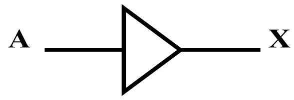
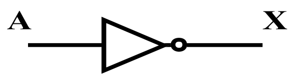
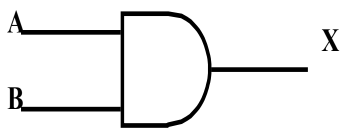
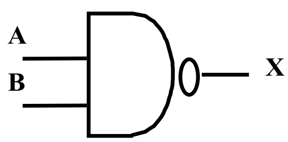
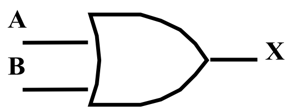
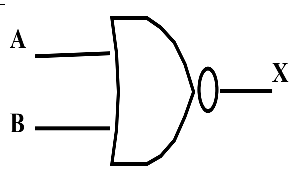
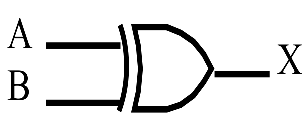
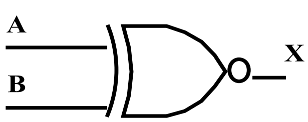
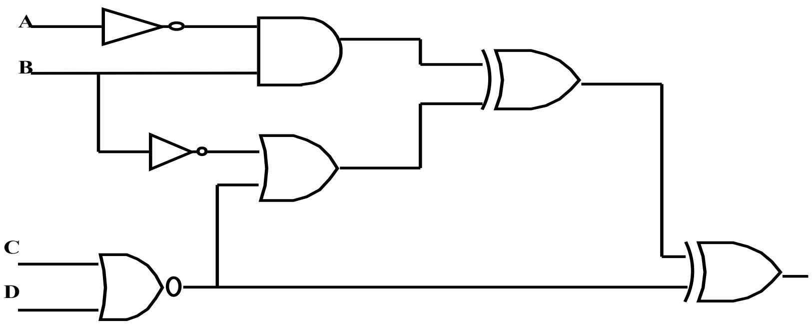
Digital Electronics

See Boolean Algebra for a description of the category as well as references.

NAME	GRAPHICAL SYMBOL	ALGEBRAIC EQN	TRUTH TABLE
BUFFER		$X = A$	A X 0 0 1 1
NOT		$X = \overline{A}$	A X 0 1 1 0
AND		$X = AB \text{ or } A*B$	A B X 0 0 0 0 1 0 1 0 0 1 1 1
NAND		$X = \overline{AB}$ or $\overline{A*B}$	A B X 0 0 1 0 1 1 1 0 1 1 1 0
OR		$X = A+B$	A B X 0 0 0 0 1 1 1 0 1 1 1 1
NOR		$X = \overline{A+B}$	A B X 0 0 1 0 1 0 1 0 0 1 1 0
EXCLUSIVE-OR (XOR)		$X = A \oplus B$	A B X 0 0 0 0 1 1 1 0 1 1 1 0
EQUIVALENCE (XNOR)		$X = \overline{A \oplus B}$	A B X 0 0 1 0 1 0 1 0 0 1 1 1

Sample Problems

Find all ordered 4-tuples (A, B, C, D), which make the following circuit **FALSE**:



The circuit translates to the following Boolean expression:

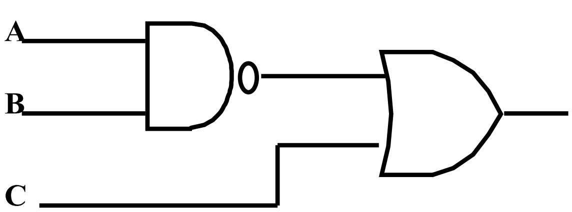
$$(\overline{C+D}+\overline{B})\oplus(\overline{A}B)\oplus(\overline{C+D})$$

The following table has the following headings: H1 is $(\overline{C+D})$, H2 is H1+$\overline{B}$, H3 is $\overline{A}\,B$, H4 is H2⊕H3 and H5 is H4⊕H1, the final expression.

A	**B**	**C**	**D**	**H1**	**H2**	**H3**	**H4**	**H5**
0	0	0	0	1	1	0	1	0
0	0	0	1	0	1	0	1	1
0	0	1	0	0	1	0	1	1
0	0	1	1	0	1	0	1	1
0	1	0	0	1	1	1	0	1
0	1	0	1	0	0	1	1	1
0	1	1	0	0	0	1	1	1
0	1	1	1	0	0	1	1	1
1	0	0	0	1	1	0	1	0
1	0	0	1	0	1	0	1	1
1	0	1	0	0	1	0	1	1
1	0	1	1	0	1	0	1	1
1	1	0	0	1	1	0	1	0
1	1	0	1	0	0	0	0	0
1	1	1	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0

Thus, the 4-tuples (0,0,0,0), (1,0,0,0), (1,1,0,0), (1,1,0,1), (1,1,1,0), and (1,1,1,1) all make the circuit **FALSE**.

Find all ordered triplets (A, B, C) which make the following circuit **FALSE**:



The circuit translates to the following Boolean expression: $\overline{AB}+C$. To find when this is **FALSE** we can equivalently find when the $\overline{\overline{AB}+C}$ is **TRUE**. We can simplify this by applying DeMorgan's Law and cancelling the double *not* over AB to yield $AB\overline{C}$. This is **TRUE** when all three terms are **TRUE**, which happens for (1, 1, 0).