Task 2 – Group 28

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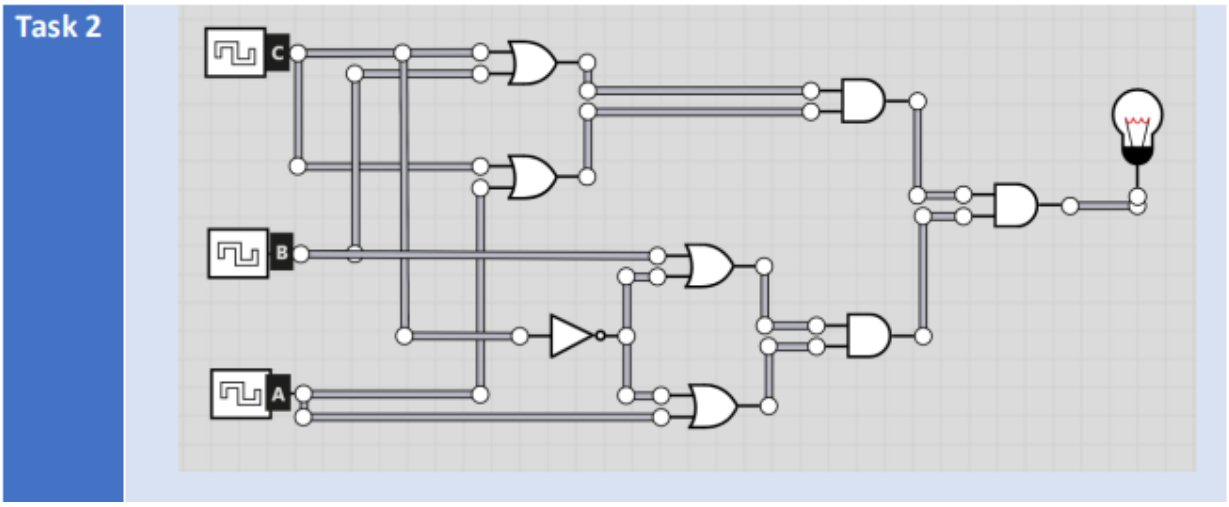
Digital Logic Circuit Simplification

This Project evaluates Boolean expressions to check the equivalence and satisfiability of **two logical circuit expressions**. It generates a **truth table for all possible input combinations of three variables AAA, BBB, and CCC,** and uses logical operations (AND, OR, NOT) to evaluate the expressions.

The program **compares the outputs of an original and a simplified** Boolean expression to check **if they are equivalent**. If the **expressions are not satisfiable** (i.e., they do not yield the same result for any input combination), the program **modifies the simplified expression by switching an AND gate to an OR gate or vice versa**, and **rechecks its satisfiability.**

Analytical Work Done



$[(A \cup \sim C) \cap (B \cup \sim C)] \cap [(C \cup B) \cap (C \cup A)]$

$[(A \cap B) \cup \sim C] \cap [C \cup (A \cap B)]$

Using distributive Property

$[(A \cap B) \cap C] \cup [(A \cap B) \cap (A \cap B)] \cup$
$[\sim C \cap C] \cup [\sim C \cap (A \cap B)]$

simplifies:

$(A \cap B) \cap C \cup (A \cap B) \cup (\sim C \cap (A \cap B))$

$(A \cap B) \cap (C \cup \sim C) \cup (A \cap B)$

$(A \cap B) \cup (A \cap B)$

$A \cap B$ #

Output of the code

```
Enter the Original circuit expression (e.g. ((A|!C)&(B|!C)]&[(C|B)&(C|A)): ((A|!C)&(B|!C)]&[(C|B)&(C|A))
Enter the Simplified circuit expression (e.g. A&B): A&B

Printing truth tables for both expressions:
Original Expression:
Truth Table for Original Expression:
0 0 0 : 0
0 0 1 : 0
0 1 0 : 0
0 1 1 : 0
1 0 0 : 0
1 0 1 : 0
1 1 0 : 1
1 1 1 : 1

Simplified Expression:
Truth Table for Simplified Expression:
0 0 0 : 0
0 0 1 : 0
0 1 0 : 0
0 1 1 : 0
1 0 0 : 0
1 0 1 : 0
1 1 0 : 1
1 1 1 : 1
Expressions are equivalent.

Satisfiable input combinations (A B C):
0 0 0
0 0 1
0 1 0
0 1 1
1 0 0
1 0 1
1 1 0
1 1 1
Expressions are satisfiable.
```

Check on paper the Output of the code

Truth table for original

A	B	C	
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

Truth table for Simplified

A	B	C	
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

So it is Equivalent.

Test another Expression (unsatisfiable)

The original : ((((!(A|!B)) & (A & B)) & C)

The simplified : A | !A

```
Enter the Original circuit expression (e.g. ((A|!C)&(B|!C)]&[(C|B)&(C|A)): ((((!(A|!B)) & (A & B) ) & C)
Enter the Simplified circuit expression (e.g. A&B): A | !A

Printing truth tables for both expressions:
Original Expression:
Truth Table for Original Expression:
0 0 0 : 0
0 0 1 : 0
0 1 0 : 0
0 1 1 : 0
1 0 0 : 0
1 0 1 : 0
1 1 0 : 0
1 1 1 : 0

Simplified Expression:
Truth Table for Simplified Expression:
0 0 0 : 1
0 0 1 : 1
0 1 0 : 1
0 1 1 : 1
1 0 0 : 1
1 0 1 : 1
1 1 0 : 1
1 1 1 : 1
Expressions are not equivalent.

Satisfiable input combinations (A B C):
No satisfiable input combinations found.
Expressions are not satisfiable. Modifying the circuit...
Modified expression: A & !A
```

It Modified the Expression and change one gate (Or to And) : A & !A

```
Printing truth tables for both expressions:
Original Expression:
Truth Table for Original Expression:
0 0 0 : 0
0 0 1 : 0
0 1 0 : 0
0 1 1 : 0
1 0 0 : 0
1 0 1 : 0
1 1 0 : 0
1 1 1 : 0

Simplified Expression:
Truth Table for Simplified Expression:
0 0 0 : 0
0 0 1 : 0
0 1 0 : 0
0 1 1 : 0
1 0 0 : 0
1 0 1 : 0
1 1 0 : 0
1 1 1 : 0
Expressions are equivalent.

Satisfiable input combinations (A B C):
0 0 0
0 0 1
0 1 0
0 1 1
1 0 0
1 0 1
1 1 0
1 1 1
Expressions are now satisfiable after modification.
```