y(n)=x(n-
2) signal');
xlabel('n'); ylabel('y(n)');
```

Folding a Discrete-time signal



m-file

```
%Folding a Discrete-time signal
n = 0:8;
x = [0 0 1 2 3 4 5 4 3];
subplot(2,1,1);stem(n,x); title('x(n) signal');
xlabel('n'); ylabel('x(n)');

m=-fliplr(n); y=fliplr(x);
subplot(2,1,2);stem(m,y); title('y(n)=x(-n)
signal');
xlabel('n'); ylabel('y(n)');
```