Evaluation of Minterm Expression

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1 Problem

(GATE CS-2014 SET-3)
Q.7 Consider the Following Minterm expression for F:

$$\mathtt{F(P,Q,R,S)} = \sum \mathtt{0,2,5,7,8,10,13,15}$$

The minterms 2,7,8 and 13 are *'do not care'* terms. The minimal sum-of-products form for F is

(A) $\mathtt{Q\bar{S}} + \mathtt{\bar{Q}S}$

(B) $\mathtt{\bar{Q}\bar{S}} + \mathtt{QS}$

(C) $\mathtt{\bar{Q}\bar{R}\bar{S}} + \mathtt{\bar{Q}R\bar{S}} + \mathtt{Q\bar{R}S} + \mathtt{QRS}$

(D) $\mathtt{\bar{P}\bar{Q}\bar{S}} + \mathtt{\bar{P}QS} + \mathtt{PQS} + \mathtt{P\bar{Q}\bar{S}}$

2 Introduction

For a given set of Boolean Logic Inputs, we can define the following terms:

- **Minterm** is a boolean expression resulting in an output of 1 for the minimum number of cells in a Karnaugh-Map (K-Map) and 0 in other cells.
- **Sum of Products** is a boolean expression for the *Sum* (OR) of various *Product* (AND) terms.
- **'do not care'** terms for a boolean expression are the set of input values for which the output of the function does not matter. The value for these can be taken as 0 or 1 by choice

3 Components

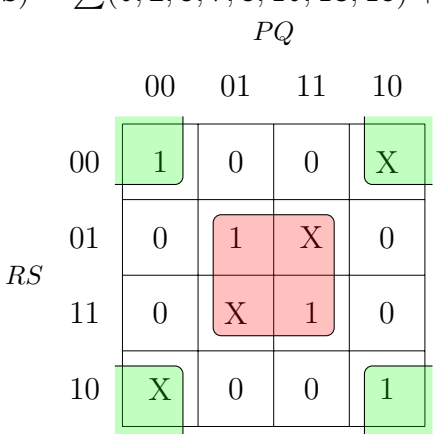
Component	Value	Quantity
Arduino	UNO	1
Breadboard	-	1
LED	-	1
Jumper Wires	M-M	10
Resistor	220 Ω	1

Table 1: Table of Components

4 Solution

4.1 Karnaugh Map

$$\mathtt{F}(\mathtt{P},\mathtt{Q},\mathtt{R},\mathtt{S}) = \sum(0,2,5,7,8,10,13,15) + \mathtt{d}(2,7,8,13)$$



The above K-Map can be simplified to:

$$\mathtt{F} = \overline{\mathtt{Q}} \cdot \overline{\mathtt{S}} + \mathtt{Q} \cdot \mathtt{S} \tag{1}$$

Therefore, the answer is **(A)**

4.2 Truth Table

P	Q	R	S	F
0	0	0	0	1
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1

Table 2: Truth Table for F

5 Connections

5.1 LED to Arduino

LED connections to Arduino are as follows:

Arduino	2	GND
LED	+	-

Table 3: LED Connections

5.2 Input Pins to Arduino

Input Pin Connections to Arduino are as follows:

Arduino	D6	D7	D8	D9
Term	P	Q	R	S

Table 4: Input Pin Connections

5.3 Setting Input Pin Values

The values of the Input pins are taken by connecting them to either $5V$ or GND according to Truth Table

6 Code

6.1 main.cpp

The Arduino implementation uses the following code:

```
// Required for Arduino
#include "Arduino.h"

// Declaring variables
byte P,Q,R,S,F;

void setup()
{
    // Output Pins
    pinMode(2, OUTPUT);

    // Input Pins
    pinMode(6, INPUT);
    pinMode(7, INPUT);
    pinMode(8, INPUT);
    pinMode(9, INPUT);
}

void loop()
    {
    // Reading P,Q,R,S
    P = digitalRead(6);
    Q = digitalRead(7);
    R = digitalRead(8);
    S = digitalRead(9);

    // F(P,Q,R,S) = Q'.S' + Q.S
    F = (Q && S) || (!Q && !S);

    // Setting Pin 2 to F
    digitalWrite(2, F);
}
```

6.2 Repository

Code is also available online at the following repository:

https://github.com/gaurav5-5/ard-workshop/tree/main/ide/latex/codes