



# **SNS COLLEGE OF TECHNOLOGY**

**Coimbatore-35**  
**An Autonomous Institution**

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



## **DEPARTMENT OF BIOMEDICAL ENGINEERING**

### **19BMB302 - BIOMEDICAL SIGNAL PROCESSING**

**III YEAR/ V SEMESTER**

## **Unit 1 : TRANSFORMS**

19BMB302 - Biomedical Signal Processing / Unit-1 / Dr. K. Manoharan, ASP / BME / SNSCT



# TRANSFORMS

- Introduction and Sampling theorem
- ECG signal conversion system
- Discrete Fourier Transform (DFT)
- Decimation in time FFT
- Decimation in time FFT Problems
- Decimation in frequency FFT
- Decimation in frequency FFT Problems
- Multi rate Signal Processing
- Wavelet Transform



Find the DFT of a sequence  
 $x(n)=\{1,2,3,4,4,3,2,1\}$  using DIT algorithm.

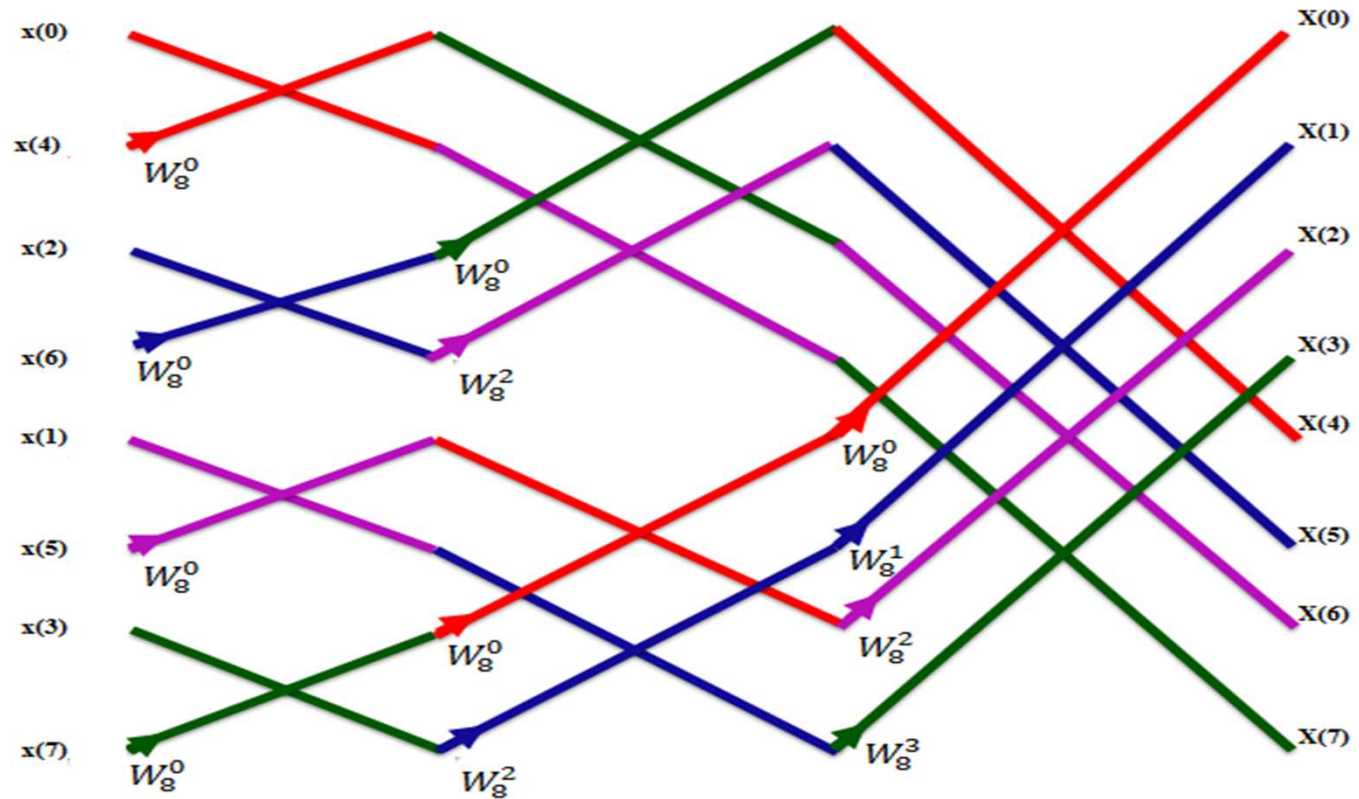
$$N=8$$

$$W_8^0 = e^{\left(\frac{-j2\pi}{8}\right)^0} = 1$$

$$W_8^1 = e^{\left(\frac{-j2\pi}{8}\right)^1} = 0.707 - j 0.707$$

$$W_8^2 = e^{\left(\frac{-j2\pi}{8}\right)^2} = -j$$

$$W_8^3 = e^{\left(\frac{-j2\pi}{8}\right)^3} = -0.707 - j 0.707$$





| Input | Stage 1 O/P | Stage 2 O/P        | Output  |
|-------|-------------|--------------------|---|
| 1     | $1+4=5$     | $5+5=10$           | $10+10=20$  |
| 4     | $1-4=-3$    | $-3+(-j)1=-3 - j$  | $(-3 - j)+(0.707-j0.707)(-1-3j)$<br>$=-5.828 - j2.414$  |
| 3     | $3+2=5$     | $5-5=0$            | 0   |
| 2     | $3-2=1$     | $-3-(-j)1=-3 + j$  | $(-3 + j)+(-0.707-j0.707)(-1+3j)$<br>$=-0.172 - j0.414$ |
| 2     | $2+3=5$     | $5+5=10$           | $10-10=0$   |
| 3     | $2-3=-1$    | $-1+(-j)3=-1 - 3j$ | $(-3 - j)-(0.707-j0.707)(-1-3j)$<br>$=-0.172 + j0.414$  |
| 4     | $4+1=5$     | $5-5=0$            | 0   |
| 1     | $4-1=3$     | $-1-(-j)3=-1 + 3j$ | $(-3 + j)-(-0.707-j0.707)(-1+3j)$<br>$=-5.828 + j2.414$ |



- $X(k) = \{20, -5.828 - j2.414, 0, -0.172 - j0.414, 0, -0.172 + j0.414, 0, -5.828 + j2.414\}$



Find the DFT of a sequence  $x(n)=\{1,1,1,1,0,1,1,1\}$   
using DIT algorithm.

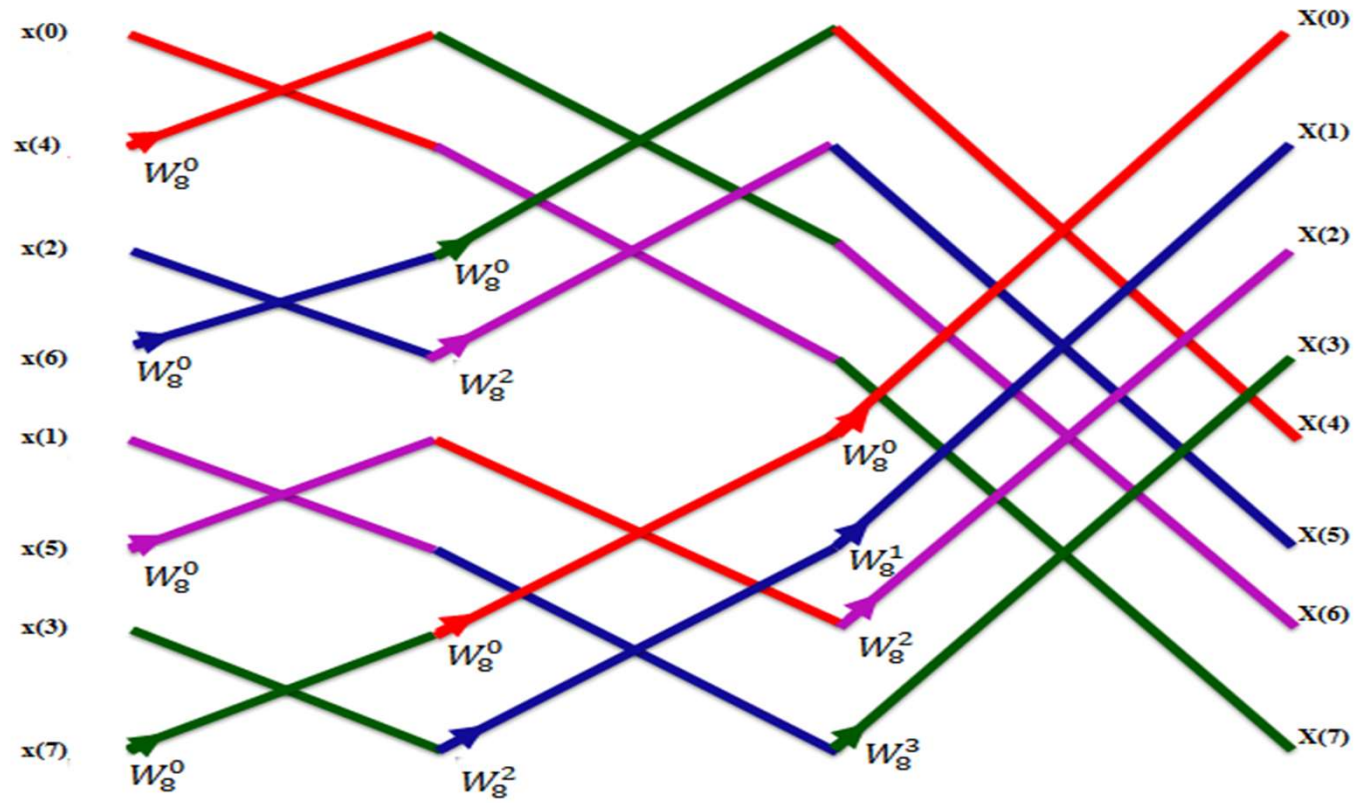
$$N=8$$

$$W_8^0 = e^{\left(\frac{-j2\pi}{8}\right)^0} = 1$$

$$W_8^1 = e^{\left(\frac{-j2\pi}{8}\right)^1} = 0.707 - j 0.707$$

$$W_8^2 = e^{\left(\frac{-j2\pi}{8}\right)^2} = -j$$

$$W_8^3 = e^{\left(\frac{-j2\pi}{8}\right)^3} = -0.707 - j 0.707$$







| Input | Stage 1 O/P | Stage 2 O/P | Output                 |
|-------|-------------|-------------|------------------------|
| 1     | $1+0=1$     | $1+2=3$     | $3+4=7$                |
| 0     | $1-0=1$     | $1+(-j)0=1$ | $1+(0.707-j0.707)0=1$  |
| 1     | $1+1=2$     | $1-2=-1$    | $-1+(-j)0=-1$          |
| 1     | $1-1=0$     | $1+(-j)0=1$ | $1+(-0.707-j0.707)0=1$ |
| 1     | $1+1=2$     | $2+2=4$     | $3-4=-1$               |
| 1     | $1-1=0$     | $0+(-j)0=0$ | $1-(0.707-j0.707)0=1$  |
| 1     | $1+1=2$     | $2-2=0$     | $-1+(-j)0=-1$          |
| 1     | $1-1=0$     | $0-(-j)0=0$ | $1+(-0.707-j0.707)0=1$ |

$$X(k) = \{7, 1, -1, 1, -1, 1, -1, 1\}$$



# Thank You!