IDFT Computation from Radix-2 DIT-FFT Algorithm.

FFT Algorithm can be used to compute the inverse-DFT of an N-point sequence $X(k)$.

IDFT of an N-point sequence $X(k)$ is defined as.

$$x(n) = \frac{1}{N} \sum_{k=0}^{N-1} X(k) W_N^{-nk} \qquad \text{——— (1)}$$

To make the above equation a comparable with DFT equation do some rearrangements in eqn (1)

Take complex conjugate and multiply by N in eqn (1).

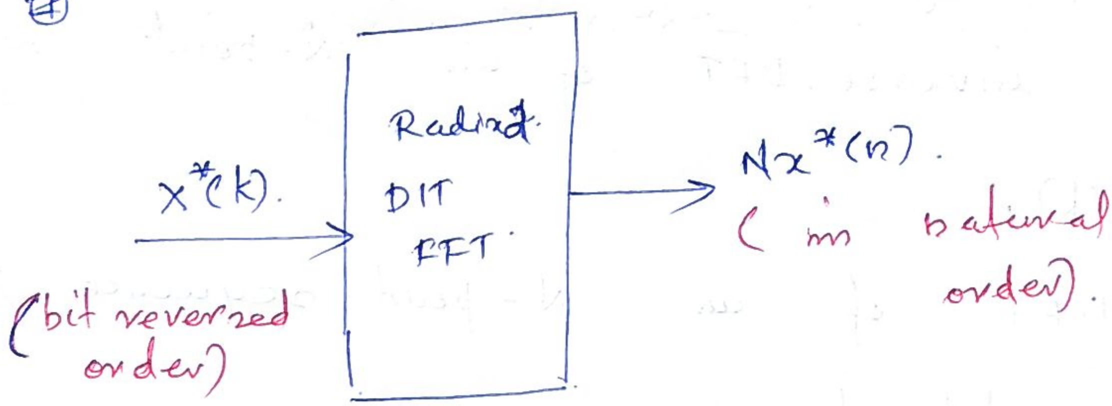
$$N x^*(n) = \sum_{k=0}^{N-1} X^*(k) W_N^{nk} \qquad \text{——— (2)}$$

RHS of eqn (2) is DFT of sequence $X^*(k)$ and can be computed using FFT algorithm with output $N x^*(n)$.

To get $x(n)$ divide by N and take

complex conjugate.

<u>Note:</u> to calculate IDFT using Radix 2 DIT FFT algorithm.



① Apply i/p as $X^*(k)$ [complex conjugate of $X(k)$] in bit reversed order.

② Output in $N\,x^*(n)$ in natural order to get $x(n)$; divide by N, take complex conjugate.

Q) Find the IDFT of the sequence

$$X(k) = \{10, -2+2j, -2, -2-2j\}$$

using Radix-2 DIT-FFT Algorithm.

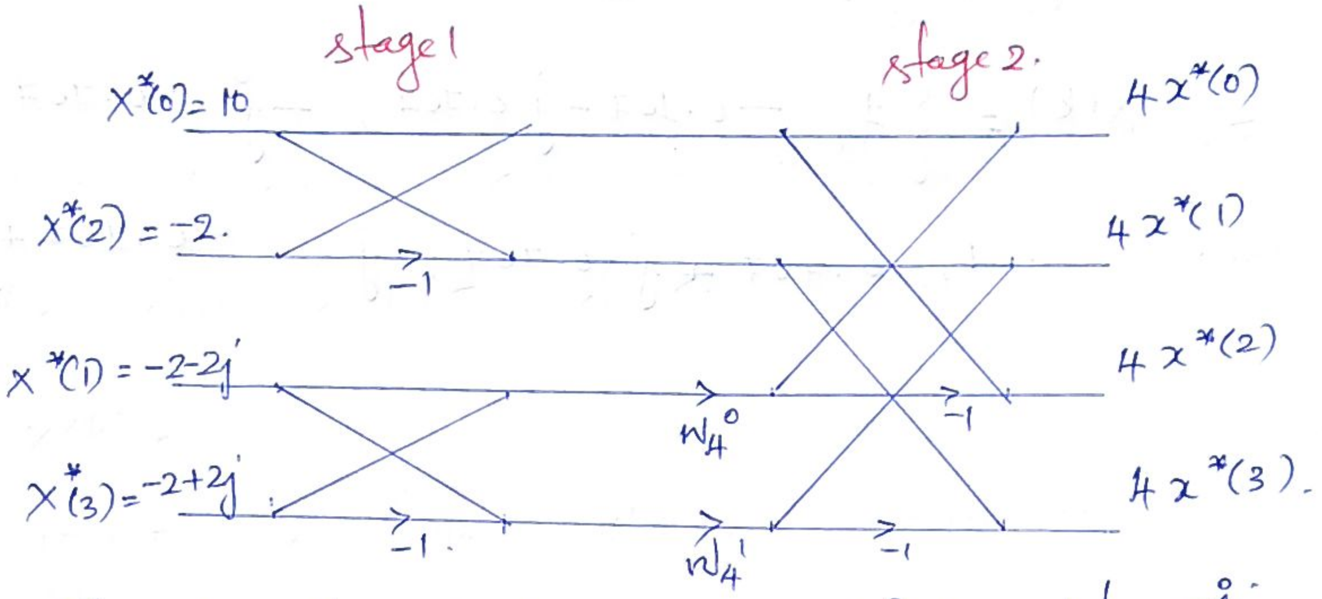
<u>Answer</u>

$X(0) = 10 \Rightarrow X^*(0) = 10$

$X(1) = -2+2j \Rightarrow X^*(1) = -2-2j$

$X(2) = -2 \Rightarrow X^*(2) = -2$

$x(3) = -2-2j$, $x^*(3) = -2+2j$.



The twiddle factors are $W_4^0 = 1$, $W_4^1 = -j$.

Input	Output of stage 1.	Output (output of stage 2).
10	8	4
-2	12.	8
$-2-2j$	-4	12.
$-2+2j$	$-4j$	16.

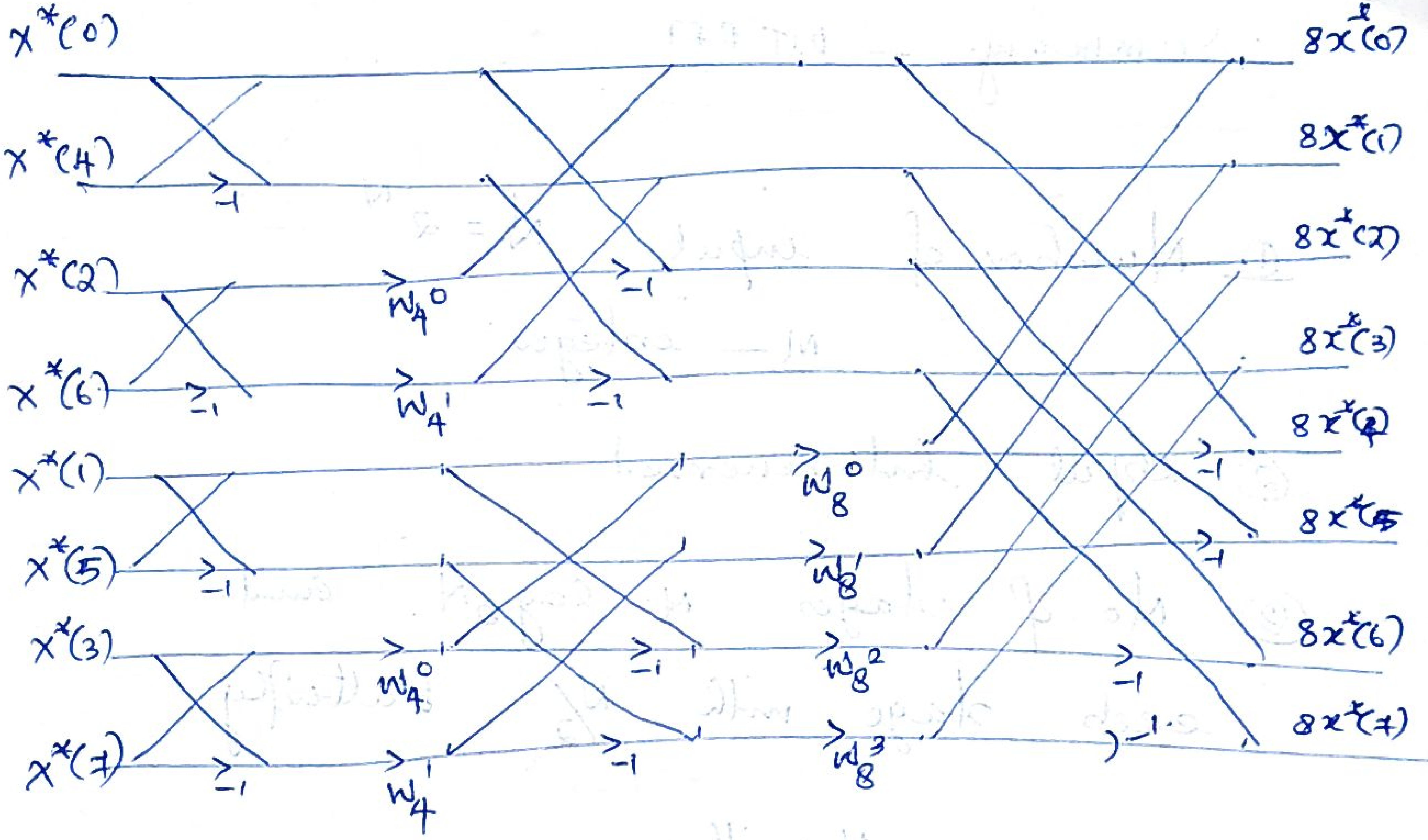
The output $Nx^*(n)$ is normal order.

$\therefore x(n) = \frac{1}{4} Nx^*(n) = \{1, 2, 3, 4\}$

Since all values are real no need to take complex conjugate.

Q) Compute IDFT of the sequence

$X(k) = \{7, -0.707 - j0.707, -j, 0.707 - j0.707,$
$1, 0.707 + j0.707, j, -0.707 + j0.707\}$
using radix-2 DIT-FFT



x*(0)
x*(4)
x*(2)
x*(6)
x*(1)
x*(5)
x*(3)
x*(7)
-1
W4 0
W4 1
W8 0
W8 1
W8 2
W8 3
8x*(0)
8x*(1)
8x*(2)
8x*(3)
8x*(4)
8x*(5)
8x*(6)
8x*(7)