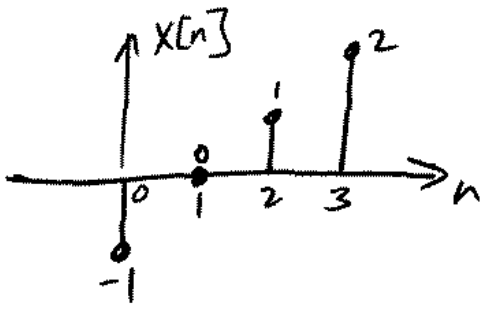
4.9 Compute the rectangular form of the four-point DFT of the following signals, all of which are zero for $n < 0$ and $n \geq 4$:

(e) $x[0] = -1, x[1] = 0, x[2] = 1, x[3] = 2$

(g) Compute the DFT for each of the foregoing signals using the MATLAB M-file `dft`. Compare these results with the results obtained analytically in parts (a) to (f).



$N = 4$

$$(4.33)\quad X_k = \sum_{n=0}^{N-1} x[n] e^{-j 2\pi kn/N} \qquad 0 \leq k \leq N-1$$

$k=0$ $\quad X_0 = -1e^{0} + 0e^{0} + 1e^{0} + 2e^{0} = \underline{2}$

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

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

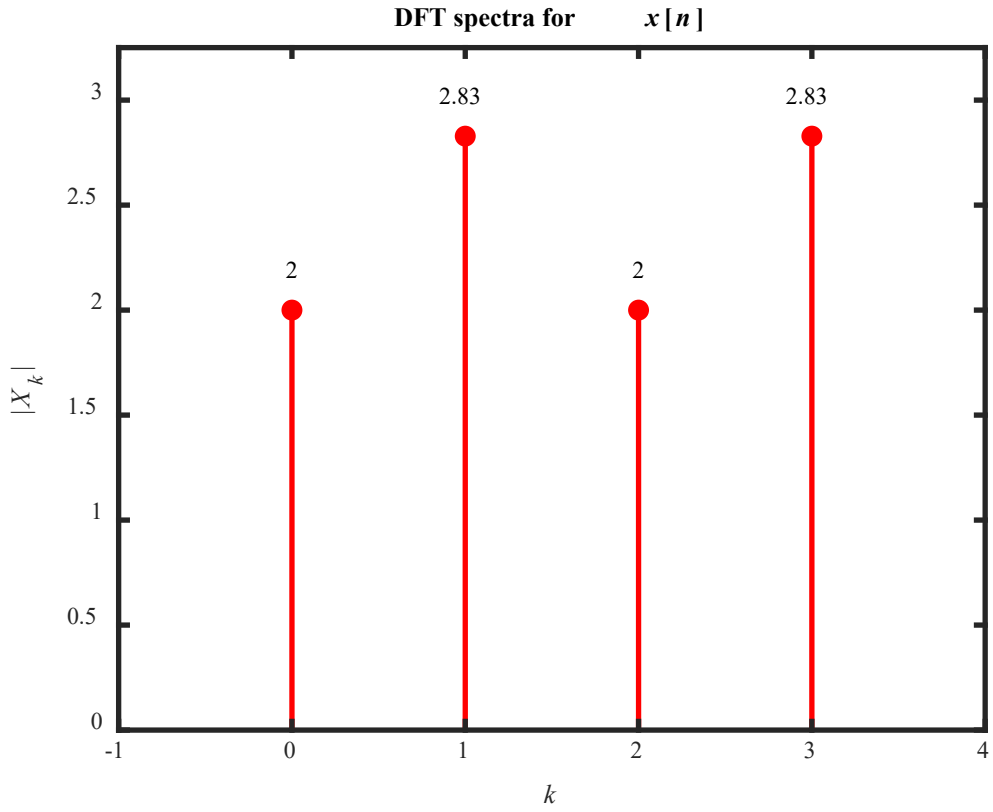
$k=2$ $\quad X_2 = -1e^{0} + 0 + 1e^{-j\frac{2\pi(2)2}{4}} + 2e^{-j\frac{2\pi(2)3}{4}}$

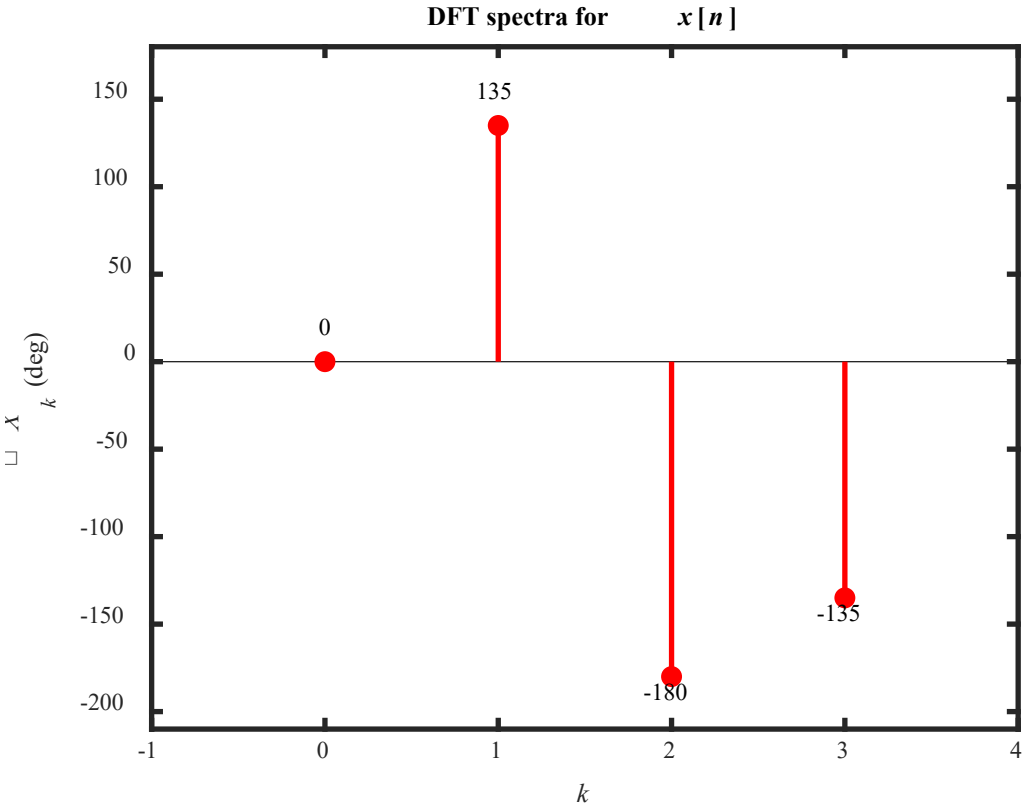
$$\underline{X_2 = -2 = 2 \angle \pm 180^\circ}$$

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

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

```
% Chapter 4 problem 4.9eg (chap4_4_09eg.m)
% Calculate & plot DFT of x[n] where
% x[0] = -1, x[1] = 0, x[2] = 1, x[3] = 2,  & 0 elsewhere.
%
clear; clc; close all;
N = 4; k = 0:1:N-1;  % Define DFT index vector
x = [-1 0 1 2]; Xk = dft(x); % Input and DFT
Xkmag = abs(Xk); Xkang = angle(Xk)*180/pi; % line spectra
% Plot amplitude and phase spectrum
stem(k,Xkmag,'r.','linewidth',2,'markersize',20), axis([-1 N 0 3.25]),
xlabel('\itk','fontsize',16,'fontname','times'),
ylabel('|{\itX_k}|','fontsize',16,'fontname','times'),
title('DFT spectra for {\itx}[{\itn}]','fontsize',16,'fontname','times'),
for n=1:1:length(k),
    text(k(n),Xkmag(n)+0.05,[' ' num2str(Xkmag(n),3)],...
        'HorizontalAlignment','center','VerticalAlignment','bottom')
end
figure, stem(k,Xkang,'r.','linewidth',2,'markersize',20),
axis([-1 N -210 180]),
xlabel('\itk','fontsize',16,'fontname','times'),
ylabel('\angle {\itX_k} (deg)','fontsize',16,'fontname','times'),
title('DFT spectra for {\itx}[{\itn}]','fontsize',16,'fontname','times'),
for n=1:1:length(k),
    if(Xkang(n)>= 0),
        text(k(n),Xkang(n)+3,[' ' num2str(Xkang(n),3)],...
            'HorizontalAlignment','center','VerticalAlignment','bottom')
    else
        text(k(n),Xkang(n)-3,[' ' num2str(Xkang(n),3)],...
            'HorizontalAlignment','center','VerticalAlignment','top')
    end
end
set(findobj('type','line'),'linewidth',1.5,'markersize',18)
set(findobj('type','axes'),'linewidth',2,'fontname','times','fontsize',12)
set(findobj('type','text'),'fontname','times','fontsize',12)
set(findobj('text','line'),'fontname','times')
```



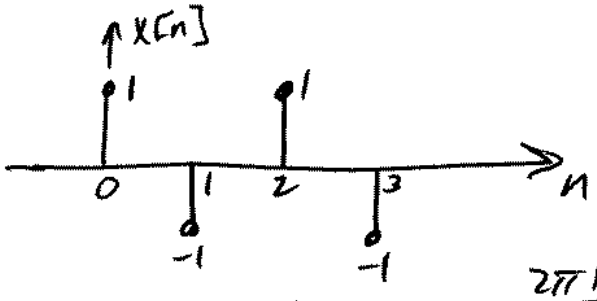


Same as answer calculated by hand!

4.9 Compute the rectangular form of the four-point DFT of the following signals, all of which are zero for $n < 0$ and $n \geq 4$:

(f) $x[0] = 1, x[1] = -1, x[2] = 1, x[3] = -1$

(g) Compute the DFT for each of the foregoing signals using the MATLAB M-file `dft`. Compare these results with the results obtained analytically in parts (a) to (f).



$N = 4$

$$(4.33)\quad X_k = \sum_{n=0}^{N-1} x[n]\, e^{-j\frac{2\pi kn}{N}} \qquad 0 \leq k \leq N-1$$

$k=0$ $\quad X_0 = 1e^{0} - 1e^{0} + 1e^{0} - 1e^{0} = \underline{0}$

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

$\underline{X_1 = 0}$

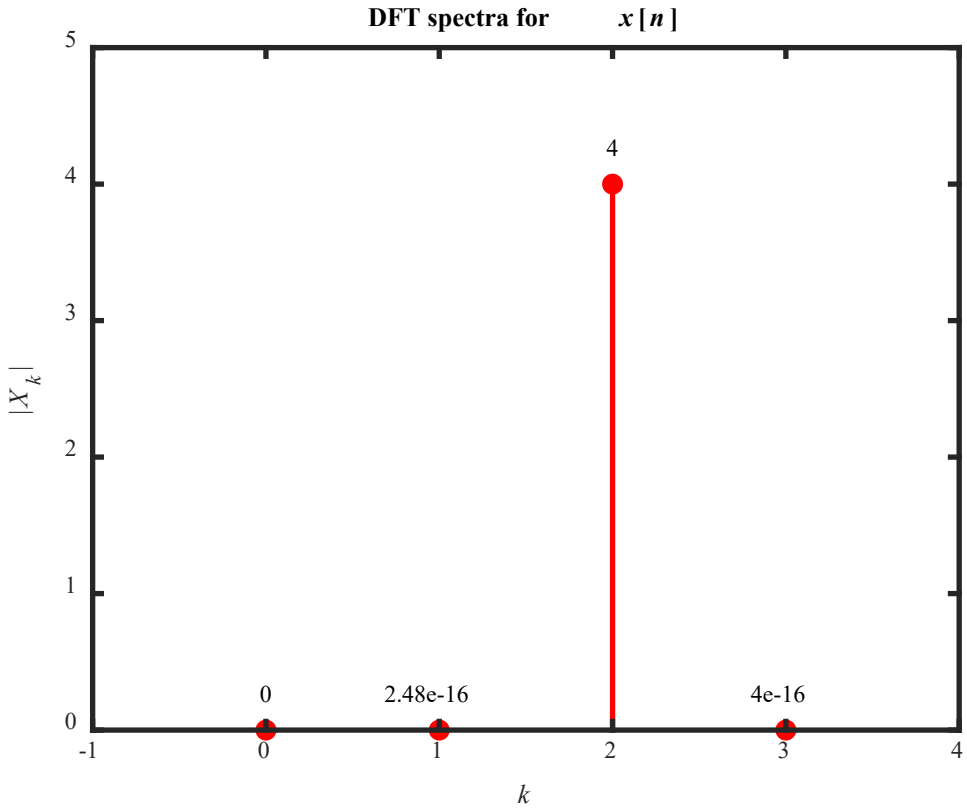
$k=2$ $\quad X_2 = 1e^{0} - 1e^{-j\frac{2\pi(2)1}{4}} + 1e^{-j\frac{2\pi(2)2}{4}} - 1e^{-j\frac{2\pi(2)3}{4}}$

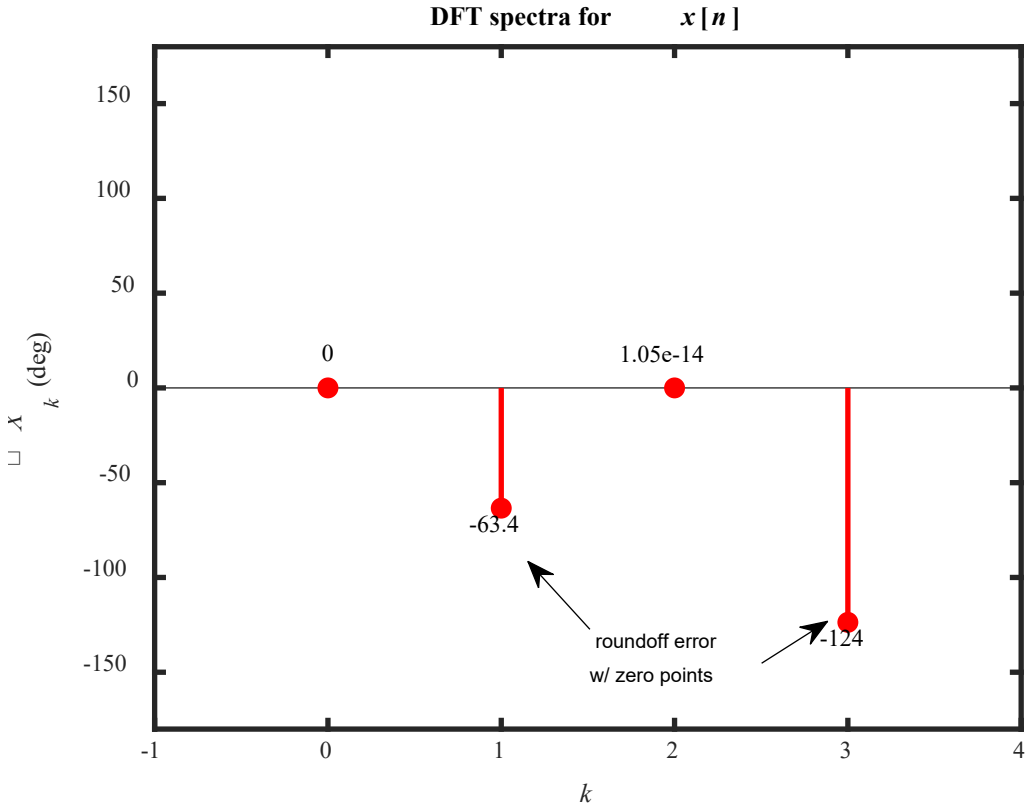
$\underline{X_2 = 4}$

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

$\underline{X_3 = 0}$

```
% Chapter 4 problem 4.9fg (chap4_4_09fg.m)
% Calculate & plot DFT of x[n] where
% x[0] = 1, x[1] = -1, x[2] = 1, x[3] = -1,  & 0 elsewhere.
%
clear;clc;close all;
N = 4; k = 0:1:N-1;  % Define DFT index vector
x = [1 -1 1 -1]; Xk = dft(x); % input & DFT
Xkmag = abs(Xk); Xkang = angle(Xk)*180/pi; % line spectra
% Plot amplitude and phase spectrum
stem(k,Xkmag,'r.','linewidth',2,'markersize',20), axis([-1 N 0 5]),
xlabel('\itk','fontsize',16,'fontname','times'),
ylabel('|{\itX_k}|','fontsize',16,'fontname','times'),
title('DFT spectra for {\itx}[{\itn}]','fontsize',16,'fontname','times'),
for n=1:1:length(k),
    text(k(n),Xkmag(n)+0.05,[' ' num2str(Xkmag(n),3)],...
        'HorizontalAlignment','center','VerticalAlignment','bottom')
end
figure, stem(k,Xkang,'r.','linewidth',2,'markersize',20),
axis([-1 N -180 180]),
xlabel('\itk','fontsize',16,'fontname','times'),
ylabel('\angle {\itX_k} (deg)','fontsize',16,'fontname','times'),
title('DFT spectra for {\itx}[{\itn}]','fontsize',16,'fontname','times'),
for n=1:1:length(k),
    if(Xkang(n)>= 0),
        text(k(n),Xkang(n)+3,[' ' num2str(Xkang(n),3)],...
            'HorizontalAlignment','center','VerticalAlignment','bottom')
    else
        text(k(n),Xkang(n)-3,[' ' num2str(Xkang(n),3)],...
            'HorizontalAlignment','center','VerticalAlignment','top')
    end
end
set(findobj('type','line'),'linewidth',1.5,'markersize',18)
set(findobj('type','axes'),'linewidth',2,'fontname','times','fontsize',12)
set(findobj('type','text'),'fontname','times','fontsize',12)
set(findobj('text','line'),'fontname','times')
```





Within round-off, same as answer calculated by hand!