

GATE-BM-Q15

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Question: Discrete signals $x(n)$ and $y(n)$ are shown below. The cross-correlation $r_{xy}(0)$ is:

By definition of $x(n)$ from Table 1:

$$r_{xy}(k) = \sum_{n=0}^6 x(n+1) x(n+k) \quad (6)$$

$$r_{xy}(0) = \sum_{n=0}^6 x(n+1) x(n) \quad (7)$$

Using values from Fig. 1:

$$r_{xy}(0) = 2\sqrt{2} \quad (8)$$

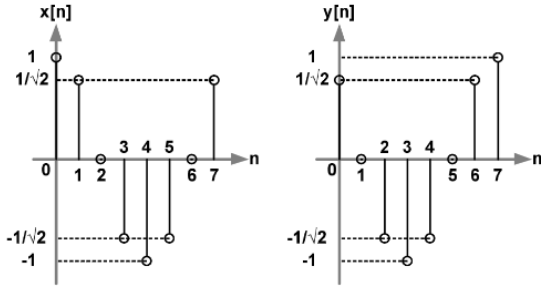


Fig. 1. Question Figure

(GATE BM 2022)

Solution:

Parameter	Description	Value
$x(n)$	First Sequence	$x(n) = \begin{cases} 0 & ; n < 0 \\ \left(1, \frac{1}{\sqrt{2}}, 0, -\frac{1}{\sqrt{2}}, -1, -\frac{1}{\sqrt{2}}, 0, \frac{1}{\sqrt{2}}\right) & ; 0 \leq n \leq 7 \\ 0 & ; n > 7 \end{cases}$
$y(n)$	Second Sequence	$y(n) = \begin{cases} 0 & ; n < 0 \\ \left(\frac{1}{\sqrt{2}}, 0, -\frac{1}{\sqrt{2}}, -1, -\frac{1}{\sqrt{2}}, 0, \frac{1}{\sqrt{2}}, 1\right) & ; 0 \leq n \leq 7 \\ 0 & ; n > 7 \end{cases}$
$r_{xy}(k)$	Cross-correlation	$\sum_{m=-\infty}^{\infty} x(m) y(m-k)$

TABLE I
PARAMETER TABLE

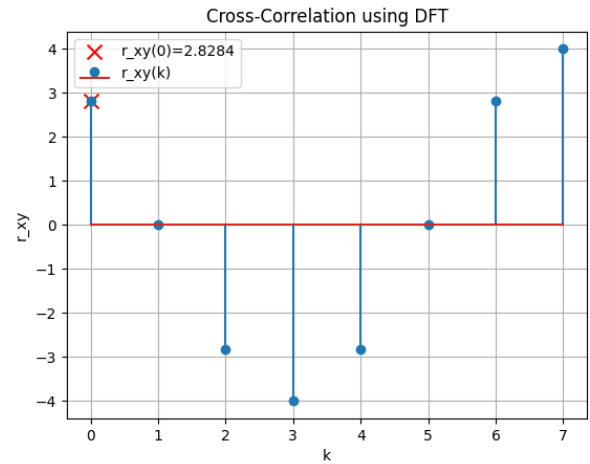


Fig. 2. Verification of result by DFT

It can be seen that :

$$y(n) = x(n+1) \quad (1)$$

From Table 1 :

$$r_{xy}(k) = \sum_{m=-\infty}^{\infty} x(m) y(m-k) \quad (2)$$

$$= x(k) * y(-k) \quad (3)$$

From (1):

$$r_{xy}(k) = x(k+1) * x(-k) \quad (4)$$

$$= \sum_{n=-\infty}^{\infty} x(n+1) x(n+k) \quad (5)$$