

BLG 231E - Digital Circuits

Assignment 2

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1. The truth table for a function $y(A, B, C, D)$ is given below:

0	0	0	0	0	0
1	0	0	0	1	1
2	0	0	1	0	0
3	0	0	1	1	1
4	0	1	0	0	0
5	0	1	0	1	1
6	0	1	1	0	0
7	0	1	1	1	0
8	1	0	0	0	0
9	1	0	0	1	1
10	1	0	1	0	1
11	1	0	1	1	0
12	1	1	0	0	1
13	1	1	0	1	0
14	1	1	1	0	1
15	1	1	1	1	1

a. Write the expressions of y in the first and second canonical forms.

1st canonical form of y in SOP ($\Sigma\Pi$) form:

$$y(A,B,C,D)=A'B'C'D + A'B'CD + A'BC'D + AB'C'D + AB'CD' + ABC'D' + ABCD' + ABCD$$

2nd canonical form of y in POS ($\Pi\Sigma$) form:

$$y(A,B,C,D)=(A+B+C+D)(A+B+C'+D)(A+B'+C+D)(A+B'+C'+D)(A+B'+C'+D')(A'+B+C+D)(A'+B+C'+D')(A'+B'+C+D')$$

b. Minimize the expression in the first canonical form using axioms and theorems of Boolean algebra.

Show all steps in your minimization and write the name of the axiom/theorem/property you use on the right-hand side of the expression at each step.

$$= \cancel{A'B'C'D} + \cancel{A'B'CD} + A'BC'D + AB'C'D + AB'CD' + ABC'D' + ABCD' + ABCD // \text{Consensus}$$

$$= \cancel{A'B'C'D} + \cancel{A'B'CD} + A'BC'D + AB'C'D + AB'CD' + ABC'D' + ABCD' + ABCD + \cancel{A'B'D} // \text{Absorption}$$

$$= A'BC'D + AB'C'D + AB'CD' + ABC'D' + \cancel{ABCD'} + \cancel{ABCD} + A'B'D // \text{Consensus}$$

$$= A'BC'D + AB'C'D + AB'CD' + ABC'D' + \cancel{ABCD'} + \cancel{ABCD} + A'B'D + \cancel{ABC} // \text{Absorption}$$

$$= A'BC'D + AB'C'D + AB'CD' + \cancel{ABC'D'} + A'B'D + \cancel{ABC} // \text{Consensus}$$

$$= A'BC'D + AB'C'D + AB'CD' + \cancel{ABC'D'} + A'B'D + ABC + \cancel{ABD'} // \text{Absorption}$$

$$= A'BC'D + AB'C'D + \cancel{AB'CD'} + A'B'D + ABC + \cancel{ABD'} // \text{Consensus}$$

$$= A'BC'D + AB'C'D + \cancel{AB'CD'} + A'B'D + ABC + ABD' + \cancel{ACD'} // \text{Absorption}$$

$$= A'BC'D + \cancel{AB'C'D} + \cancel{A'B'D} + ABC + ABD' + ACD' // \text{Consensus}$$

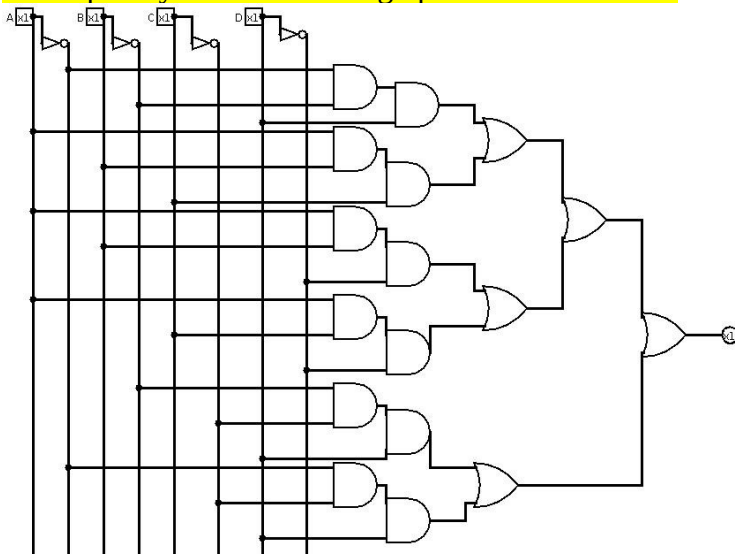
$$= A'BC'D + \cancel{AB'C'D} + A'B'D + ABC + ABD' + ACD' + \cancel{B'C'D} // \text{Absorption}$$

$$= \cancel{A'BC'D} + \cancel{A'B'D} + ABC + ABD' + ACD' + B'C'D // \text{Consensus}$$

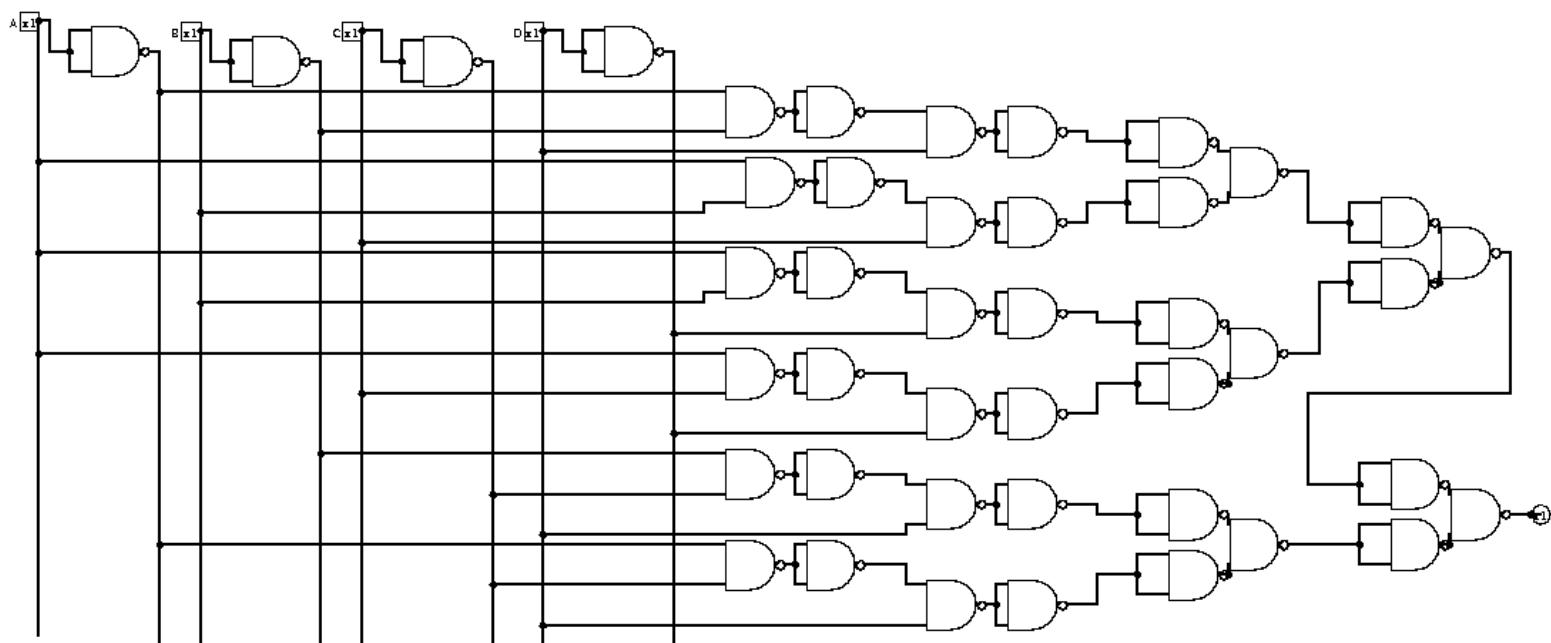
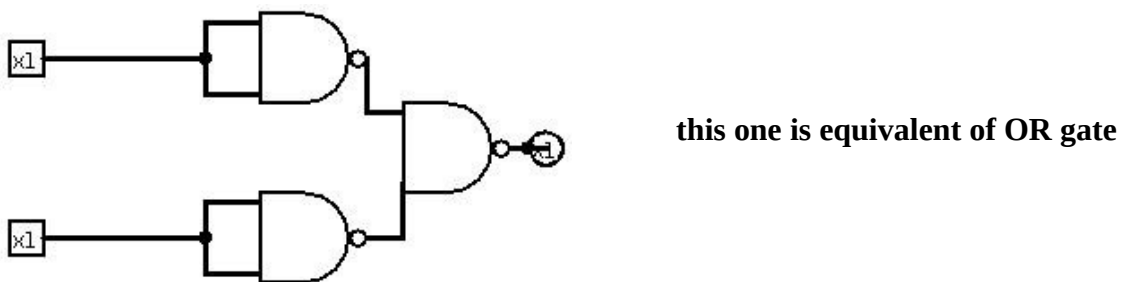
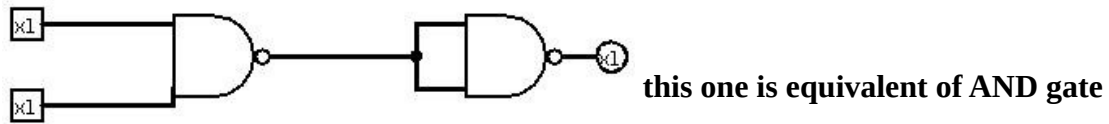
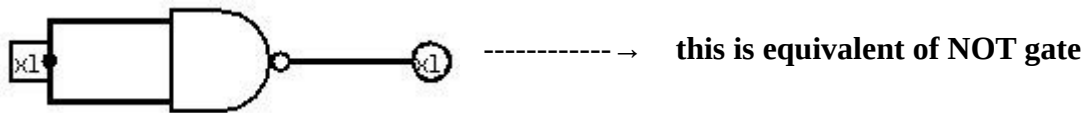
$$= \cancel{A'BC'D} + A'B'D + ABC + ABD' + ACD' + B'C'D + \cancel{A'C'D} // \text{Absorption}$$

$$= A'B'D + ABC + ABD' + ACD' + B'C'D + A'C'D$$

c. Draw the circuit for the minimized expression in (b) using 2-input NAND gates only. Show all steps and explain your work leading up to the final circuit.



This is the circuit for $A'B'D + ABC + ABD' + ACD' + B'C'D + A'C'D$ with using AND, OR and NOT gates. I will convert all of the AND, OR and NOT to NAND gate.



I deleted two not gates which are come after each other, because $(A')' = A$

