

# GATE Question Paper 2018, CS

## Question Number 49

Q.49 Consider the minterm list form of a Boolean function  $F$  given below.

$$F(P, Q, R, S) = \sum m(0, 2, 5, 7, 9, 11) + d(3, 8, 10, 12, 14)$$

Here,  $m$  denotes a minterm and  $d$  denotes a don't care term. The number of essential prime implicants of the function  $F$  is \_\_\_\_.

ANSWER

### 1. Create the 4 variable K-map:

We have a function  $F(P, Q, R, S)$  with 4 variables, so we'll need a 4-variable K-map.

RS	00	01	11	10
PQ 00	$m_0$	$m_1$	$m_3$	$m_2$
PQ 01	$m_4$	$m_5$	$m_7$	$m_6$
PQ 11	$m_{12}$	$m_{13}$	$m_{15}$	$m_{14}$
PQ 10	$m_8$	$m_9$	$m_{11}$	$m_{10}$

### 2. Fill in the minterms (m) and don't cares (d):

- Minterms (m): 0, 2, 5, 7, 9, 11
- Don't cares (d): 3, 8, 10, 12, 14

RS	00	01	11	10
PQ 00	1	0	1	1
PQ 01	0	1	1	0
PQ 11	d	0	0	d
PQ 10	d	1	1	d

Table 1: k map for(p,q,r,s)

	00( $r's'$ )	01( $r's$ )	11( $rs$ )	10( $rs'$ )
00( $p'q'$ )	1		X	1
01( $p'q$ )		1	1	
11( $pq$ )	X			X
10( $p'q$ )	X	1	1	X

### 3. Identify the prime implicants:

**Prime implicant:** A group of 1's (or 1's and don't cares) that cannot be further combined into a larger group.

Let's look for the largest possible groups:

- **Group 1:** The 1's in cells 8, 9, 10 and 11 can be combined:  $PQ'$
- **Group 2:** The 1's in cells 0, 2, 8 and 10 can be combined:  $PS'$
- **Group 3:** The 1's in cells 2, 3, 10 and 11 can be combined:  $RQ'$

### 4. Identify the essential prime implicants:

**Essential prime implicant:** A prime implicant that covers at least one minterm that is not covered by any other prime implicant.

Let's check each minterm:

- **Minterm 0:** Covered only by  $P'Q'S'$  (Essential)
- **Minterm 2:** Covered only by  $P'Q'S'$  (Essential)
- **Minterm 9:** Covered only by  $PQ'S$  (Essential)

**Therefore, all for all three implicants are essential.**

**Answer:** The number of essential prime implicants of the function  $F$  is 3.