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## GATE CS 2010 – Question 9

### Question

The Boolean expression for the output  $f$  of the multiplexer shown below is:

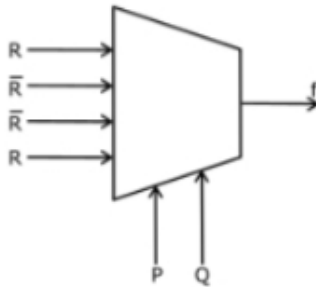


Fig. 1

### Options:

- (a)  $P \oplus Q \oplus R$
- (b)  $\overline{P \oplus Q \oplus R}$
- (c)  $P + Q + R$
- (d)  $\overline{P + Q + R}$

## Question Analysis

The given circuit is a 4:1 Multiplexer.

**Select lines:**  $P$  and  $Q$

**Inputs:**

- $I_0 = R$
- $I_1 = \overline{R}$
- $I_2 = \overline{R}$
- $I_3 = R$

**General 4:1 MUX equation:**

$$f = \overline{PQ}I_0 + \overline{PQ}I_1 + P\overline{Q}I_2 + PQI_3$$

**Substituting values:**

$$f = \overline{PQ}R + \overline{PQ}\overline{R} + P\overline{Q}\overline{R} + PQR$$

**Grouping terms:**

$$f = R(\overline{PQ} + PQ) + \overline{R}(\overline{PQ} + P\overline{Q})$$

Using identities:

$$\overline{PQ} + PQ = P \odot Q$$

$$\overline{PQ} + P\overline{Q} = P \oplus Q$$

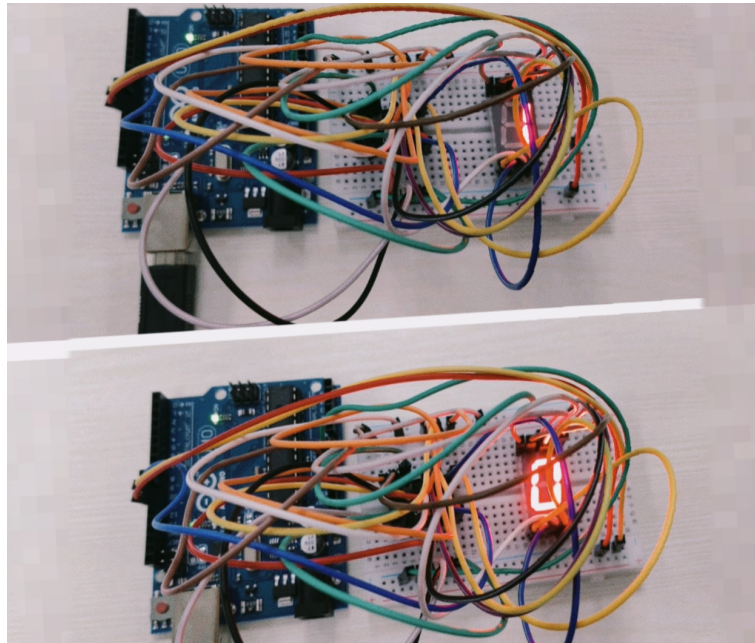
Therefore,

$$f = P \oplus Q \oplus R$$

## Truth Table

P	Q	R	f
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

## Circuit Diagram



## Required Components

- Arduino UNO
- Breadboard
- 7-Segment Display (Common Anode)
- IC 7447
- Connecting wires
- resistor
- Switches

## Pin Connections

### Input Connections:

- $P \rightarrow$  Digital Pin 2
- $Q \rightarrow$  Digital Pin 3
- $R \rightarrow$  Digital Pin 4

### 7447 Connections:

- A  $\rightarrow$  Pin 8
- B  $\rightarrow$  Pin 9
- C  $\rightarrow$  Pin 10
- D  $\rightarrow$  Pin 11
- Common Anode  $\rightarrow$  +5V

## Code Uploading Steps

1. Create a PlatformIO project.
2. Write the code in `src/main.cpp`.
3. Run the command `pio run`.
4. Copy the generated `.hex` file.
5. Connect Arduino UNO using OTG cable.
6. Upload using “Upload Precompiled” option.
7. Observe the output on the 7-segment display.

## Conclusion

The output obtained matches the truth table.

Hence the Boolean expression of the given multiplexer is:

- Correct option: (a)  $f = P \oplus Q \oplus R$