SNS COLLEGE OF TECHNOLOGY

An Autonomous Institution

Coimbatore-35

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECB212 – DIGITAL SIGNAL PROCESSING

II YEAR/ IV SEMESTER

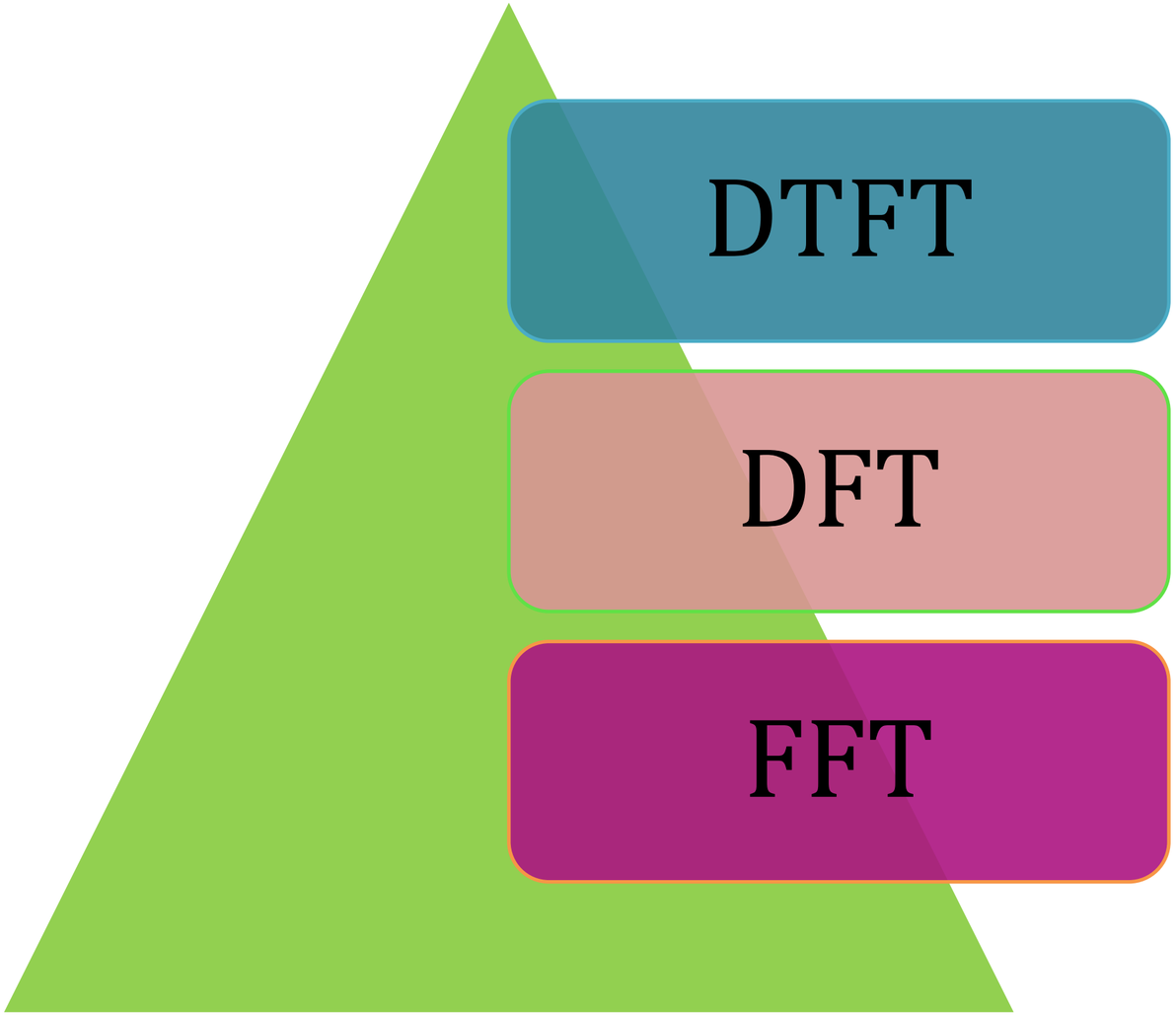
UNIT 1 – DISCRETE FOURIER TRANSFORM

TOPIC – FAST FOURIER TRANSFORM - DIT

PROBLEM

1. • Conversion from time to frequency domain is slow
2. • Cannot able to apply for vast applications
3. • Filtering of the signals is also a slow process

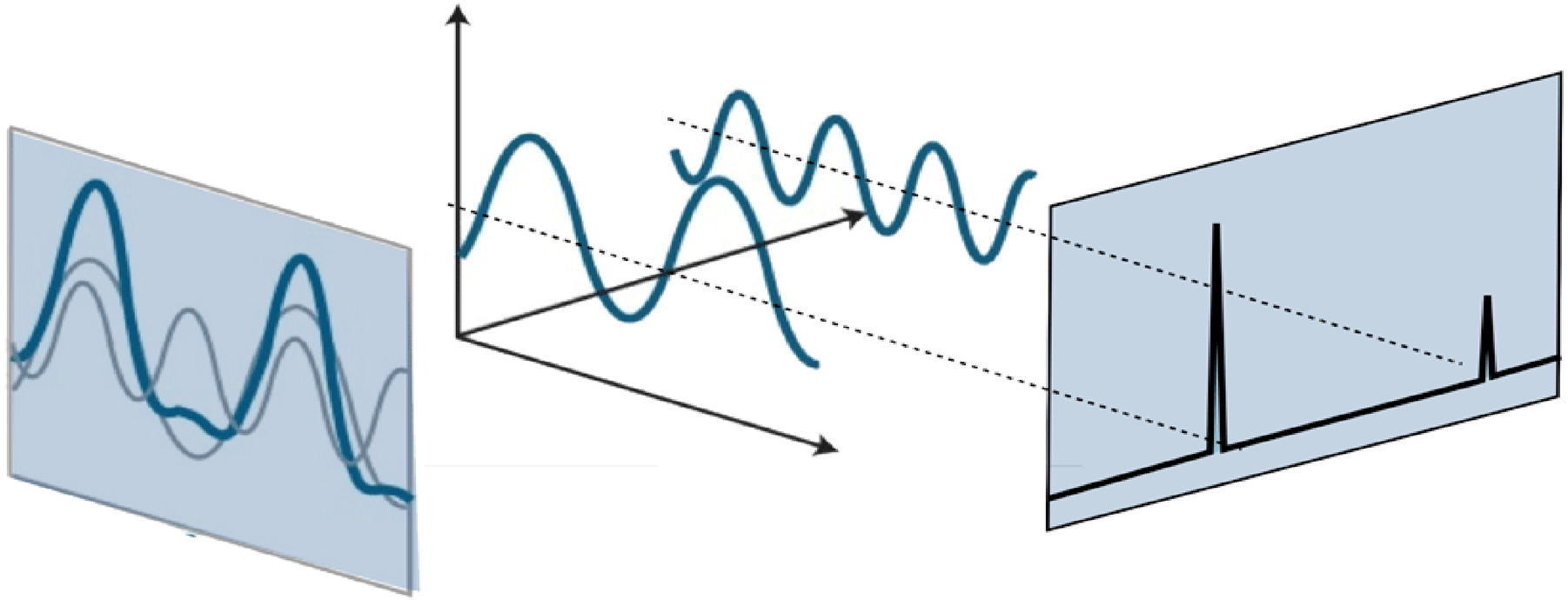
METHOD



FAST FOURIER TRANSFORM

- The Fast Fourier Transform (FFT) is a family of algorithms that calculates efficiently the Discrete Fourier Transform (DFT)
- The DFT is also a sequence, X[k]
- This efficiency of the FFT is at a maximum when the length of the sequence is a power of 2, i.e., $N=2^p$, with p is a positive integer
- The complexity of FFT algorithms is $O(N\log_2 N)$.

FAST FOURIER TRANSFORM



METHODS OF FFT

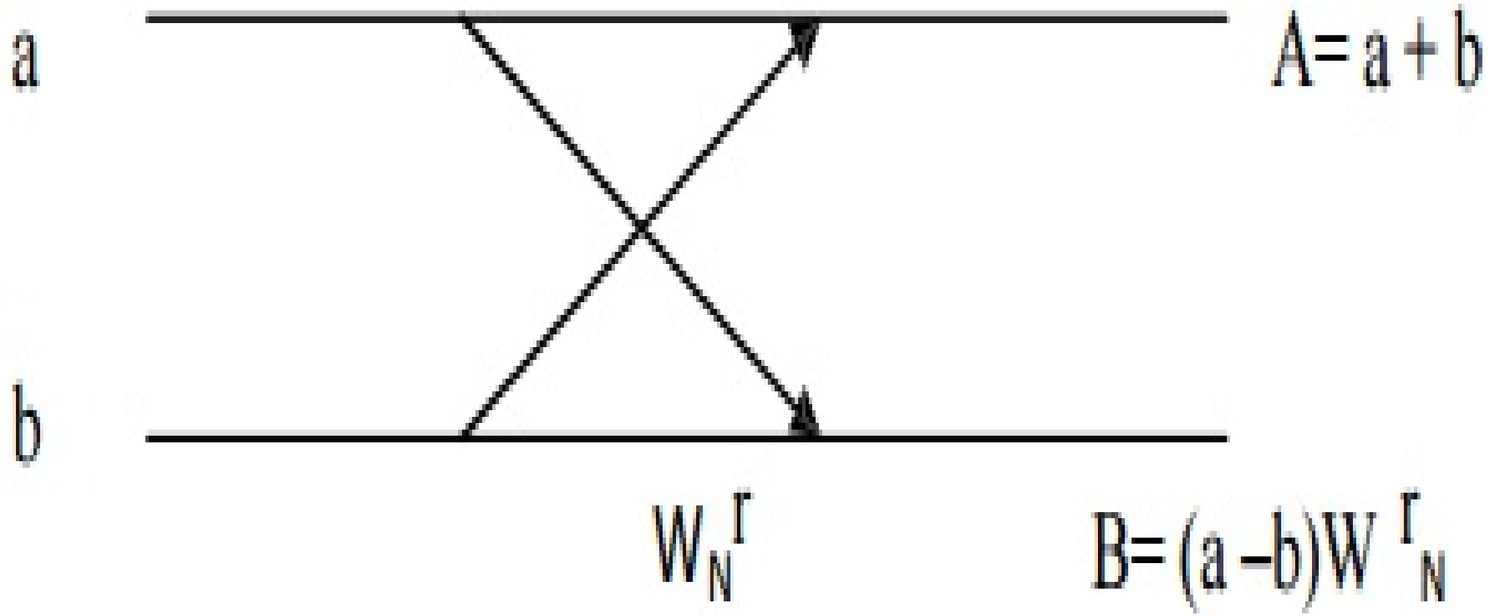
DIT

- **Decimation in Time**

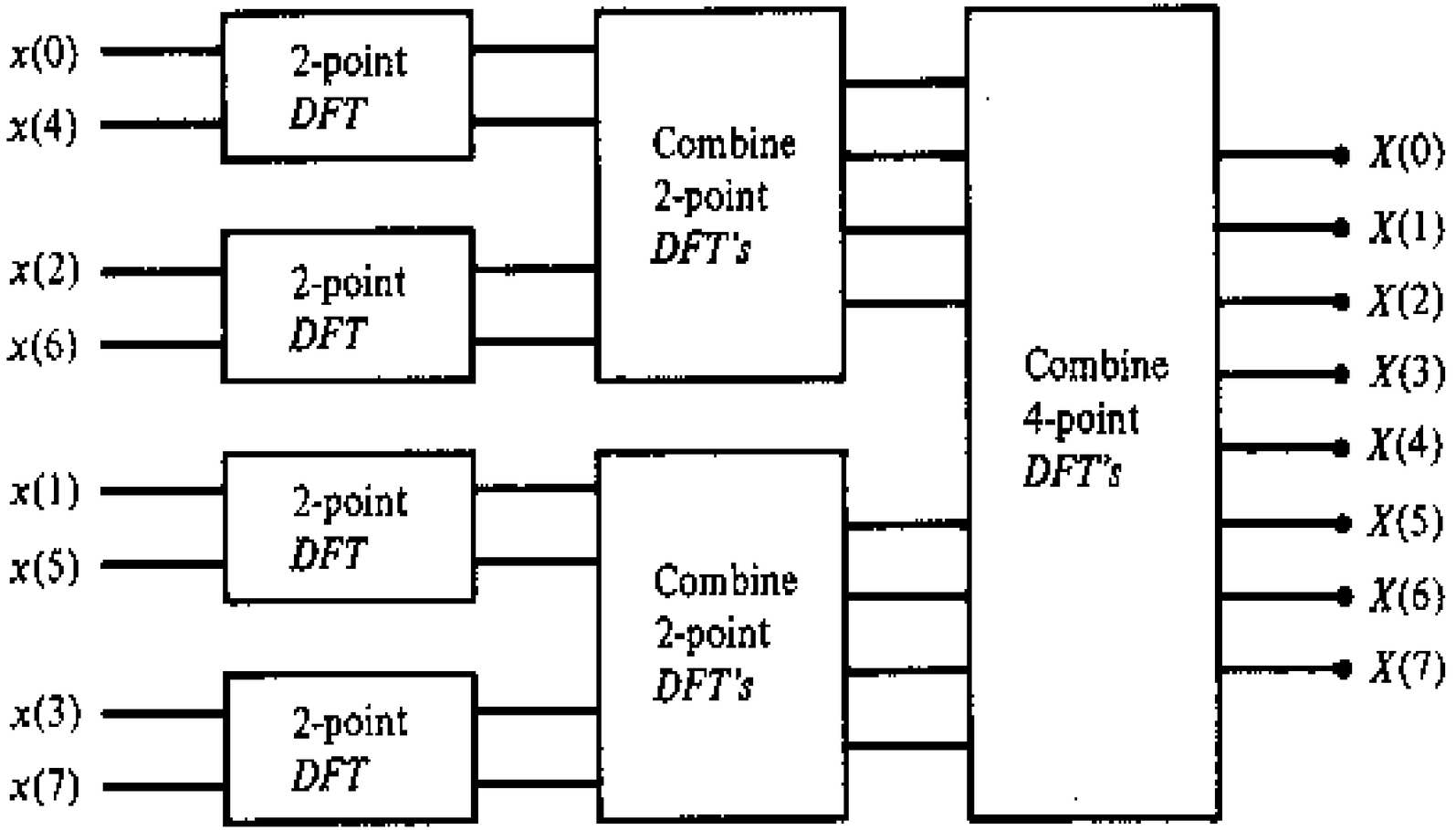
DIF

- **Decimation in Frequency**

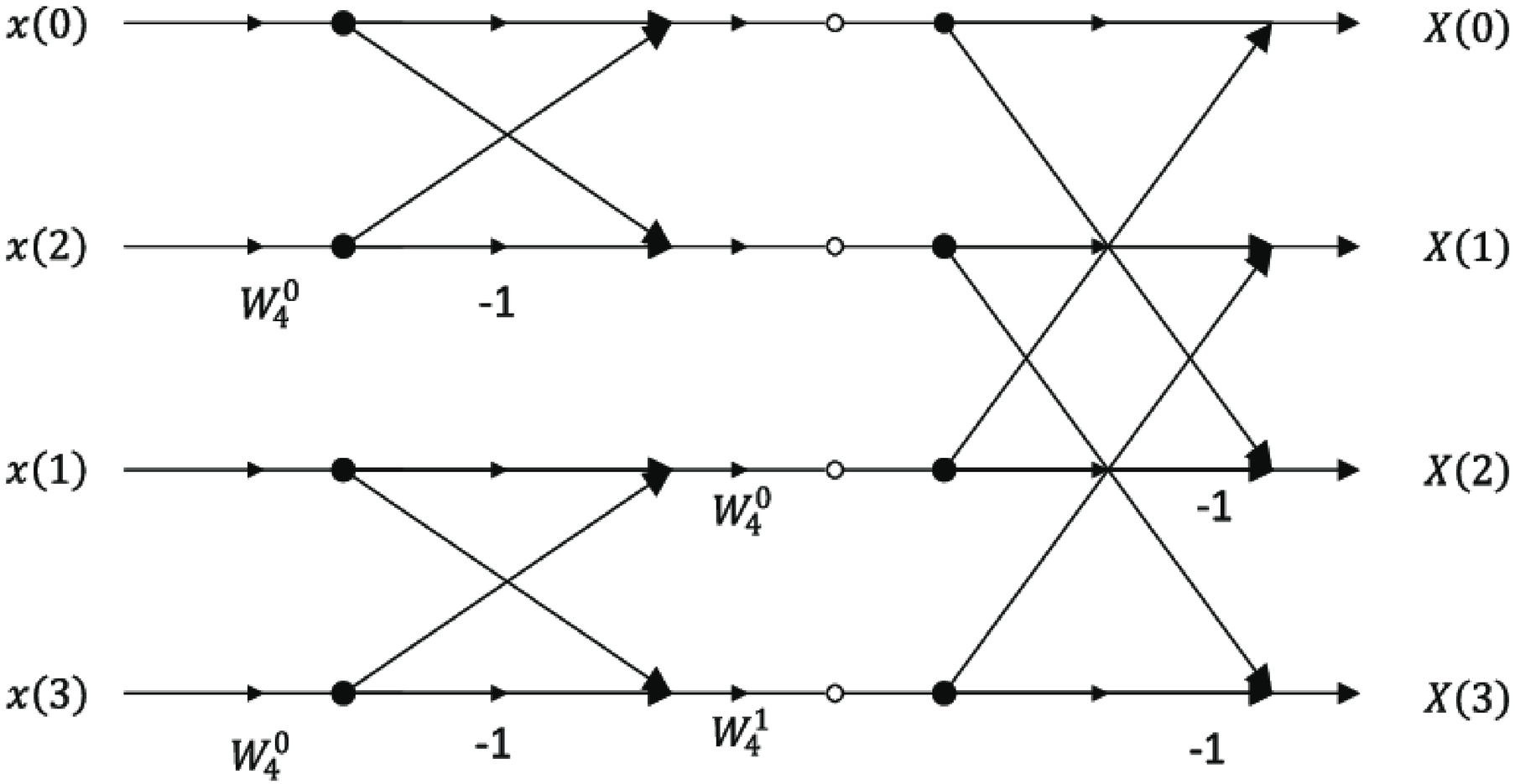
RADIX 2 DIT FFT



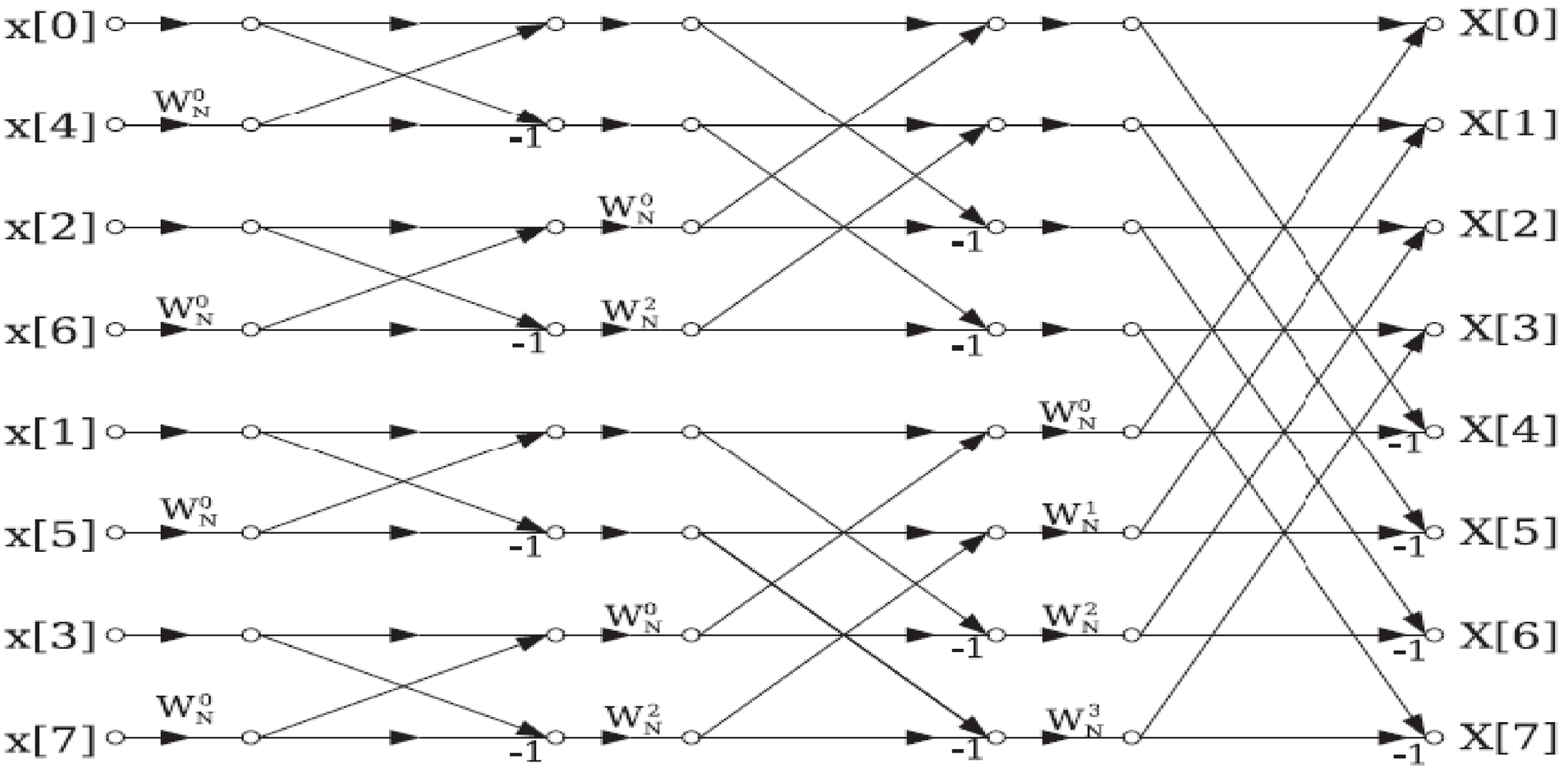
DECIMATION IN TIME FLOW GRAPH



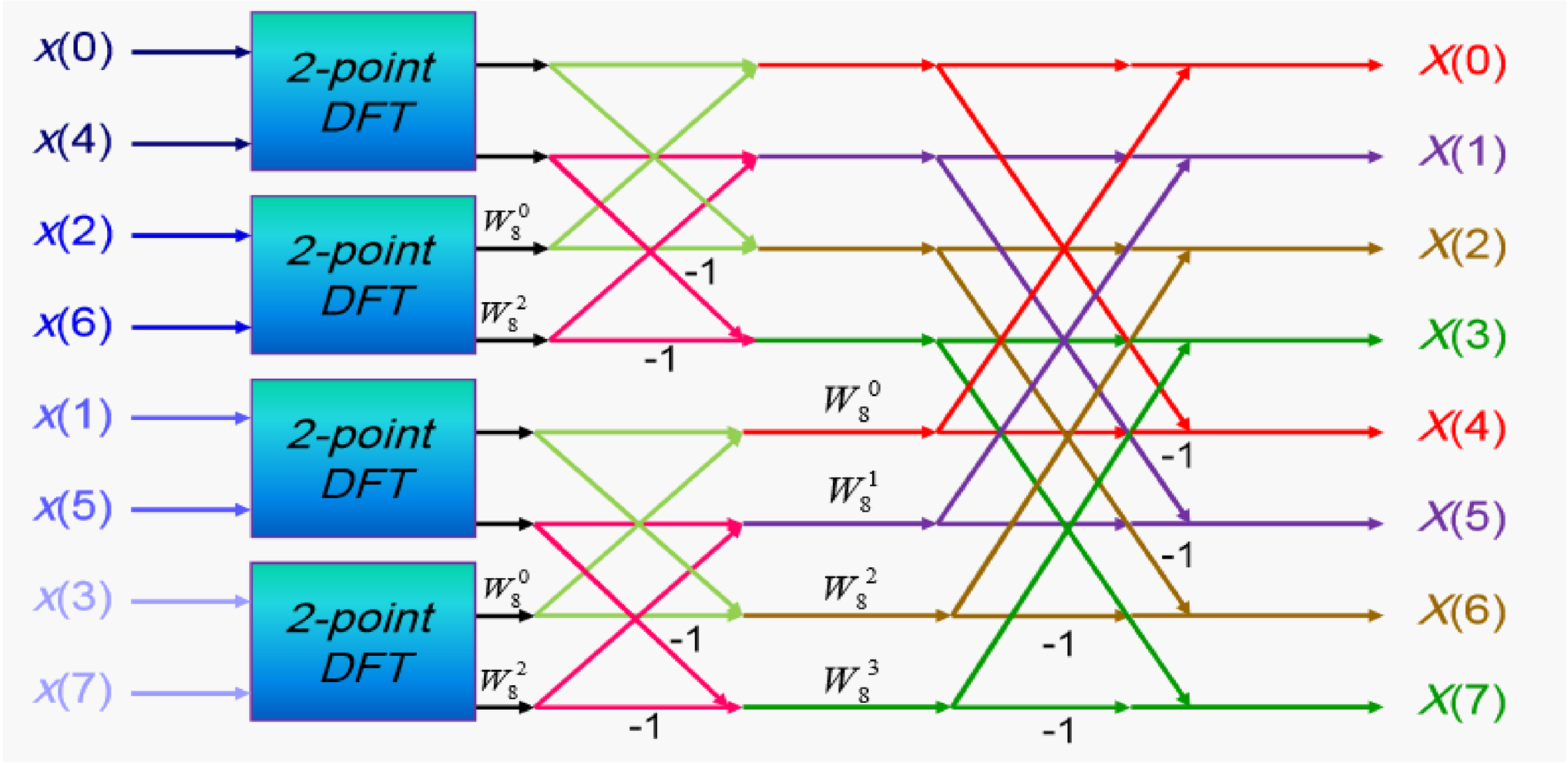
4 POINT DECIMATION IN TIME FFT



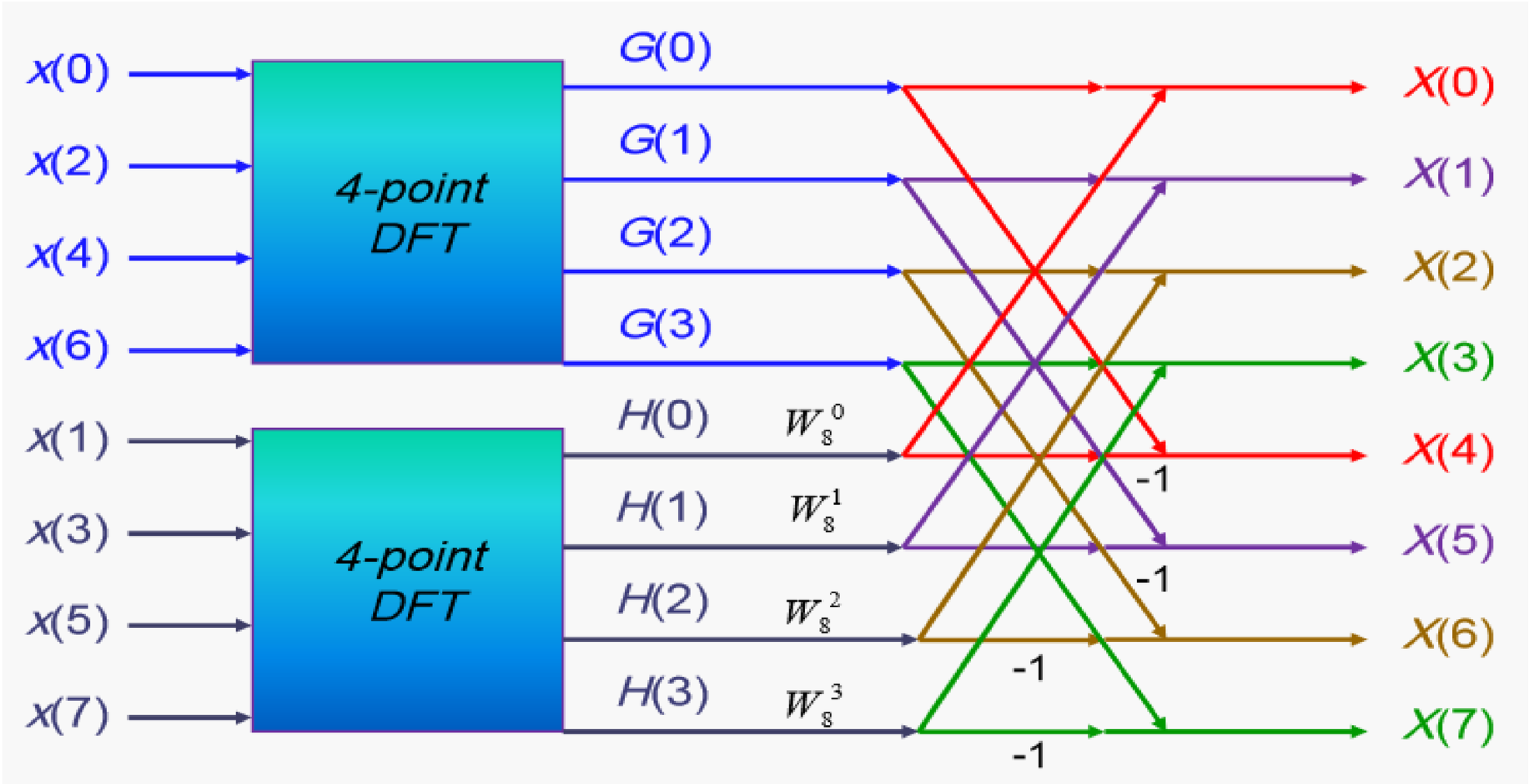
8 POINT DECIMATION IN TIME FFT



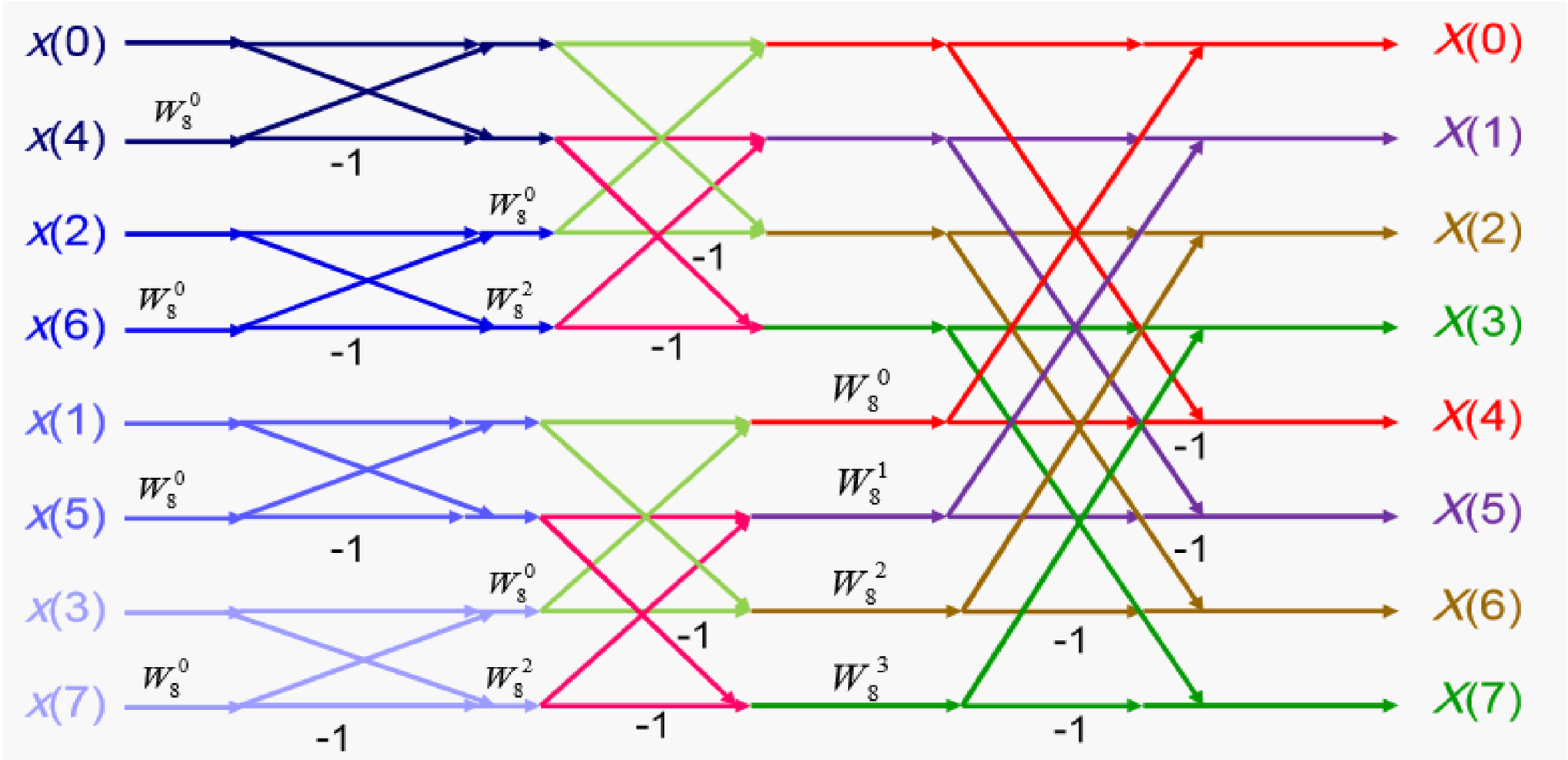
DECIMATION IN TIME FFT



DECIMATION IN TIME FFT



DECIMATION IN TIME FFT



INPUT SEQUENCE ORDER

Original	Binary Form	Reversed Form	Final
0	000	000	0
1	001	100	4
2	010	010	2
3	011	110	6
4	100	001	1
5	101	101	5
6	110	011	3
7	111	111	7

COMPLEX MULTIPLICATIONS

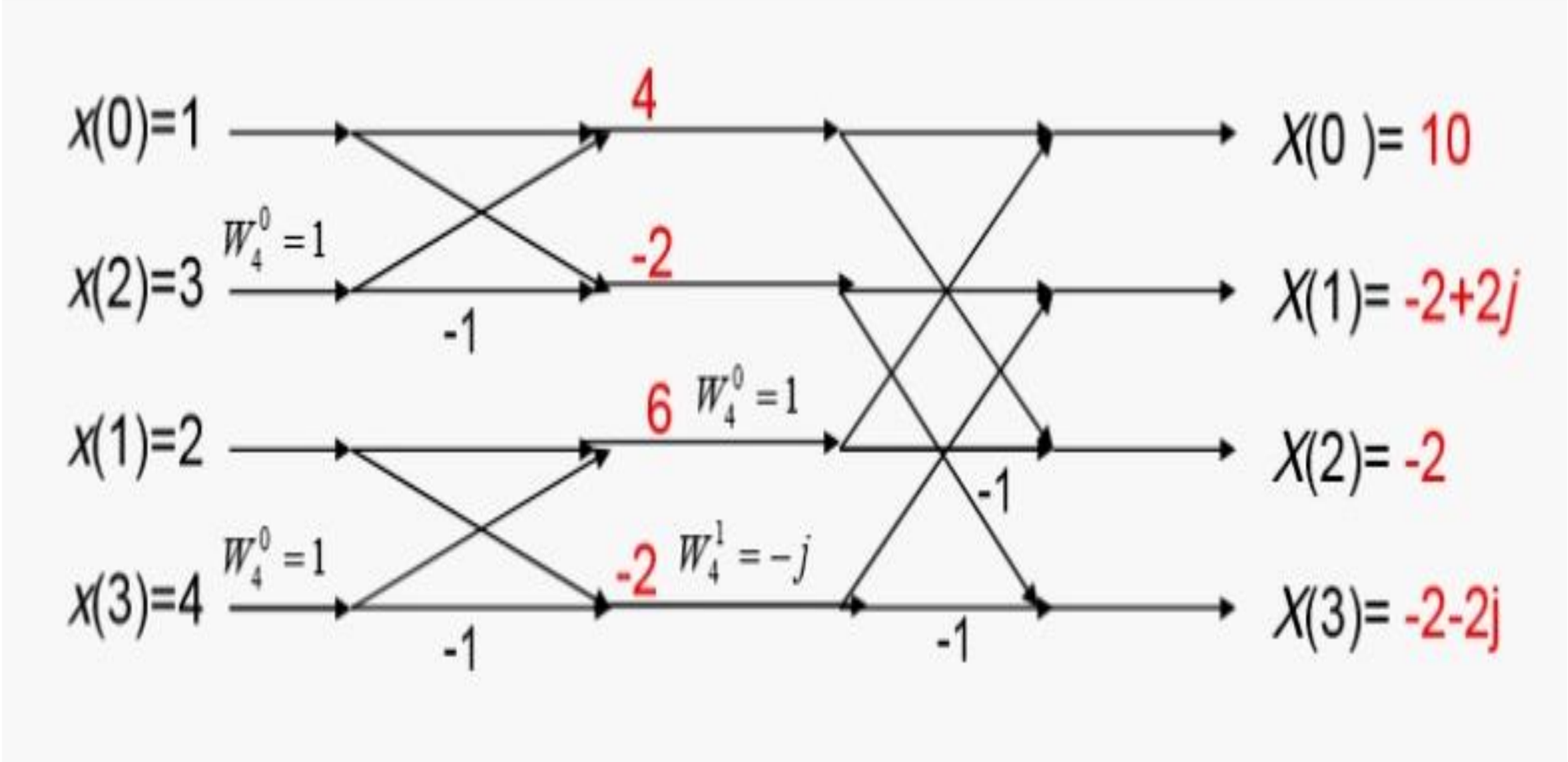
- *Each inner product requires N complex multiplications*
- *There are N inner products*
- *Hence we require* N^2 *multiplications*
- *However, the first row and first column are all 1s, and should not be counted as multiplications*
- *There are 2N −1 such instances*
- *Hence, the number of complex multiplications is* N^2-2N+1*, i.e.,* $(N-1)^2$

COMPLEX ADDITIONS

- *Each inner product requires N –1 complex additions*
- *There are N inner products*
- *Hence we require N(N –1) complex additions*
- ***No. of complex multiplications: $(N-1)^2$***
- ***No. of complex additions: N(N –1)***

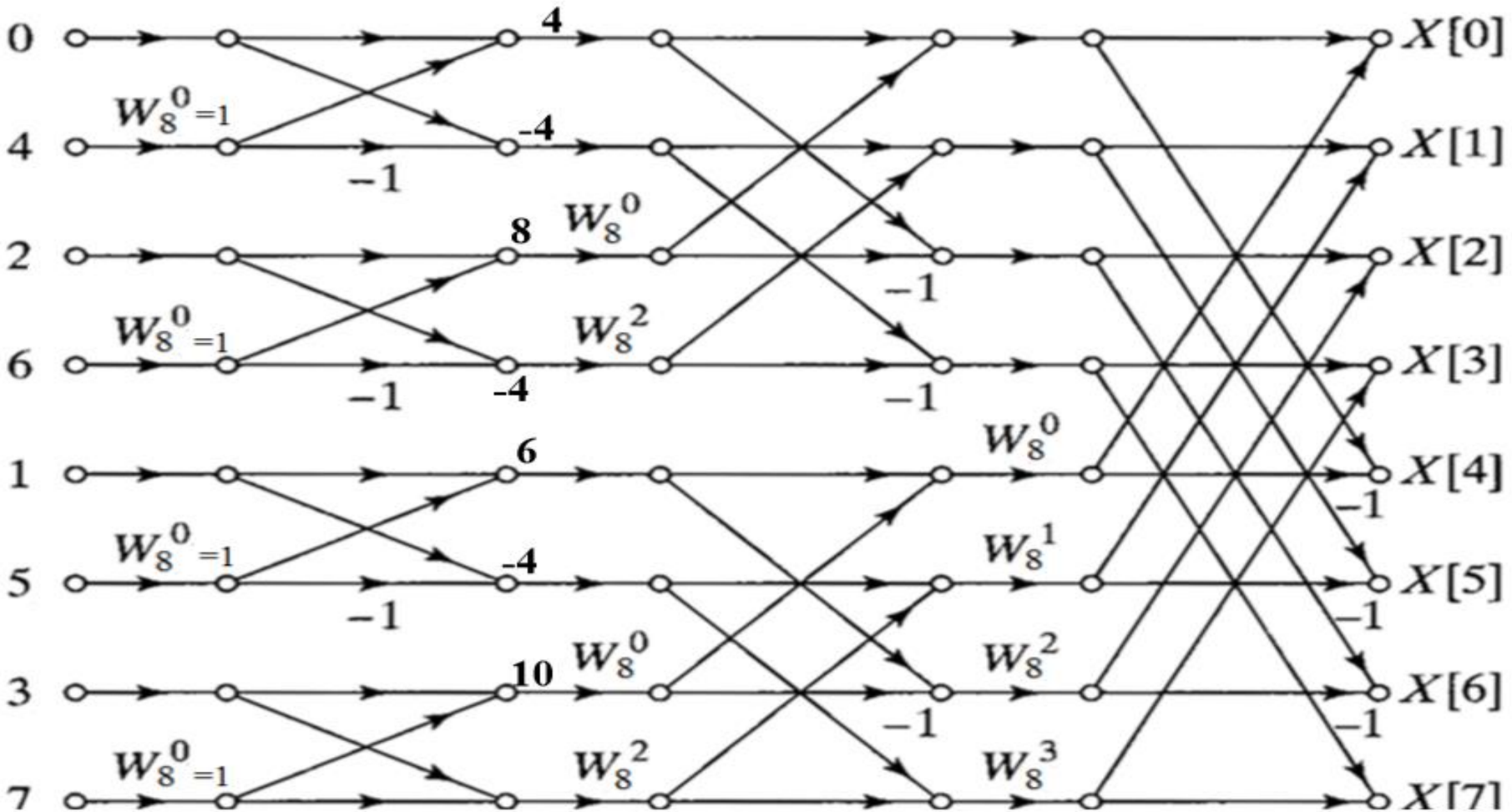
DECIMATION IN TIME

Given x(n)={1,2,3,4}, find X[k] using 4 Point DIT FFT algorithm

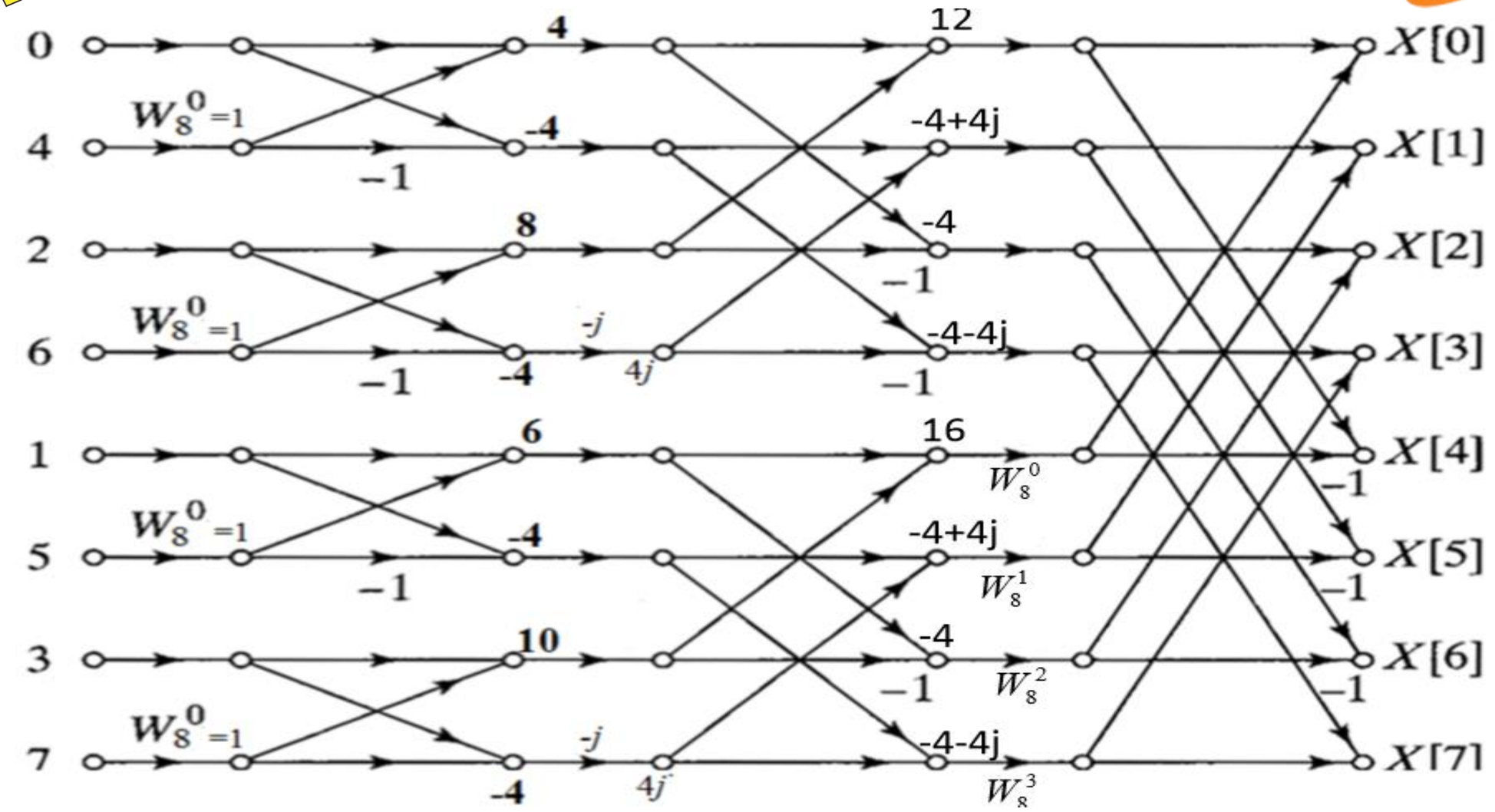


DECIMATION IN TIME – STAGE 1

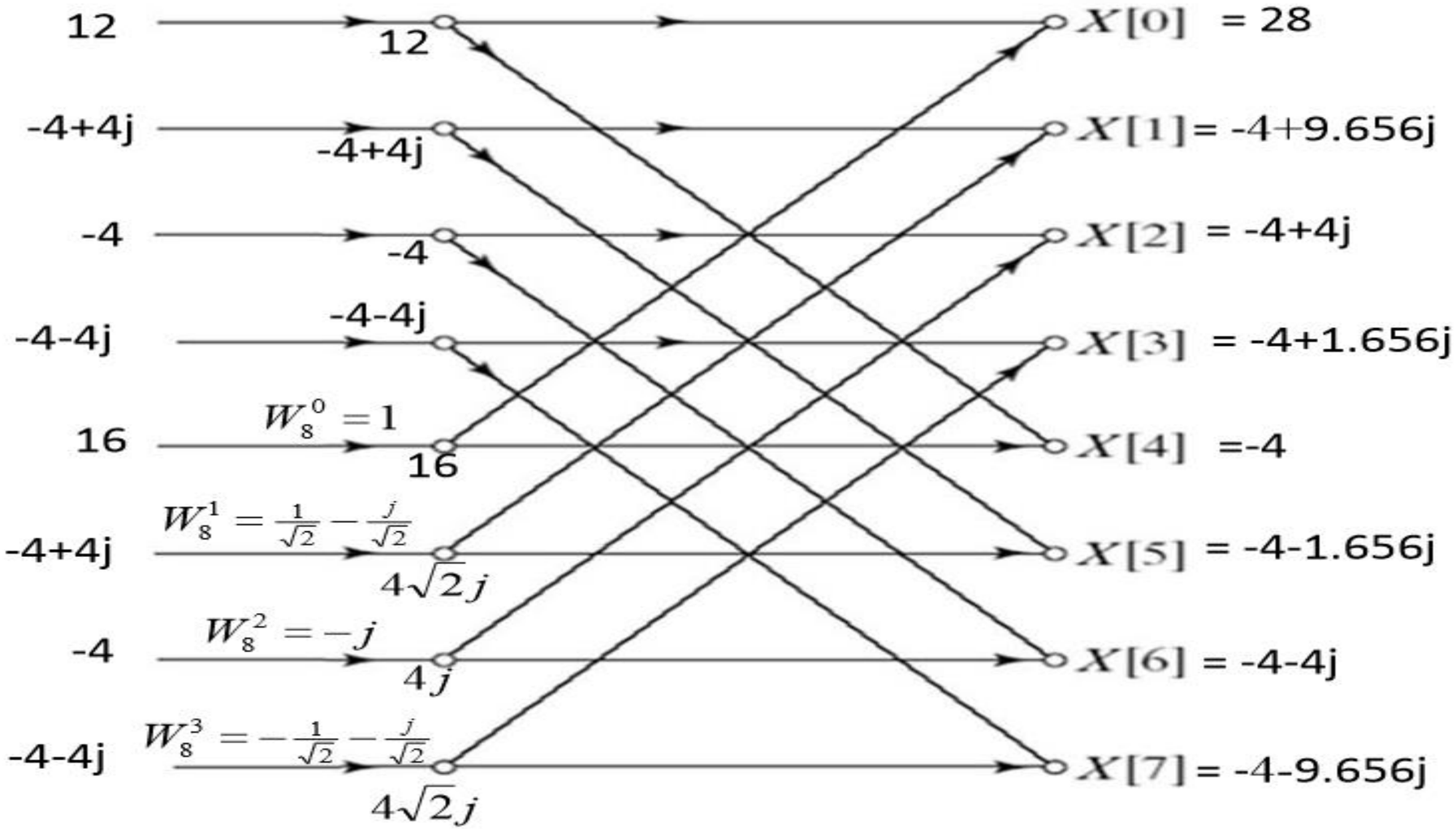
Given x(n)={0,1,2,3,4,5,6,7}, find X[k] using DIT FFT algorithm



DECIMATION IN TIME – STAGE 2



DECIMATION IN TIME – STAGE 3



DIFFERENCE B/W DIRECT COMPUTATION & RADIX-2 FFT

S.No.	Direct Computation	Radix 2 FFT
1	Direct computation requires large number of computations as compared with FFT algorithms.	Radix-2 FFT algorithms requires less number of computations.
2	Processing time is more and more for large number of N hence processor remains busy.	Processing time is less hence these algorithms compute DFT very quickly as compared with direct computation.
3	Direct computation does not requires splitting operation.	Splitting operation is done on time domain basis (DIT) or frequency domain basis (DIF)
4	As the value of N in DFT increases, the efficiency of direct computation decreases.	As the value of N in DFT increases, the efficiency of FFT algorithms increases.

ASSESSMENT

1. What is meant by FFT and list the methods of FFT.
2. In Fast Fourier Transform, ------- domain can be converted into ------- domain.
3. In Decimation in Time, the flow graph is represented as -----, 4 – Point and -----FFT.
4. What is the difference between direct computation and Radix 2 FFT.
5. Determine DIT of x(n) = { 1,2,3,4}
6. In Fast Fourier Transform,

No. of complex multiplications: ---------- No. of complex additions: ----------

THANK YOU