

AVR-GCC 2009 EC – Question 36 Analysis

Question

Q.36) If $X = 1$ in the logic equation

$F = X + Z(Y' + (Z' + XY'))(X' + Z'(X + Y)) = 1$,
 then determine the correct condition.

- | | |
|--------------|-------------|
| (A) $Y = Z$ | (C) $Z = 1$ |
| (B) $Y = Z'$ | (D) $Z = 0$ |

Answer: (D) $Z = 0$

(GATE EC 2009)

Detailed Question Analysis

- The given Boolean expression is $F = X + Z(Y' + (Z' + XY'))(X' + Z'(X + Y))$.
- The condition given is $X = 1$.
- When $X = 1$, then $X' = 0$.
- Substitute $X = 1$ into the expression.
- The first part becomes $1 + Z(Y' + (Z' + Y'))$.
- Since $1 + A = 1$, the first part reduces to 1.
- The second part becomes $0 + Z'(1 + Y)$.
- Since $1 + Y = 1$, the second part reduces to Z' .
- Therefore, the overall expression simplifies to $F = 1 \cdot Z'$.
- Hence, $F = Z'$.
- For $F = 1$, we must have $Z' = 1$.
- This implies $Z = 0$.
- Therefore, option (D) is correct.

Logic Description

- The Boolean function is implemented using basic logic gates.
- NOT gates generate the complemented variables X' , Y' , and Z' .
- AND gates implement product terms such as XY' and $Z'(X + Y)$.
- OR gates implement summation terms such as $Z' + XY'$ and $X + Y$.
- The two major parts of the expression are combined using an AND gate.
- When $X = 1$, the circuit reduces to $F = Z'$.
- Thus, the output becomes HIGH only when $Z = 0$.

Required Components and Connections

S.No	Component
1	Arduino Uno Board
2	Breadboard
3	Seven Segment Display
4	220Ω Resistor
5	Jumper Wires
6	USB Cable

Segment	Arduino Pin
a	Digital 2
b	Digital 3
c	Digital 4
d	Digital 5
e	Digital 6
f	Digital 7
g	Digital 8
GND	GND
VCC	5V

Code Uploading Steps

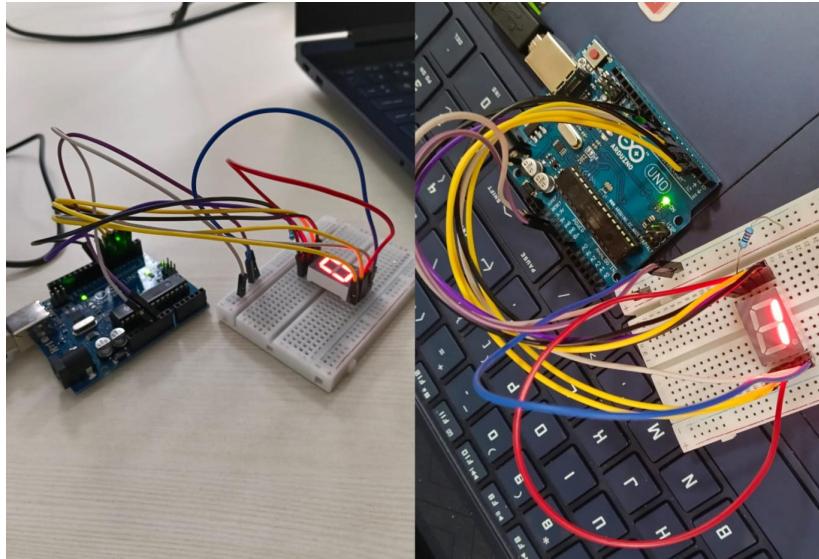
1. Create project folder and write Makefile.
2. Write the program in main.c.
3. Run the command make to generate the .hex file.
4. Copy the .hex file to ArduinoDroid folder.
5. Connect Arduino UNO using OTG cable.
6. Upload the .hex file using upload precompiled option.
7. Observe output and verify logical condition.

Truth Table for F and Z

F	Z
1	0
0	1

Hardware Implementation

- The simplified expression is $F = Z'$.
- When $Z = 0$, the output becomes HIGH.
- When $Z = 1$, the output becomes LOW.
- The hardware results match the theoretical simplification.



Conclusion Summary

- Substituting $X = 1$ simplifies the Boolean expression.
- The expression reduces to $F = Z'$.
- For the output to be equal to 1, the condition $Z = 0$ must hold.
- Both algebraic simplification and hardware verification confirm the result.
- Therefore, option (D) is correct.