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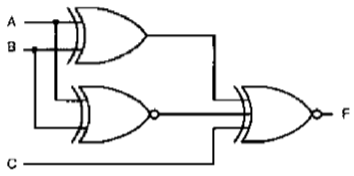
GATE Question Paper 2010, EC Question Number 12

Q.12 For the output F to be 1 in the logic circuit shown, the input combination should be



(A) A = 1, B = 1, C = 0
(B) A = 1, B = 0, C = 0
(C) A = 0, B = 1, C = 0
(D) A = 0, B = 0, C = 1

Question Analysis

Given: A logic circuit composed of two OR gates, one NOR gate, and one final OR gate. **Task:** Find the input combination of A, B, C for which output $F = 1$.

Solution:

Step 1: Top OR Gate:
Output1 = $A + B$

Step 2: Bottom OR Gate:
Output2 = $A + C$

Step 3: Middle NOR Gate:
Inputs to NOR = Output1, Output2 NOR output = $\overline{(A+B)+(A+C)}$

Step 4: Final OR Gate:
Inputs = NOR output and C

$$F = \overline{(A+B)+(A+C)} + C$$

Step 5: Try Input Combinations:

- (A=1, B=1, C=0) $\rightarrow F = 0$
- (A=1, B=0, C=0) $\rightarrow F = 0$
- (A=0, B=1, C=0) $\rightarrow F = 1$
- (A=0, B=0, C=1) $\rightarrow F = 0$

Correct Option: (C)

$$\boxed{A = 0,\ B = 1,\ C = 0}$$

Truth Table

A	B	C	Expression	F
0	0	0	$\overline{(0+0)+(0+0)}+0 = \overline{0}+0 = 1$	1
0	1	0	$\overline{(0+1)+(0+0)}+0 = \overline{1}+0 = 0$	0
1	0	0	$\overline{(1+0)+(1+0)}+0 = \overline{1}+0 = 0$	0
0	1	0	$\overline{(0+1)+(0+0)}+0 = \overline{1}+0 = 0$	0
0	1	0	$\overline{(0+1)+(0+0)}+0 = \overline{1}+0 = 0$	0
0	1	0	$\overline{(0+1)+(0+0)}+0 = \overline{1}+0 = 0$	0
0	1	0	$\overline{(0+1)+(0+0)}+0 = \overline{1}+0 = 0$	0
0	1	0	$\overline{(0+1)+(0+0)}+0 = \overline{1}+0 = 0$	0
0	**1**	**0**	$\overline{(0+1)+(0+0)}+0 = \overline{1}+0 = 0$	**0**
0	**1**	**0**	$\overline{(0+1)+(0+0)}+0 = \overline{1}+0 = 0$	**0**

Partial Truth Table for Logic Expression

Hardware Implementation

Goal: Implement the logic using gates and test outputs using an LED.

Hardware Requirements

S.No	Component
1	Raspberry Pi Pico 2 W / Arduino Uno
2	Breadboard
3	Push Buttons (3x) – A, B, C inputs
4	LED (1x) for output F
5	Resistors (220Ω for LED, 10kΩ for pull-down)
6	Jumper Wires
7	USB Cable

Component List

GPIO Pin Mapping – Pico 2 W

Arduino Uno Pin Mapping

Steps for Implementation

For Pico2W:

1. Connect Pico while holding BOOTSEL.
2. Open Thonny IDE and select MicroPython (Pico).

Component	Pico Pin	Function
Button A	GP14	Input A
Button B	GP15	Input B
Button C	GP16	Input C
LED F	GP13	Output
GND	GND	Ground
3.3V	3.3V	Pull-up Supply

Pico Pin Mapping for F Output Circuit

Component	Arduino Pin	Function
Button A	D2	Input A
Button B	D3	Input B
Button C	D4	Input C
LED F	D5	Output
GND	GND	Ground
5V	VCC	Pull-up Supply

Arduino Pin Mapping

3. Write logic in Python:

$$F = \overline{(A + B) + (A + C)} + C$$

4. Toggle buttons and test LED output.

For Arduino:

1. Open Arduino IDE.
2. Use digitalRead() to read A, B, C.
3. Implement logic for F.
4. Output to digitalWrite(pin, F).
5. Upload and observe result on LED.

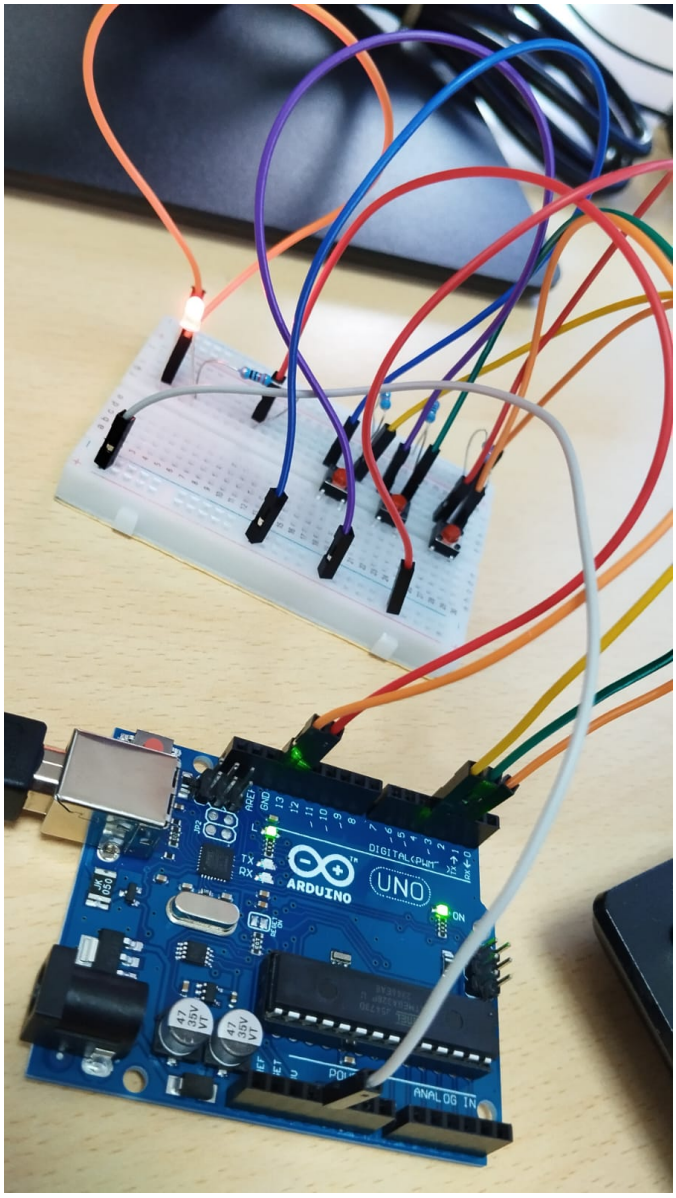
Conclusion

The logic circuit is analyzed and verified with the combination:

$$\boxed{A = 0,\ B = 1,\ C = 0 \Rightarrow F = 1}$$

Implemented using both theoretical truth table and GPIO hardware logic.

GitHub Repo: github.com/aisusmitha/FWC.git



Experiment Setup (Representative)