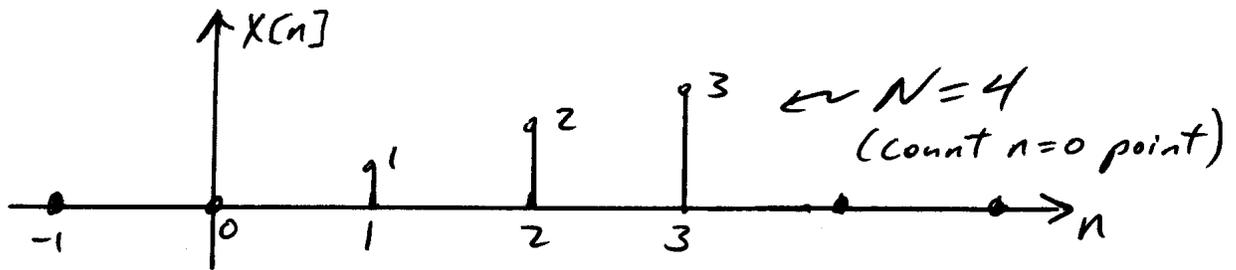


Example- Compute the DFT of the signal $x[n]$ shown.



$$X_k = \sum_{n=0}^{N-1} x[n] e^{-j \frac{2\pi kn}{N}} = \sum_{n=0}^3 x[n] e^{-j \frac{2\pi kn}{4}}$$

$$k=0 \quad X_0 = 0e^0 + 1e^0 + 2e^0 + 3e^0 = \underline{\underline{6 = 6 \angle 0^\circ}}$$

$$k=1 \quad X_1 = 0e^0 + 1e^{-j \frac{2\pi(1)(1)}{4}} + 2e^{-j \frac{2\pi(1)(2)}{4}} + 3e^{-j \frac{2\pi(1)(3)}{4}}$$

$$\underline{\underline{X_1 = -2 + j2 = 2.828 \angle 135^\circ}}$$

$$k=2 \quad X_2 = 0e^0 + 1e^{-j \frac{2\pi(2)(1)}{4}} + 2e^{-j \frac{2\pi(2)(2)}{4}} + 3e^{-j \frac{2\pi(2)(3)}{4}}$$

$$\underline{\underline{X_2 = -2 = 2 \angle 180^\circ}}$$

$$k=3 \quad X_3 = 0e^0 + 1e^{-j \frac{2\pi(3)(1)}{4}} + 2e^{-j \frac{2\pi(3)(2)}{4}} + 3e^{-j \frac{2\pi(3)(3)}{4}}$$

$$\underline{\underline{X_3 = -2 - j2 = 2.828 \angle -135^\circ}}$$

```

% Chapter 4 DFT Example 1 (chap_04_dft_example_1.m)
% Compute DFT of  $x[n] = r[n](u[n]-u[n-4])$ 
clear;clc;close all;
x=[0, 1, 2, 3];           % Define the input vector
n = 0:1:length(x)-1;    % time indices
Xk = dft(x);            % Call DFT function
Xkmag = abs(Xk); Xkang = angle(Xk)*180/pi; % line spectra of Xk
k = 0:length(Xk)-1; % indices for DFT
% Plot input signal
stem(k,x,'r.','linewidth',1.5,'markersize',18),axis([-0.4 3.4 0 3.5]),
ylabel('\itx[\itn]','fontsize',14,'fontname','times'),
xlabel('\itn','fontsize',14,'fontname','times'),
title('Discrete-time input signal  $\itx[\itn] = r[n](u[n]-u[n-4])$ ','...
      'fontsize',16,'fontname','times'),
% Plot amplitude and phase spectra
figure,
subplot(211),stem(k,Xkmag,'r.','linewidth',1.5,'markersize',18),
axis([-0.4 3.4 0 8]),
ylabel('|\itX_{\itk}|','fontsize',14,'fontname','times'),
title('DFT spectra for input
signal','fontsize',16,'fontname','times'),
for m=1:length(Xk),
    text(k(m),Xkmag(m)+0.2,[num2str(Xkmag(m),4)],...
        'horizontalalignment','center','verticalalignment','bottom')
end
subplot(212),stem(k,Xkang,'r.','linewidth',1.5,'markersize',18),
axis([-0.4 3.4 -200 200]),
ylabel('\angle \itX_{\itk} (deg)','fontsize',14,'fontname','times'),
xlabel('\itk','fontsize',14,'fontname','times'),
for m=1:length(Xk),
    text(k(m)+0.05,Xkang(m)+0.05,[num2str(Xkang(m),4)],'\circ',...
        'horizontalalignment','left','verticalalignment','bottom')
end
set(findobj('type','line'),'linewidth',1.5,'markersize',18)
set(findobj('type','axes'),'linewidth',2,'fontsize',12,'fontname','times')
set(findobj('type','text'),'fontsize',12,'fontname','times')
*****
% Discrete Fourier Transform
function Xk = dft(x)
[N,M] = size(x);
if M ~ =1, % makes sure that x is a column vector
    x = x';
    N = M;
end
Xk=zeros(N,1);
n = 0:N-1;
for k=0:N-1
    Xk(k+1) = exp(-j*2*pi*k*n/N)*x;
end

```

