Example 3.4 Find IDFT of the sequence IT AU Dec'03

$$X(k) = \{5, 0, 1-j, 0, 1, 0, 1+j, 0\}$$

Solution

We have $x(n) = \dfrac{1}{N}\displaystyle\sum_{k=0}^{N-1} X(k)e^{j2\pi kn/N} \quad n = 0, 1, \ldots, N-1$

For $N = 8$

$$x(n) = \frac{1}{8}\sum_{k=0}^{N-1} X(k)e^{j\pi kn/4} \quad n = 0, 1, \ldots, 7$$

For $n = 0$

$$x(0) = \frac{1}{8}\left[\sum_{k=0}^{7} X(k)\right] = \frac{1}{8}[5+0+1-j+0+1+0+1+j+0] = 1$$

$$x(1) = \frac{1}{8}\left[\sum_{k=0}^{7} X(k)e^{j\pi k/4}\right] = \frac{1}{8}[5+(1-j)(j)+1(-1)+(1+j)(-j)]$$

$$= \frac{1}{8}[6] = 0.75$$

$$x(2) = \frac{1}{8}\left[\sum_{k=0}^{7} X(k)e^{j\pi k/2}\right] = \frac{1}{8}[5+(1-j)(-1)+1(1)+(1+j)(-1)]$$

$$= \frac{1}{8}[4] = 0.5$$

$$x(3) = \frac{1}{8}\left[\sum_{k=0}^{7} X(k)e^{j3\pi k/4}\right] = \frac{1}{8}[5 + (1-j)(-j) + 1(-1) + (1+j)(j)]$$

$$= \frac{1}{8}[2] = 0.25$$

$$x(4) = \frac{1}{8}\left[\sum_{k=0}^{7} X(k)e^{j\pi k}\right] = \frac{1}{8}[5 + (1-j)(1) + 1(1) + (1+j)(1)]$$

$$= 1$$

$$x(5) = \frac{1}{8}\left[\sum_{k=0}^{7} X(k)e^{j5\pi k/4}\right] = \frac{1}{8}[5 + (1-j)(j) + (1)(-1) + (1+j)(-j)]$$

$$= \frac{1}{8}[6] = 0.75$$

$$x(6) = \frac{1}{8}\left[\sum_{k=0}^{7} X(k)e^{j3\pi k/2}\right] = \frac{1}{8}[5 + (1-j)(-1) + 1(1) + (1+j)(-1)]$$

$$= \frac{1}{8}[4] = 0.5$$

$$x(7) = \frac{1}{8}\left[\sum_{k=0}^{7} X(k)e^{j7\pi k/4}\right] = \frac{1}{8}[5 + (1-j)(-j) + 1(-1) + (1+j)(j)]$$

$$= \frac{1}{8}[2] = 0.25$$

$$x(n) = \{1, 0.75, 0.5, 0.25, 1, 0.75, 0.5, 0.25\}$$