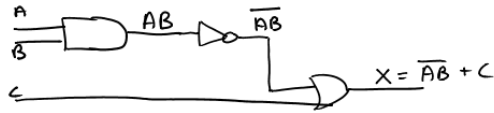


Combinational Logic

- Uses multiple logic gates

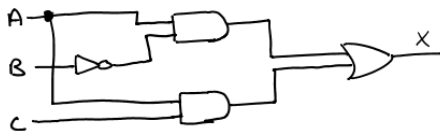


A	B	C	AB	\overline{AB}	$X = \overline{AB} + C$
0	0	0	0	1	1
0	0	1	0	1	1
0	1	0	0	1	1
0	1	1	0	1	1
1	0	0	0	1	1
1	0	1	0	1	1
1	1	0	1	0	0
1	1	1	1	0	1

Start with $\overline{AB} + AC$

A	B	C	\overline{B}	AC	\overline{AB}	$X = \overline{AB} + AC$
0	0	0	1	0	0	0
0	0	1	1	0	0	0
0	1	0	0	0	0	0
0	1	1	0	0	0	0
1	0	0	1	0	1	1
1	0	1	1	1	1	1
1	1	0	0	0	0	0
1	1	1	0	1	0	1

$\overline{AB} + AC$



Boolean Algebra

- Form of algebra for logic gates
- Laws, Rules, and Theorems of Boolean Algebra are found in the textbook

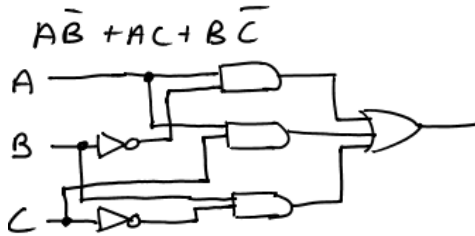
Boolean Simplification

- The goal is to produce a more efficient and simplified circuit
- Order of operations
 - 1.) Parenthesis
 - 2.) NOT
 - 3.) All other logic gates

Standard Forms of Boolean Algebra

Sum of Products (SOP)

- Product (AND) terms added (OR) together



- Logic

- Product Term

= 1, one combination of the inputs

- Sum

To be = 1, any of the product terms is 1

- Expression

For the output to be 1, one of the product terms must be 1.

Binary Representation

- Values of the inputs to produce a 1 for the product term

$A\bar{B}C + AB\bar{C} + \bar{A}\bar{B}\bar{C}$

1 0 1 1 1 0 0 0 0

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

Standard SOP Form

- Every variable is present in each product term

Converting Non-Standard Product Terms to Standard Form

$$X = A\bar{C} + ABC$$

└ B is missing

1.) Using Boolean Algebra

Multiply by the missing variable plus its complement (NOT $(x + \bar{x})$)

$$A\bar{C} \Rightarrow A\bar{C}(B + \bar{B}) = A\bar{C}B + A\bar{C}\bar{B}$$

$$X = A\bar{C}B + A\bar{C}\bar{B} + ABC$$

1 1 0 1 0 0 1 1 1

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

2.) Using the binary representation

- Write down the combinations of the missing variables

$$X = A\bar{C} + ABC$$

A(B) \bar{C}

1 0 0

1 1 0

Determining the Boolean Expression from the Truth Table

- Find the product term from the binary representation

A	B	C	X
0	0	0	0
0	0	1	0
0	1	0	1 $\rightarrow \bar{A}\bar{B}C$
0	1	1	0
1	0	0	1 $\rightarrow A\bar{B}\bar{C}$
1	0	1	1 $\rightarrow A\bar{B}C$
1	1	0	1 $\rightarrow AB\bar{C}$
1	1	1	0

$$X = \bar{A}\bar{B}C + A\bar{B}\bar{C} + A\bar{B}C + AB\bar{C}$$

Not Simplified \Rightarrow Use Boolean Algebra to simplify

$$\bar{A}\bar{B}C + A\bar{B}\bar{C} + A\bar{B}C + AB\bar{C}$$

$$B\bar{C}(\bar{A} + A) + A\bar{B}\bar{C} + AB\bar{C}$$

$$B\bar{C} + A\bar{B}(\bar{C} + C)$$

$$= B\bar{C} + A\bar{B}$$

Product of Sums (POS)

- Sum (OR) terms are multiplied (AND) together

$$(\bar{A} + B)(A + \bar{B} + C)(A + C)$$

Binary Representation of a Sum Term

- Sum Term = 0

$$\begin{array}{ccc} \bar{A} + B & (C) & \\ 1 & 0 & 0 \\ 1 & 0 & 1 \end{array}$$

$$\begin{array}{ccc} A + \bar{B} + C & & \\ 0 & 1 & 0 \end{array}$$

$$\begin{array}{ccc} A + B + C & & \\ 0 & 0 & 0 \\ 0 & 1 & 0 \end{array}$$

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