

# Boolean Algebra

Wednesday, 11 October 2023 11:48 AM

Electronic devices have 2 states,  
off | false | low - 0  
on | true | high - 1

## The 3 basic Boolean algebra operators:

AND  
OR  
NOT

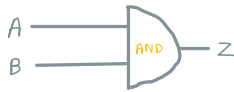
### AND:

The AND operator will take 2 or more inputs, and it will produce 1 output.

If both the inputs are high (1), then the output will be high (1).

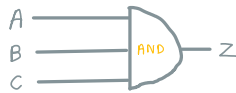
#### AND Truth Table with 2 inputs:

| A | B | Z (A.B) |
|---|---|---------|
| 0 | 0 | 0       |
| 0 | 1 | 0       |
| 1 | 0 | 0       |
| 1 | 1 | 1       |



#### AND Truth Table with 3 inputs:

| A | B | C | Z (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 | 0         |
| 1 | 1 | 1 | 1         |



### OR:

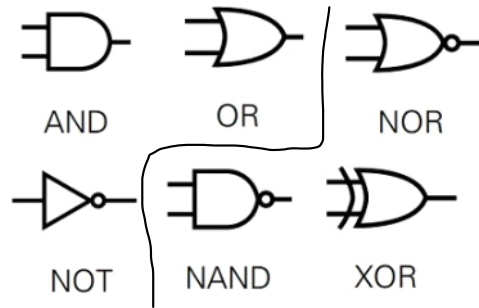
The OR operator takes 2 or more inputs, and produces 1 output.  
If any one of the inputs are high (1), the output will be high (1).

#### OR Truth Table with 2 inputs:

| A | B | Z (A+B) |
|---|---|---------|
| 0 | 0 | 0       |
| 0 | 1 | 1       |
| 1 | 0 | 1       |
| 1 | 1 | 1       |

#### OR Truth Table with 3 inputs:

| A | B | C | Z (A+B+C) |
|---|---|---|-----------|
| 0 | 0 | 0 | 0         |



### Precedence:

There actually isn't an aggregated upon standard except for **NOT > AND > OR** :3

NOT

AND  
NAND

XOR  
OR  
NOR

|   |   |   |   |
|---|---|---|---|
| 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 |

### NOT:

It negates the input.

It takes only 1 input, and outputs its opposite!

A

*NOT truth table - remember, only 1 input!*

| A |   |
|---|---|
| 0 | 1 |
| 1 | 0 |

### NAND:

Not AND! If all the inputs are high (1), the output will be low (0).

*NAND Truth Table with 2 inputs:*

| A | B | NAND |
|---|---|------|
| 0 | 0 | 1    |
| 0 | 1 | 1    |
| 1 | 0 | 1    |
| 1 | 1 | 0    |

*NAND Truth Table with 3 inputs:*

| A | B | C | NAND |
|---|---|---|------|
| 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 | 0    |

### NOR

Not OR!

If all the inputs are low (0), then the output will be high (1).

*NOR Truth Table with 2 inputs:*

| A | B | ? Z (A+B) |
|---|---|-----------|
| 0 | 0 | 1         |

|   |   |   |
|---|---|---|
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 0 |

*NOR Truth Table with 3 inputs:*

| A | B | C | Z (A+B+C) |
|---|---|---|-----------|
| 0 | 0 | 0 | 1         |
| 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         |

## XOR

Exclusive OR!

Needs 2 or more inputs.

It outputs high (1) when there is an odd number of 1s in the input.

*XOR Truth Table with 3 inputs:*

| A | B | C | XOR |
|---|---|---|-----|
| 0 | 0 | 0 | 0   |
| 0 | 0 | 1 | 1   |
| 0 | 1 | 0 | 1   |
| 0 | 1 | 1 | 0   |
| 1 | 0 | 0 | 1   |
| 1 | 0 | 1 | 0   |
| 1 | 1 | 0 | 0   |
| 1 | 1 | 1 | 1   |

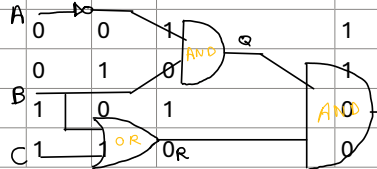
## IB Questions on Truth Tables:

- Construct the truth table for  
**A NAND (B NOR C)**

| A | B | C | B NOR C<br>(you can call this D) | A NAND D |
|---|---|---|----------------------------------|----------|
| 0 | 0 | 0 | 1                                | 1        |
| 0 | 0 | 1 | 0                                | 1        |
| 0 | 1 | 0 | 0                                | 1        |
| 0 | 1 | 1 | 0                                | 1        |
| 1 | 0 | 0 | 1                                | 0        |
| 1 | 0 | 1 | 0                                | 1        |
| 1 | 1 | 0 | 0                                | 1        |
| 1 | 1 | 1 | 0                                | 1        |

2. Construct the truth table for  
(A XOR B) AND NOT C

| A | B | C | NOT C<br>(you can call this D) | A XOR B<br>(E) | E AND D |
|---|---|---|--------------------------------|----------------|---------|
| 0 | 0 | 0 | 1                              | 0              | 0       |
| 0 | 0 | 1 | 0                              | 0              | 0       |
| 0 | 1 | 0 | 1                              | 1              | 1       |
| 0 | 1 | 1 | 0                              | 1              | 0       |
| 1 | 0 | 0 | 1                              | 1              | 1       |
| 1 | 0 | 1 | 0                              | 0              | 0       |
| 1 | 1 | 0 | 1                              | 0              | 0       |
| 1 | 1 | 1 | 0                              | 1              | 0       |

3. 

| A | B | C | NOT A<br>(P) | B OR C<br>(R) | P AND B<br>(Q) | Q AND R<br>(Z) |
|---|---|---|--------------|---------------|----------------|----------------|
| 0 | 0 | 0 | 1            | 0             | 0              | 0              |
| 0 | 0 | 1 | 1            | 1             | 0              | 0              |
| 0 | 1 | 0 | 1            | 1             | 1              | 1              |
| 0 | 1 | 1 | 1            | 1             | 1              | 1              |
| 1 | 0 | 0 | 0            | 0             | 0              | 0              |
| 1 | 0 | 1 | 0            | 1             | 0              | 0              |
| 1 | 1 | 0 | 0            | 1             | 1              | 1              |
| 1 | 1 | 1 | 0            | 1             | 1              | 1              |

4. 