4. DFT COMPUTATION

1.Let $x(n) = (0.7)^n u(n)$. Sample its z-transform on the unit circle with N = 5 and study its effect in the time domain.

$$X(z) = \frac{1}{1-0.7z^{-1}} = \frac{z}{z-0.7}, \quad |z| > 0.7$$

We can now use MATLAB to implement the sampling operation

$$\tilde{X}(k) = X(z)|_{z=e^{j2\pi k/N}}, \quad k = 0, \pm 1, \pm 2, \ldots$$

and the inverse DFS computation to determine the corresponding time-domain

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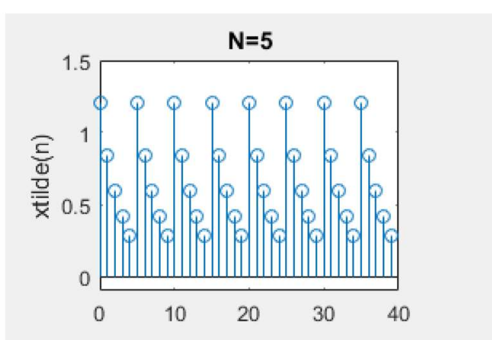
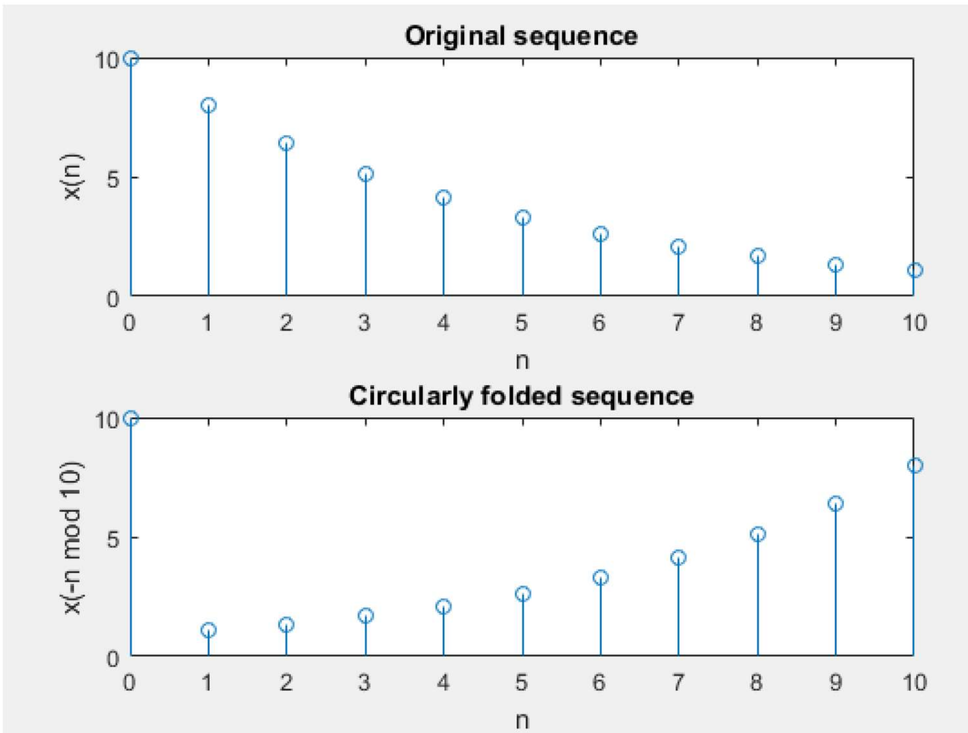
```
function [xn] = idfs(Xk,N)
% Computes Inverse Discrete Fourier Series
n = [0:1:N-1];              % row vector for n
k = [0:1:N-1];              % row vecor for k
WN = exp(-j*2*pi/N);        % Wn factor
nk = n'*k;                  % creates a N by N matrix of nk values
WNnk = WN .^ (-nk);         % IDFS matrix
xn = (Xk * WNnk)/N;         % row vector for IDFS values
```

```
N = 5;
k = 0:1:N-1;              % sample index
wk = 2*pi*k/N;
zk = exp(j*wk);           % samples of z
Xk = (zk)./(zk-0.7);      % DFS as samples of X(z)
xn = real(idfs(Xk,N));    % IDFS
xtilde = xn'* ones(1,8); xtilde = (xtilde(:))'; % Periodic sequence
subplot(2,2,1); stem(0:39,xtilde);axis([0,40,-0.1,1.5])
xlabel('n'); ylabel('xtilde(n)'); title('N=5')
```



2. Let $x(n) = 10(0.8)^n$, $0 \le n \le 10$. Determine and plot $x((-n))_{11}$.

```
n = 0:10;
x = 10*(0.8) .^ n;
y = x(mod(-n,11)+1);
subplot(2,1,1); stem(n,x); title('Original sequence')
xlabel('n'); ylabel('x(n)');
subplot(2,1,2); stem(n,y); title('Circularly folded sequence')
xlabel('n'); ylabel('x(-n mod 10)');
```



3. Write a MATLAB program to perform circular convolution of the discrete time sequences x1(n)={0,1,0,1} and x1(n)={1,2,1,2} using DFT.

```
% Program to perform Circular Convolution via DFT
clear all
clc
N = 4;            % declare the value of N
x1 = [0,1,0,1]; % declare the input sequences
x2 = [1,2,1,2];
disp('The 4-point DFT of x1(n) is');
X1 = fft(x1,N) % compute 4-point DFT of x1(n)
disp('The 4-point DFT of x2(n) is,');
X2 = fft(x2,N) % compute 4-point DFT of x2(n)
disp('The product of DFTs is,');
```

```
X1X2 = X1.*X2     % product of DFTs
disp('Circular convolution of x1(n) and x2(n) is,');
X3 = ifft(X1X2)     % perform IDFT to get result of circular convolution
```

```
The 4-point DFT of x1(n) is
X1 =
    2     0    -2     0
The 4-point DFT of x2(n) is,
X2 =
    6     0    -2     0
The product of DFTs is,
X1X2 =
   12     0     4     0
Circular convolution of x1(n) and x2(n) is,
X3 =
    4     2     4     2
```

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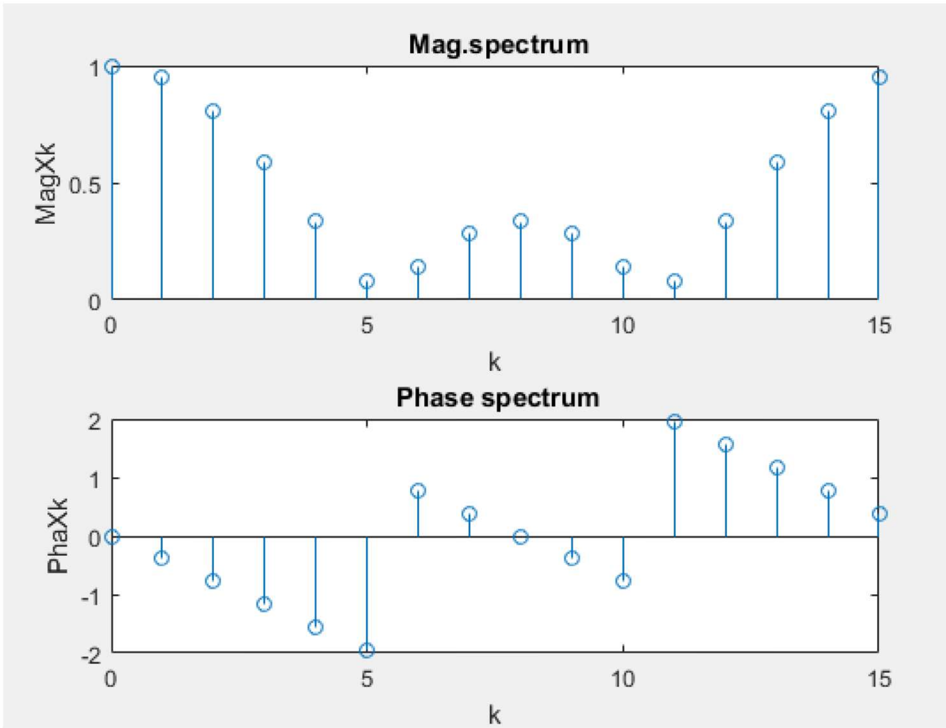
4. Write a MATLAB program to perform 16-point DFT of the discrete time sequence x(n)={1/3,1/3,1/3} and sketch the magnitude and phase spectrum.

```
% program to find DFT and frequency spectrum
clear all
clc
N = 16;                   % specify the length of the DFT
j = sqrt(-1);
xn = zeros (1,N);     % initialize input sequence as zeros
xn(1) = 1/3;          %let given sequence be first three samples
xn(2) = 1/3;
xn(3) = 1/3;
Xk = zeros (1,N);     %initialize output sequence as zeros
for k = 0:1:N-1       % compute DFT
for n = 0:1:N-1
Xk(k+1) = Xk(k+1)+xn(n+1)*exp(-j*2*pi*k*n/N);
end
end
disp ('The DFT sequence is,'); Xk
disp ('The Magnitude sequence is,');MagXk = abs(Xk)
disp ('The Phase sequence is,');PhaXk = angle(Xk)
Wk = 0 : 1 : N - 1 ; %specify a discrete frequency vector
subplot( 2 , 1 , 1 )
stem ( Wk , MagXk ) ;
title ( ' Mag.spectrum');
xlabel ( ' k ' ) ; ylabel ( ' MagXk ' );
```

```
subplot( 2 , 1 , 2 )
stem ( Wk , PhaXk ) ;
title ( ' Phase spectrum');
xlabel ( ' k ' ) ; ylabel ( ' PhaXk ' )
```



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5. Write a MATLAB program to verify the properties of DFT such as linearity and time-shift