Name: N.Srinivas
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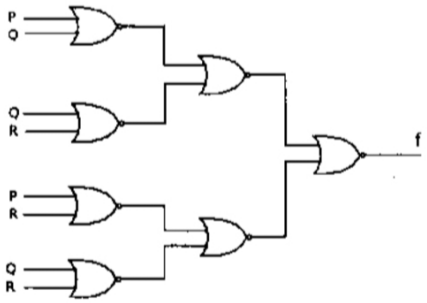
GATE 2010 CS, 31^{th} Question Analysis

Q.31

What is the boolean expression for the output f of the combinational logic circuit of NOR gates given below?



Solution

Each gate in the circuit is a NOR gate, which performs the operation: $A \downarrow B = \overline{A + B}$

- Gate A: $A = \overline{P + Q}$
- Gate B: $B = \overline{Q + R}$
- Gate C: $C = \overline{A + B} = \overline{\overline{P + Q} + \overline{Q + R}}$
- Gate D: $D = \overline{P + R}$
- Gate E: $E = \overline{Q + R}$
- Gate F: $F = \overline{D + E} = \overline{\overline{P + R} + \overline{Q + R}}$
- Final Output: $f = \overline{C + F} = \overline{\overline{\overline{P + Q} + \overline{Q + R}} + \overline{\overline{P + R} + \overline{Q + R}}}$

Truth Table

P	Q	R	$f = \overline{Q + R}$
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	0

Hardware Implementation

The above problem is implemented and tested in hardware using Arduino UNO board. Here we implemented a FSM using the 7474 IC and blinked the LED as per truth table and verified the expression.

Required Components & Pin Connections

S.No	Component
1	Arduino Uno Board
2	Breadboard
3	7474 IC (2)
4	LEDs (1)
5	7447 IC (1)
6	Seven segment (1)
7	Resistors: 220Ω (2)
8	Jumper Wires
9	USB Cable

Component	Arduino Pin
Input P (7474-1 Q3)	Digital 2
Input Q (7474-1 Q2)	Digital 3
Input R (7474-2 Q1)	Digital 4
Output D (7447 D)	Digital 8
Output C (7447 C)	Digital 9
Output B (7447 B)	Digital 10
Output A (7447 A)	Digital 11
Output F (LED)	Digital 5
Output clk (7474 clk)	Digital 13
GND	GND
VCC	5V

Code Uploading Steps

1. Create a avr-gcc project
2. Write The code in main.c in src
3. Run the PIO project with command "make hex". It will compile the code and creates .hex file
4. Copy the .hex file to ArduinoDriod folder
5. connect the Arduino UNO to mobile with OTG cable
6. Upload the hex file using "upload precomplied" option
7. Observe the ouput and verify the expression

Answer:

$\boxed{f = \overline{Q + R}}$

Correct option: **(A)**