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ECE 582
Project 2 Report
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Problem 1

Task 1

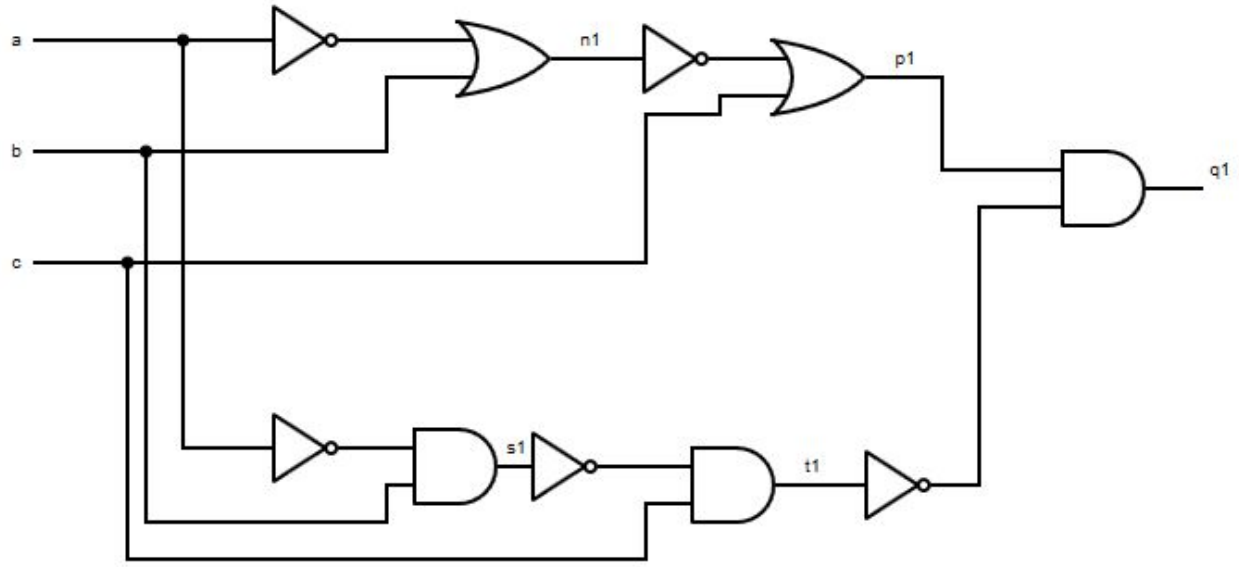

Figure 1: C1 Schematic with 10 Gates

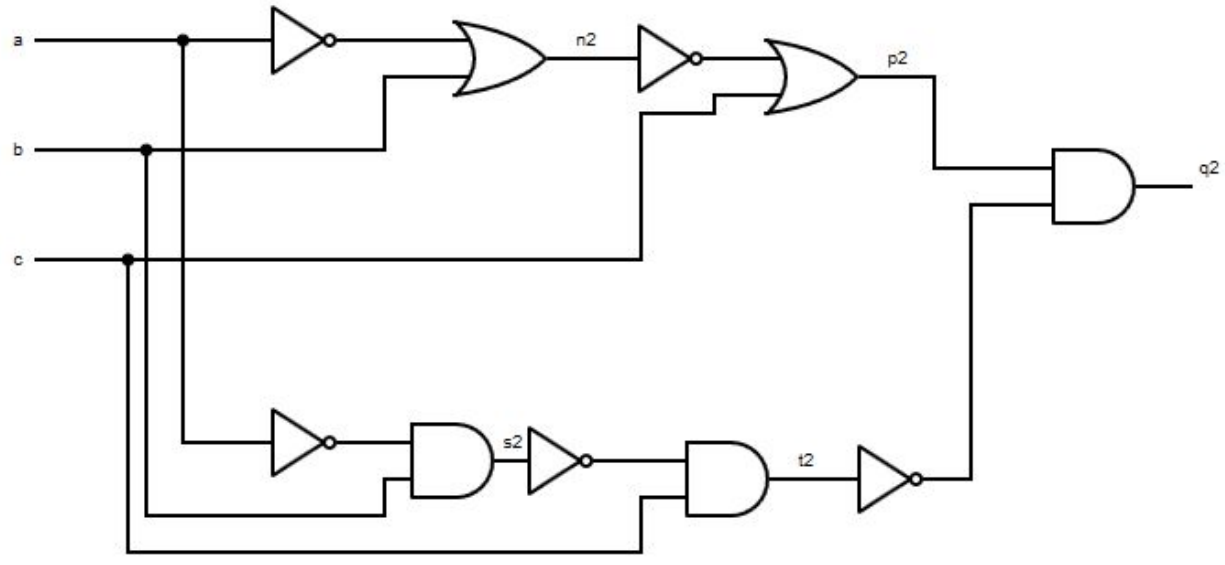

Figure 2: C2 Schematic with 10 Gates

CNF form for both C1 and C2 is shown below

$$\begin{aligned}\text{CNF\_CR(C1)} = {} & (a+n_1)(\overline{b}+n_1)(\overline{a}+b+\overline{n_1}) \\ & (n_1+p_1)(\overline{c}+p_1)(\overline{n_1}+c+\overline{p_1}) \\ & (\overline{a}+\overline{s_1})(b+\overline{s_1})(a+\overline{b}+s_1) \\ & (\overline{s_1}+\overline{t_1})(c+\overline{t_1})(s_1+\overline{c}+t_1) \\ & (p_1+\overline{q_1})(\overline{t_1}+\overline{q_1})(\overline{p_1}+t_1+q_1)\end{aligned}$$

$$\begin{aligned}\text{CNF\_CR(C2)} = {} & (a+n_2)(\overline{b}+n_2)(\overline{a}+b+\overline{n_2}) \\ & (n_2+p_2)(\overline{c}+p_2)(\overline{n_2}+c+\overline{p_2}) \\ & (\overline{a}+\overline{s_2})(b+\overline{s_2})(a+\overline{b}+s_2) \\ & (\overline{s_2}+\overline{t_2})(c+\overline{t_2})(s_2+\overline{c}+t_2) \\ & (p_2+\overline{q_2})(\overline{t_2}+\overline{q_2})(\overline{p_2}+t_2+q_2)\end{aligned}$$

$$\text{CNF}(\overline{(q_1=q_2)}) = (q_1+q_2)(\overline{q_1}+\overline{q_2})$$

Using the SAT solver (http://dai.fmph.uniba.sk/~simko/satsolver/)
The result says unsatisfiable, which means these two circuits are equivalent.

Online SAT Solver

Propositional theory in DIMACS format

```
2 -8 0
1 -2 8 0
-8 -7 0
3 -7 0
8 -3 7 0
5 -6 0
-7 -6 0
-5 7 6 0
1 9 0
-2 9 0
-1 2 -9 0
9 10 0
-3 10 0
-9 3 -10 0
-1 -13 0
2 -13 0
1 -2 13 0
-13 -12 0
```

solve

Answer

unsat

Parsed program

```
1 4
-2 4
-1 2 -4
4 5
-3 5
-4 3 -5
-1 -8
2 -8
1 -2 8
-8 -7
3 -7
8 -3 7
5 -6
-7 -6
-5 7 6
1 9
-2 9
-1 2 -9
9 10
-3 10
-9 3 -10
-1 -13
2 -13
1 -2 13
-13 -12
3 -12
13 -3 12
10 -11
-12 -11
-10 12 11
6 11
-6 -11
```

Figure 3: Results of SAT Solver for C1 and C2

Task 2

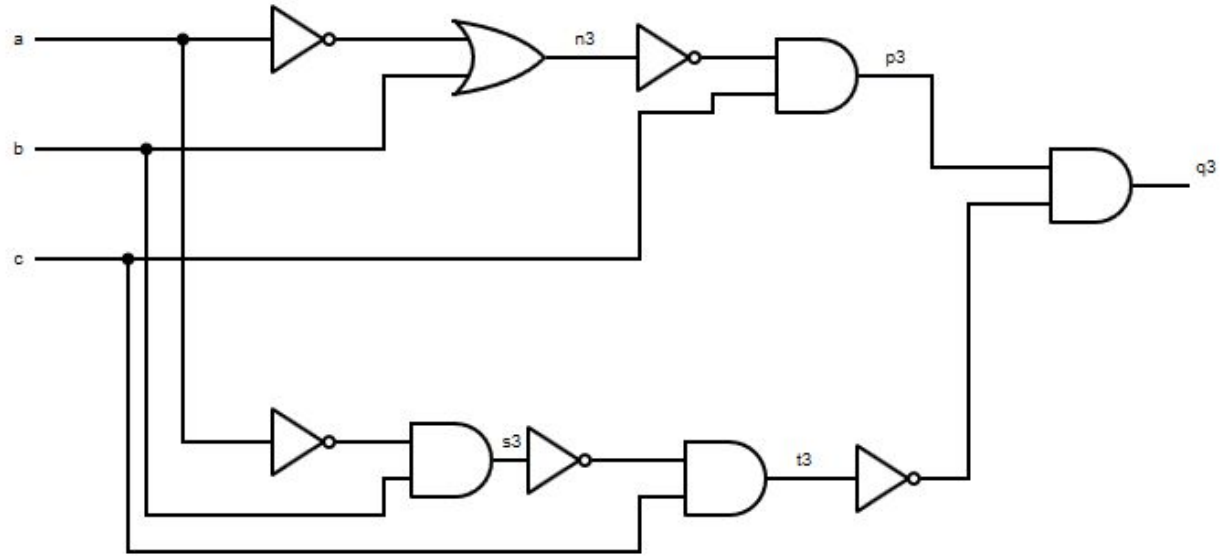

Figure 4: C3 Schematic with an AND Gate Instead of OR

$$\text{CNF\_CR(C3)} = (a + n_3)(\overline{b} + n_3)(\overline{a} + b + \overline{n_3})$$
$$(\overline{n_3} + \overline{p_3})(c + \overline{p_3})(n_3 + \overline{c} + p_3)$$
$$(\overline{a} + \overline{s_3})(b + \overline{s_3})(a + \overline{b} + s_3)$$
$$(\overline{s_3} + \overline{t_3})(c + \overline{t_3})(s_3 + \overline{c} + t_3)$$
$$(p_3 + \overline{q_3})(\overline{t_3} + \overline{q_3})(\overline{p_3} + t_3 + q_3)$$

$$\text{CNF\_CR}(\overline{(q_1 = q_3)}) = (q_1 + q_3)(\overline{q_1} + \overline{q_3})$$

Using the same SAT solver, the result is satisfiable which means these two circuits C1 and C3 are not equivalent.

Online SAT Solver

Propositional theory in DIMACS format

```
-5 7 6 0
1 9 0
-2 9 0
-1 2 -9 0
-9 -10 0
3 -10 0
9 -3 10 0
-1 -13 0
2 -13 0
1 -2 13 0
-13 -12 0
3 -12 0
13 -3 12 0
10 -11 0
-12 -11 0
-10 12 11 0
6 11 0
-6 -11 0
```

solve

Answer

sat

Model

1	-2	-3	-4	5
6	-7	-8	-9	-10
-11	-12	-13		

Parsed program

1 4
-2 4
-1 2 -4
4 5
-3 5
-4 3 -5
-1 -8
2 -8
1 -2 8
-8 -7
3 -7
8 -3 7
5 -6
-7 -6
-5 7 6
1 9
-2 9
-1 2 -9
-9 -10
3 -10
9 -3 10
-1 -13
2 -13
1 -2 13
-13 -12
3 -12
13 -3 12
10 -11
-12 -11
-10 12 11
6 11
-6 -11

Figure 5: Results of SAT Solver for C1 and C3