EEN - 521 Digital Signal and Image Processing

1) Generate the following sequences in MATLAB:

a) An impulse at t = 0

```
clc;
n=-5:5;
n0=input('Enter the Location of impulse = ')
```

```
n0 = 0
```

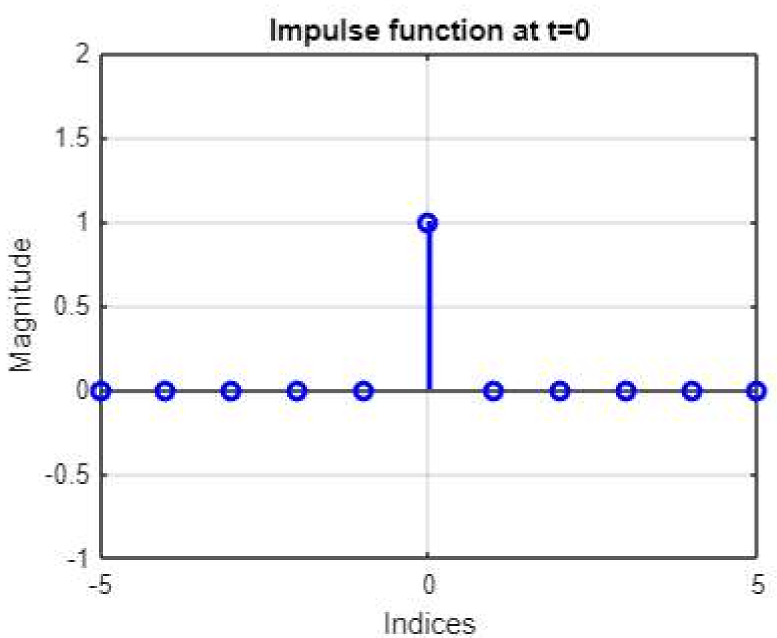
```
del= [n-n0==0];
display(del,'Sequence');
```

```
Sequence = 1×11 logical array
   0   0   0   0   0   1   0   0   0   0   0
```

```
display(n, 'Idices')
```

```
Idices = 1×11
    -5    -4    -3    -2    -1     0     1     2     3     4     5
```

```
figure;
stem(n,del,'linewidth',2,'color','b'); grid
title("Impulse function at t=0")
xlabel("Indices")
ylabel("Magnitude")
xlim([-5 5])
ylim([-1 2])
```



b) Unit step sequence of length N

```
N=input('Enter the Length of Unit Step Sequence = ')
```

```
N = 10
```

```
n1=-N/2:N/2-1
```

```
n1 = 1×10
    -5    -4    -3    -2    -1     0     1     2     3     4
```

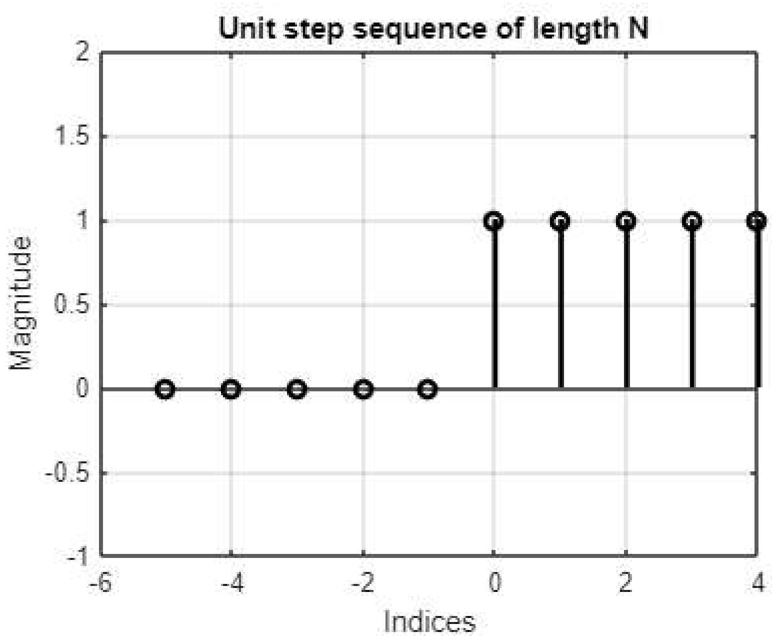
```
u= [(n1-0) >= 0];
display(u,'Sequence');
```

```
Sequence = 1×10 logical array
   0   0   0   0   0   1   1   1   1   1
```

```
display(n1, 'Idices')
```

```
Idices = 1×10
    -5    -4    -3    -2    -1     0     1     2     3     4
```

```
figure;
stem(n1,u,'linewidth',2,'color','k'); grid
title(" Unit step sequence of length N")
xlabel("Indices")
ylabel("Magnitude")
ylim([-1 2])
```



c) Ramp signal of length N and slope S

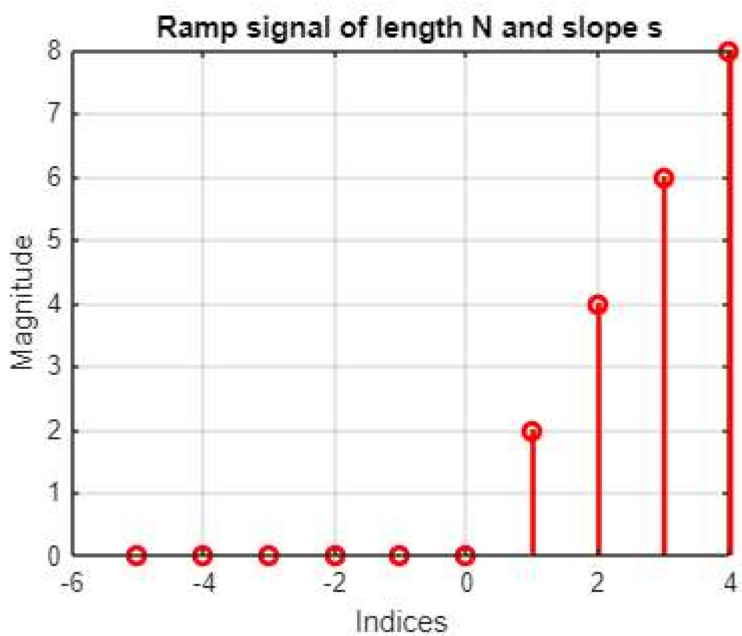
```
s=input('Enter the Slop of Ramp, s = ');
ramp = s*n1.*u;
display(ramp,'Sequence');
```

```
Sequence = 1×10
     0     0     0     0     0     0     2     4     6     8
```

```
display(n1, 'Idices')
```

```
Idices = 1×10
    -5    -4    -3    -2    -1     0     1     2     3     4
```

```
figure
stem(n1,ramp,'linewidth',2,'color','r'); grid
title("  Ramp signal of length N and slope s")
xlabel("Indices")
ylabel("Magnitude")
```



d) $x(n) = 2\delta(n + 2) - \delta(n - 4)$, $-5 \le n \le 5$

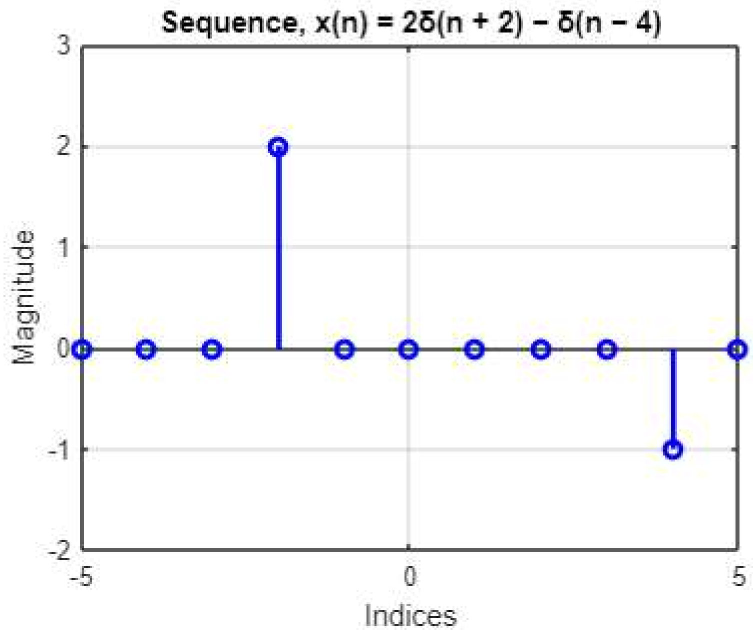
```
n = -5:5;
xn = 2*((n+2)==0)-((n-4)==0); % The delta function
display(xn,'Sequence');
```

```
Sequence = 1×11
     0     0     0     2     0     0     0     0     0    -1     0
```

```
display(n, 'Idices')
```

```
Idices = 1×11
    -5    -4    -3    -2    -1     0     1     2     3     4     5
```

```
figure;
stem(n,xn,'linewidth',2,'color','b'); grid
title("Sequence, x(n) = 2δ(n + 2) − δ(n − 4)")
xlabel("Indices")
ylabel("Magnitude")
ylim([-2 3])
```



e) $x(n) = \cos(0.04\pi n) + 0.2w(n)$, $0 \leq n \leq 50$, where $w(n)$ is a Gaussian random sequence with zero mean and unit variance.

```
mu=input('Enter the value of mean = ');
var=input('Enter the value of Variation = ');
sigma=sqrt(var)
```

```
sigma = 1
```

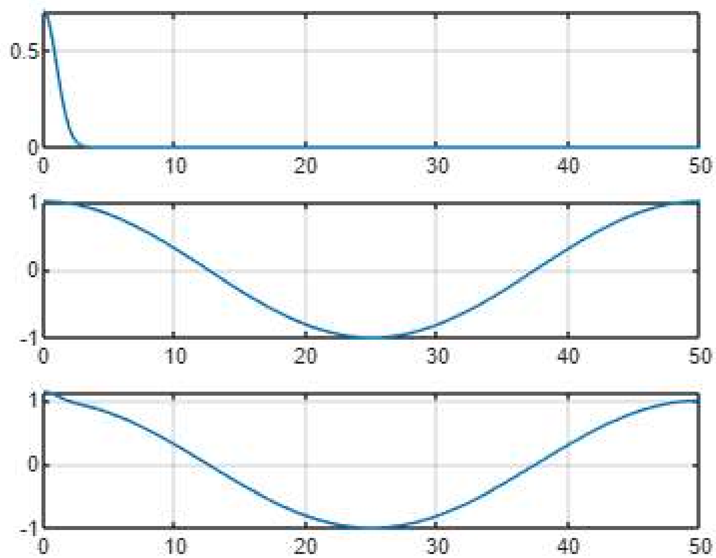
```
xn=1:50;
pdf = @(x) (1/sqrt(2*sigma^2))*exp((-(x-mu).^2)/(2*sigma^2));
figure
subplot(311)
fplot(pdf,  [0 50]); grid
cos_f = @(x) cos(0.04*pi*x)
```

```
cos_f = function_handle with value:
    @(x)cos(0.04*pi*x)
```

```
subplot(312)
fplot(cos_f, [0 50]); grid
xn =@(x) cos_f + pdf
```

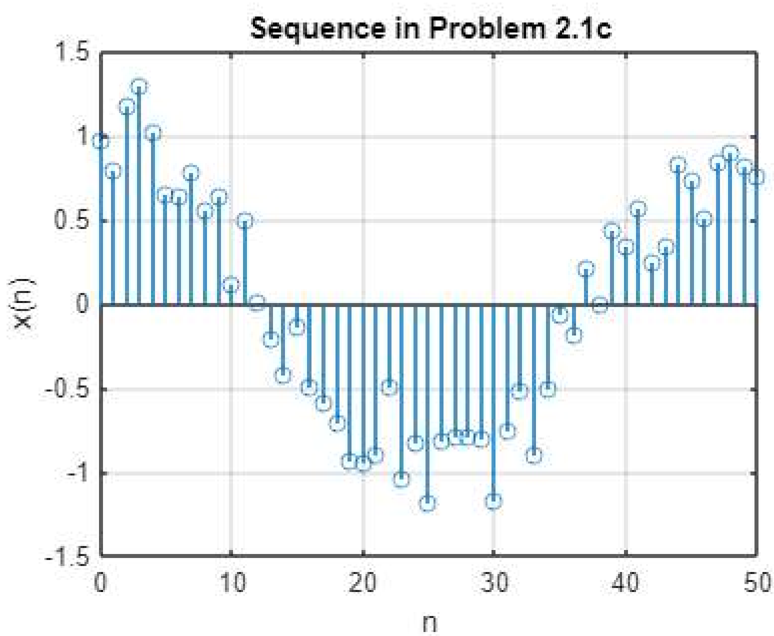
```
xn = function_handle with value:
    @(x)cos_f+pdf
```

```
xn1 =@(x) cos(0.04*pi*x) + 0.2*(1/sqrt(2*sigma^2))*exp((-(x-mu).^2)/(2*sigma^2));
subplot(313)
fplot(xn1, [0 50]); grid
```



2nd Method

```
n = 0:50;
xn = cos(0.04*pi*n)+0.2*randn(size(n));
figure
stem(n,xn); grid
title('Sequence in Problem 2.1c')
xlabel('n');
ylabel('x(n)');
```



2) Let x(n) = {1, 2, 3, 4, 5, 6, 7, 6, 5, 4, 3, 2, 1}. Determine and plot the following sequence

a) x1(n) = 2x(n − 5) − 3x(n + 4)

```
n = -2:10
```

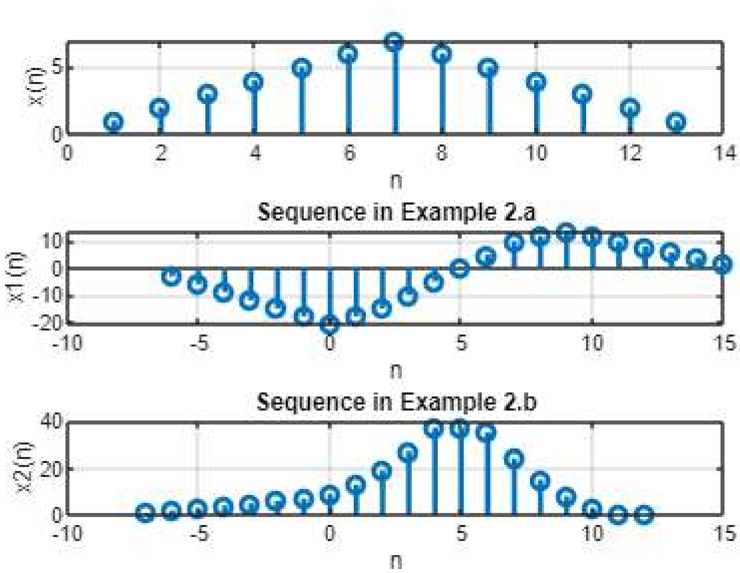
```
n = 1×13
```

```
    -2    -1     0     1     2     3     4     5     6     7     8     9    10
```

```
xn = [1:7,6:-1:1]
```

```
xn = 1×13
     1     2     3     4     5     6     7     6     5     4     3     2     1
```

```
figure
subplot(311)
stem(xn,'linewidth',2); grid
xlabel('n');
ylabel(['x(n)']);

[x11,n11] = sigshift(xn,n,5);
[x12,n12] = sigshift(xn,n,-4);
[x1,n1] = sigadd(2*x11,n11,-3*x12,n12);
subplot(312)
stem(n1,x1,'linewidth',2); grid
title('Sequence in Example 2.a')
xlabel('n');
ylabel('x1(n)');

[x21,n21] = sigfold(xn,n);
[x21,n21] = sigshift(x21,n21,3);
[x22,n22] = sigshift(xn,n,2);
[x22,n22] = sigmult(xn,n,x22,n22);
[x2,n2] = sigadd(x21,n21,x22,n22);
subplot(313)
stem(n2,x2,'linewidth',2); grid
title(['Sequence in Example 2.b'])
xlabel('n');
ylabel('x2(n)');
```



3) For given matrices A and B, perform matrix multiplication and scalar multiplication

```
A=input('Enter the Elements of First Matrix = ');
```

```
B=input('Enter the Elements of Second Matrix = ');

[r1 c1] = size(A);
[r2 c2] = size(B);
if c1 ~= r2
    disp ('* not able to multiply matrices *');
end

for i = 1 : r1;
    for j = 1 : c2;
        s = 0;
        for k = 1 : c1
            A(i,k);
            B(k,j);
            s = s + A(i,k) * B(k,j);
        end
        C(i,j) = s;
    end
end
display(C, 'Output Matrix')
```

```
   111   126   141
   174   198   222
   237   270   303
```

```
% Compare our result with a multiplication by Matlab
display(A*B, 'Using Direct Method')
```

```
   111   126   141
   174   198   222
   237   270   303
```

4) Generate the complex-valued signal x(n) = e^(−0.1+j0.3)n , −10 ≤ n ≤ 10

and plot its magnitude, phase, the real part, and the imaginary part in four separate subplots.

```
n=-10:10
```

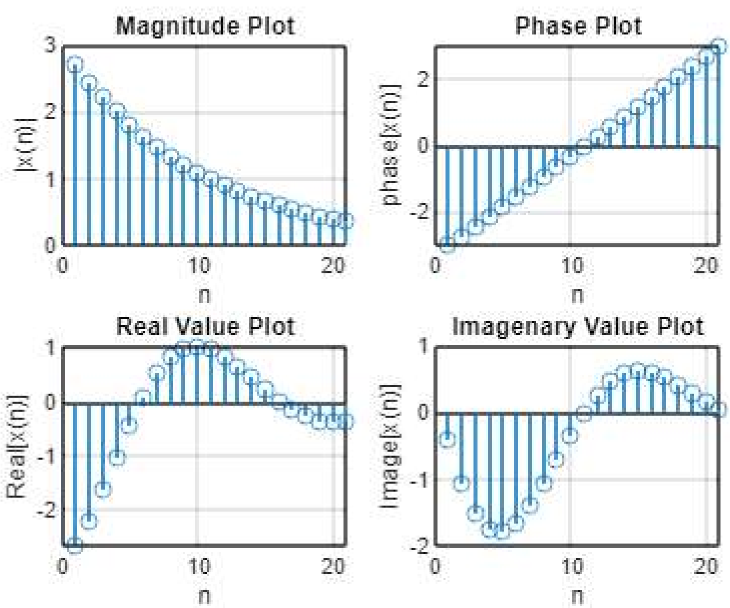
```
n = 1×21
   -10    -9    -8    -7    -6    -5    -4    -3    -2    -1     0     1     2     3     4     5
```

```
x_n=exp((-0.1+0.3i)*n)
```

```
x_n = 1×21 complex
  -2.6911 - 0.3836i  -2.2237 - 1.0512i  -1.6411 - 1.5033i  -1.0166 - 1.7383i  -0.4140 - 1.7745i
```

```
figure
subplot(221)
stem(abs(x_n)); grid
title('Magnitude Plot')
xlabel('n');
ylabel('|x(n)|');
subplot(222)
stem(angle(x_n)); grid
```

```
title('Phase Plot')
xlabel('n');
ylabel('phase[x(n)]');
subplot(223)
stem(real(x_n)); grid
title('Real Value Plot')
xlabel('n');
ylabel('Real[x(n)]');
subplot(224)
stem(imag(x_n)); grid
xlabel('n');
ylabel('Image[x(n)]');
title('Imagenary Value Plot')
```



5) Given the following two sequences x(n) = {3, 11, 7, 0, −1, 4, 2} , −3 ≤ n ≤ 3; h(n) = {2, 3, 0, −5, 2, 1} , −1 ≤ n ≤ 4, determine the convolution y(n) = x(n) ∗ h(n) in MATLAB.

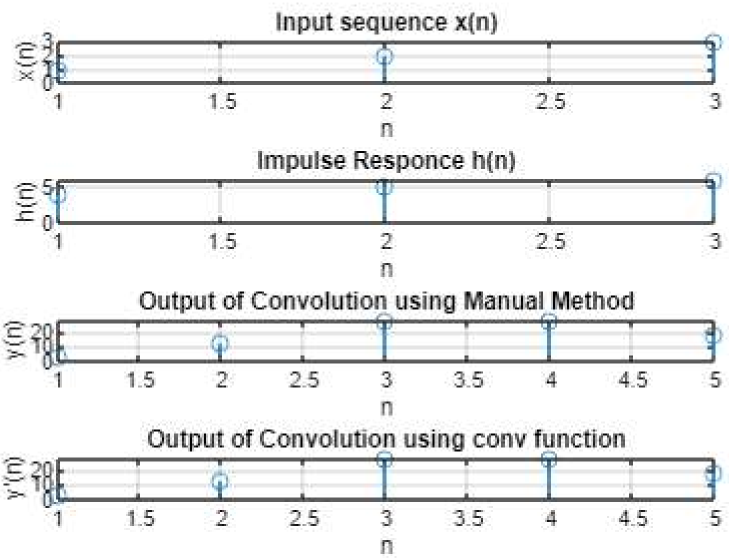
```
xn=input('Enter the sequence x(n)= ');
hn=input('Enter the sequence h(n)= ');
m=length(xn);
n=length(hn);
X=[xn,zeros(1,n)];
H=[hn,zeros(1,m)];
for i=1:n+m-1
    yn(i)=0;
    for j=1:m;
        if(i-j+1>0)
            yn(i)=yn(i)+X(j)*H(i-j+1);
        else
        end
    end
end
display(yn, 'Output of Convolution');
```

```
4    13    28    27    18
```

```
yn1=conv(xn,hn);
display(yn1, 'Output of Convolution using conv function');
```

```
     4    13    28    27    18
```

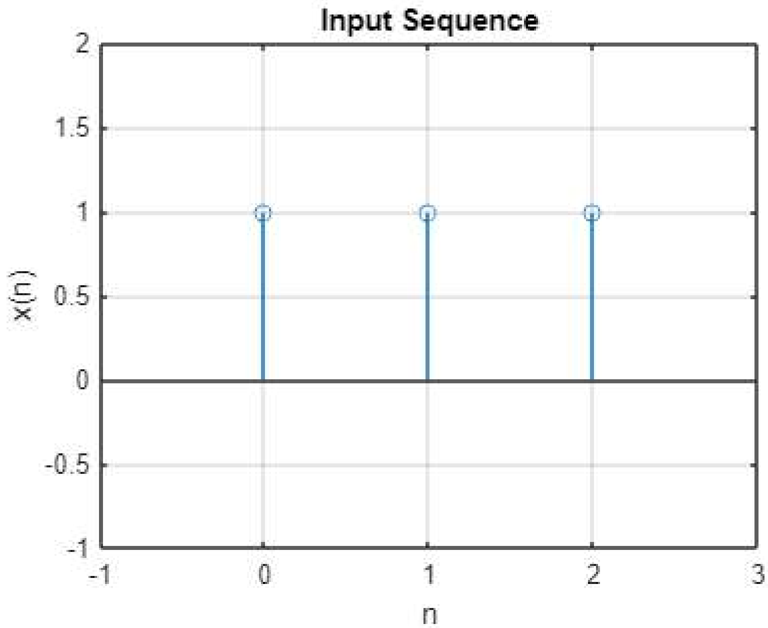
```

figure
subplot(411)
stem(xn); grid
title('Input sequence x(n)')
xlabel('n')
ylabel('x(n)')

subplot(412)
stem(hn); grid
title('Impulse Responce h(n)')
xlabel('n')
ylabel('h(n)')

subplot(413)
stem(yn); grid
title('Output of Convolution using Manual Method')
xlabel('n')
ylabel('y(n)')

subplot(414)
stem(yn1); grid
title('Output of Convolution using conv function');
xlabel('n')
ylabel("y'(n)")
```



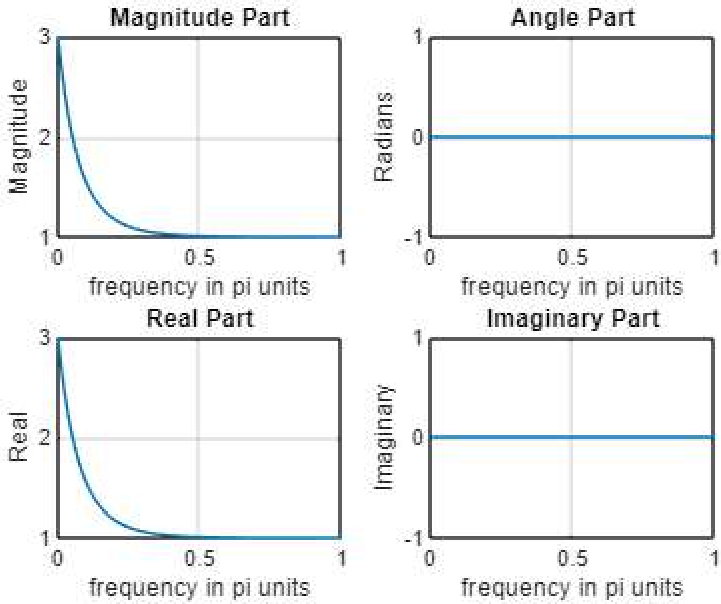
6) Determine the discrete-time Fourier transform of the following finite-duration sequence at 501 equispaced frequencies between [0,π]:

a) x1(n) = {1, 1, 1}

```
n = 0:2;
x = [1 1 1];
figure; stem(n,x); grid
xlabel('n'); ylabel('x(n)');
axis([-1 3 -1 2]); title('Input Sequence');
```

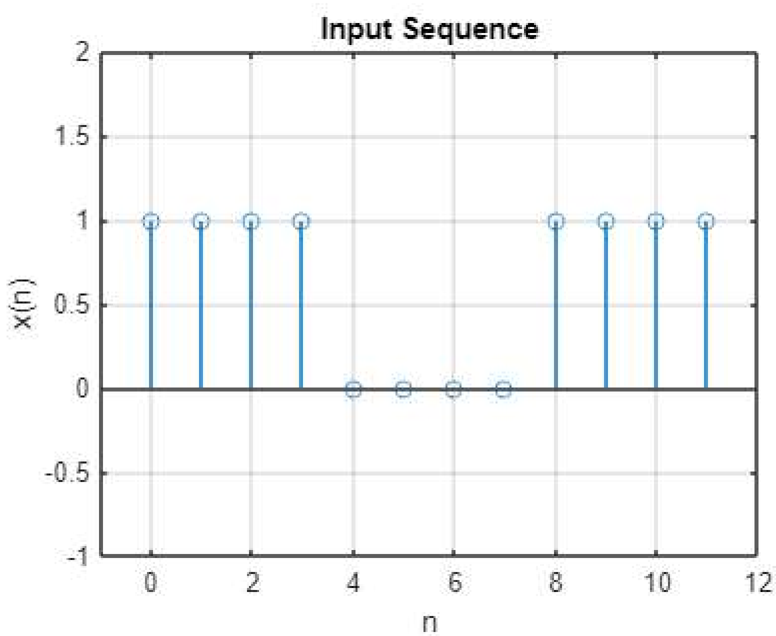



```
k = 0:500;
w = (pi/500)*k;

% DTFT
X = x * (exp(-j*pi/500)) .^ (n'*k); % DTFT Calculation
magX = abs(X); angX = angle(X);
realX = real(X); imagX = imag(X);

figure; subplot(2,2,1); plot(w/pi,magX); grid
xlabel('frequency in pi units'); ylabel('Magnitude');
title('Magnitude Part');

subplot(2,2,2); plot(w/pi,angX); grid
xlabel('frequency in pi units'); subplot(2,2,2);
title('Angle Part'); ylabel('Radians')

subplot(2,2,3); plot(w/pi,realX); grid
xlabel('frequency in pi units');  ylabel('Real');
title('Real Part');

subplot(2,2,4); plot(w/pi,imagX); grid
xlabel('frequency in pi units'); ylabel('Imaginary');
title('Imaginary Part');
```



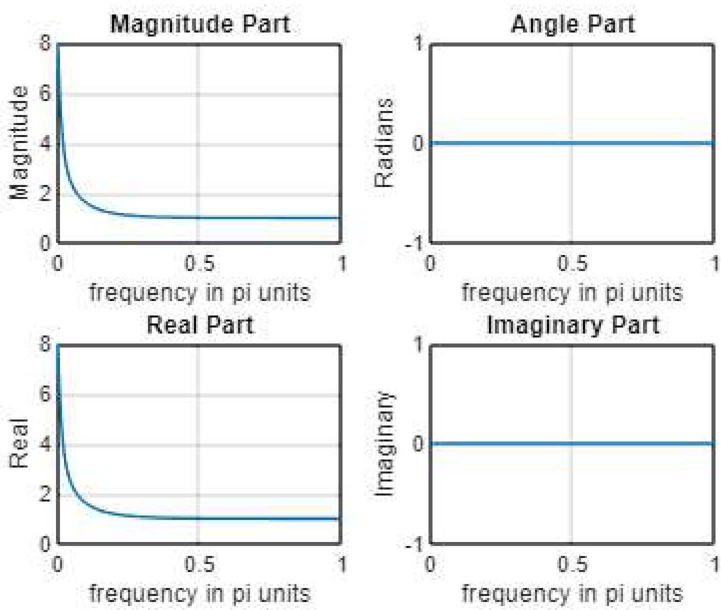
b) x(n) = {1, 1, 1, 1, 0, 0, 0, 0, 1, 1, 1, 1}

```
n = 0:11;
x = [1, 1, 1, 1, 0, 0, 0, 0, 1, 1, 1, 1];

figure; stem(n,x); grid
xlabel('n'); ylabel('x(n)');
axis([-1 12 -1 2]); title('Input Sequence');
```



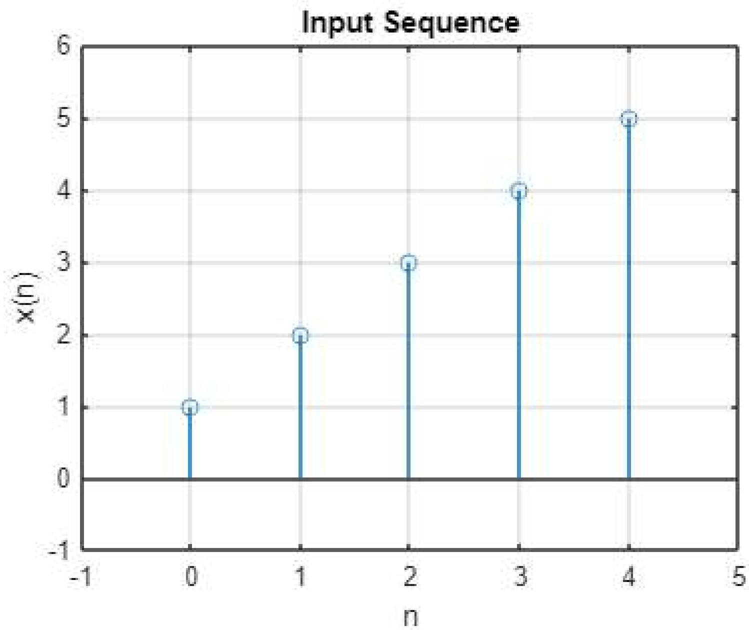

```
k = 0:500;
w = (pi/500)*k;

% DTFT
X = x * (exp(-j*pi/500)) .^ (n'*k); % DTFT Calculation
magX = abs(X); angX = angle(X);
realX = real(X); imagX = imag(X);
```

```
figure; subplot(2,2,1); plot(w/pi,magX); grid
xlabel('frequency in pi units'); ylabel('Magnitude');
title('Magnitude Part');

subplot(2,2,2); plot(w/pi,angX); grid
xlabel('frequency in pi units'); subplot(2,2,2);
title('Angle Part'); ylabel('Radians')

subplot(2,2,3); plot(w/pi,realX); grid
xlabel('frequency in pi units');  ylabel('Real');
title('Real Part');

subplot(2,2,4); plot(w/pi,imagX); grid
xlabel('frequency in pi units'); ylabel('Imaginary');
title('Imaginary Part');
```

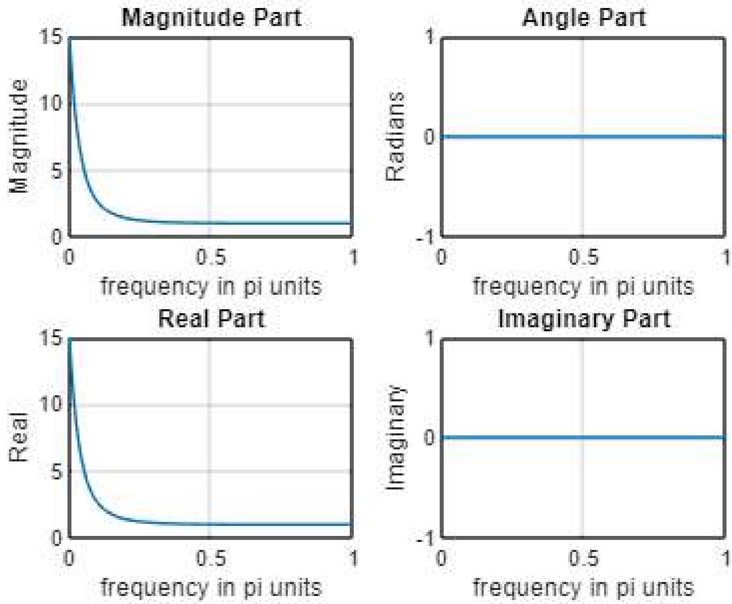


c) x2(n) = {1, 2, 3, 4, 5}

```
n = 0:4;
x = [1:5];

figure; stem(n,x); grid
xlabel('n'); ylabel('x(n)');
axis([-1 5 -1 6]); title('Input Sequence');
```

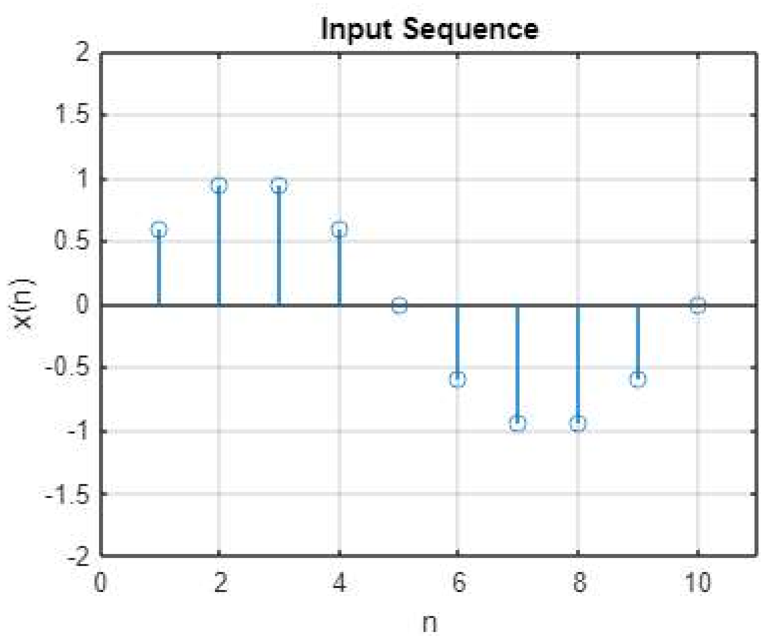



```
k = 0:500; % DTFT Points
w = (pi/500)*k;

% DTFT
X = x * (exp(-j*pi/500)) .^ (n'*k); % DTFT Calculation
magX = abs(X); angX = angle(X);
realX = real(X); imagX = imag(X);

figure; subplot(2,2,1); plot(w/pi,magX); grid
xlabel('frequency in pi units'); ylabel('Magnitude');
title('Magnitude Part');

subplot(2,2,2); plot(w/pi,angX); grid
xlabel('frequency in pi units'); subplot(2,2,2);
title('Angle Part'); ylabel('Radians')

subplot(2,2,3); plot(w/pi,realX); grid
xlabel('frequency in pi units');  ylabel('Real');
title('Real Part');

subplot(2,2,4); plot(w/pi,imagX); grid
xlabel('frequency in pi units'); ylabel('Imaginary');
title('Imaginary Part');
```



d) x3(n) = {sin(πn/5)} , n = {1, 2, ...10}

```
n = 1:10;
x = sin(pi*n/5);

figure; stem(n,x); grid
xlabel('n'); ylabel('x(n)');
axis([0 11 -2 2]); title('Input Sequence');
```




```
k = 0:500; % DTFT Points
w = (pi/500)*k;

% DTFT
X = x * (exp(-j*pi/500)) .^ (n'*k); % DTFT Calculation
magX = abs(X); angX = angle(X);
realX = real(X); imagX = imag(X);
```

```
figure; subplot(2,2,1); plot(w/pi,magX); grid
xlabel('frequency in pi units'); ylabel('Magnitude');
title('Magnitude Part');

subplot(2,2,2); plot(w/pi,angX); grid
xlabel('frequency in pi units'); subplot(2,2,2);
title('Angle Part'); ylabel('Radians')

subplot(2,2,3); plot(w/pi,realX); grid
xlabel('frequency in pi units');  ylabel('Real');
title('Real Part');

subplot(2,2,4); plot(w/pi,imagX); grid
xlabel('frequency in pi units'); ylabel('Imaginary');
title('Imaginary Part');
```