

## 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)

	$00(r' \cdot s')$	$01(r' \cdot s)$	$11(r \cdot s)$	$10(r \cdot s')$
$00(p' \cdot q')$	1		X	1
$01(p' \cdot q)$		1	1	
$11(p \cdot q)$	X			X
$10(p \cdot q')$	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.