Maths for IT

5N18396

WHAT YOU WILL KNOW:

- Truth tables & Logic gates
  - AND
  - OR
  - NOT
  - NAND
  - NOR
  - XOR
- De Morgan's Laws (Logical equivalences)
- https://en.wikipedia.org/wiki/De_Morgan%27s_laws#Set_theory_and_Boolean_algebra

BOOLEAN LOGIC

- Computers use Boolean Algebra to solve problems and perform tasks
- It is a simple system of Inputs and Outputs
- Inputs and Outputs are either ON (1) or OFF (0)
- In computers each Input or Output is a *bit* (Binary digit)
- Binary is a base 2 counting system made up of 1s and 0s (we will see this later in the course)
- Boolean logic can be explained with two ideas:
  - You start off with the idea that some statement, P, is either true or false, it can't be anything in between (this called the law of the excluded middle)
  - Then you can form other statements, which are true or false, by combining these initial statements together using the fundamental operators AND, OR and NOT

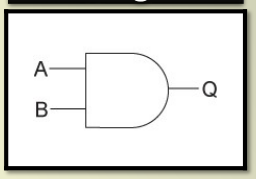
LOGIC GATES AND TRUTH TABLES

- Different logic gates affect the outputs based on the inputs
- We use truth tables to write down all the possible inputs and corresponding outputs

- We will look at AND, OR, NOT, NAND, NOR and XOR gates

LOGIC GATES AND TRUTH TABLES

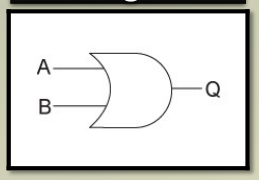
AND gate



A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

AND gates give an Output of ON only if all the Inputs are ON. Otherwise it is OFF

OR gate

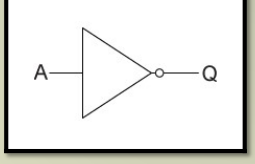


A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1

OR gates give an Output of ON if either or both Inputs are ON. Otherwise it is OFF

LOGIC GATES AND TRUTH TABLES

NOT gate

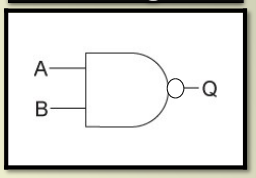


A	Q
0	1
1	0

NOT gates invert the Input

LOGIC GATES AND TRUTH TABLES

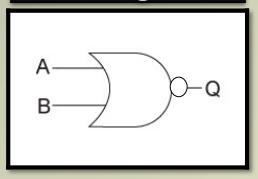
NAND gate



A	B	Q
0	0	1
0	1	1
1	0	1
1	1	0

NAND gates give an Output of OFF only if all the Inputs are ON. Otherwise it is ON

NOR gate

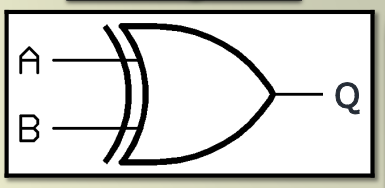


A	B	Q
0	0	1
0	1	0
1	0	0
1	1	0

NOR gates give an Output of OFF if either or both Inputs are ON. Otherwise it is ON

LOGIC GATES AND TRUTH TABLES

XOR gate



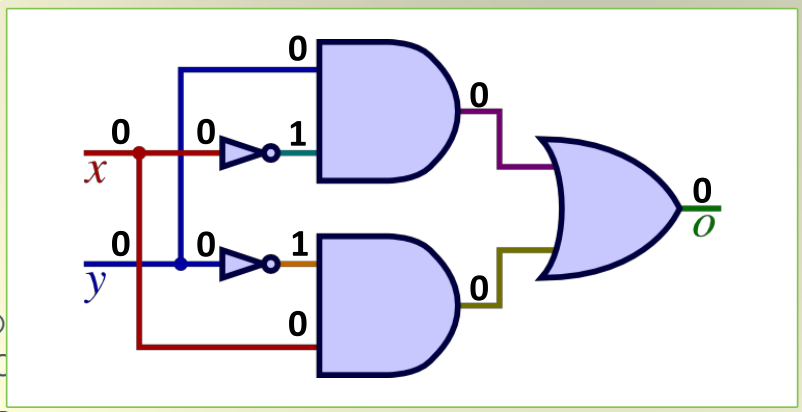
A	B	Q
0	0	0
0	1	1
1	0	1
1	1	0

If you were asked "*do you want tea or coffee?*" you wouldn't usually answer: both

XOR gates (exclusive OR) give an Output of ON only if one of the two inputs are on. If both are ON or both are OFF the output is OFF

LOGIC GATES AND TRUTH TABLES - EXAMPLE

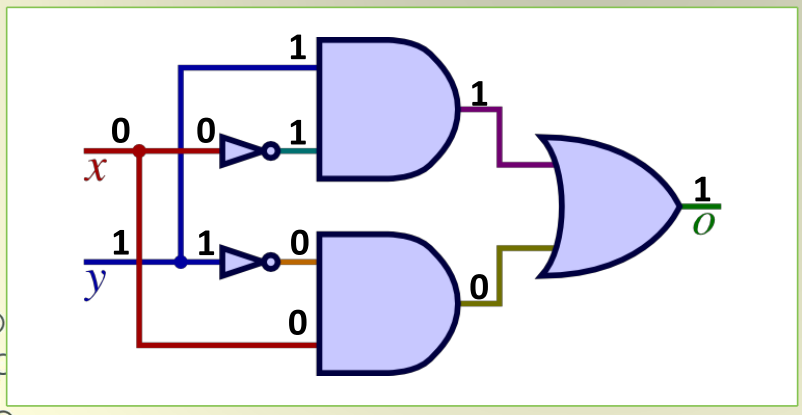
Write out a truth table for the following circuit



A	B	Q
0	0	0

LOGIC GATES AND TRUTH TABLES - EXAMPLE

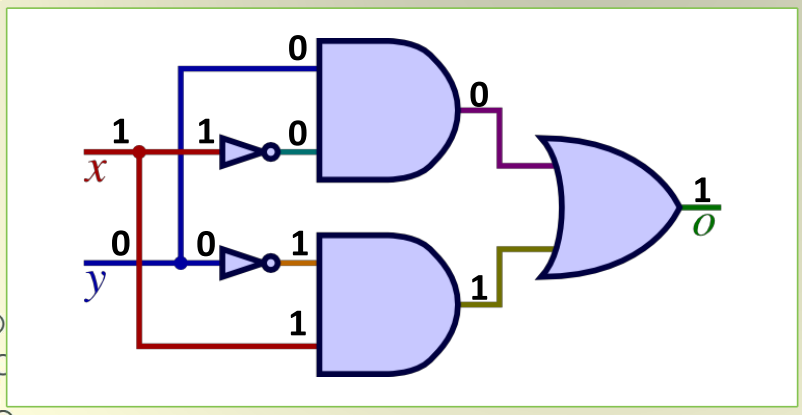
Write out a truth table for the following circuit



A	B	Q
0	0	0
0	1	1

LOGIC GATES AND TRUTH TABLES - EXAMPLE

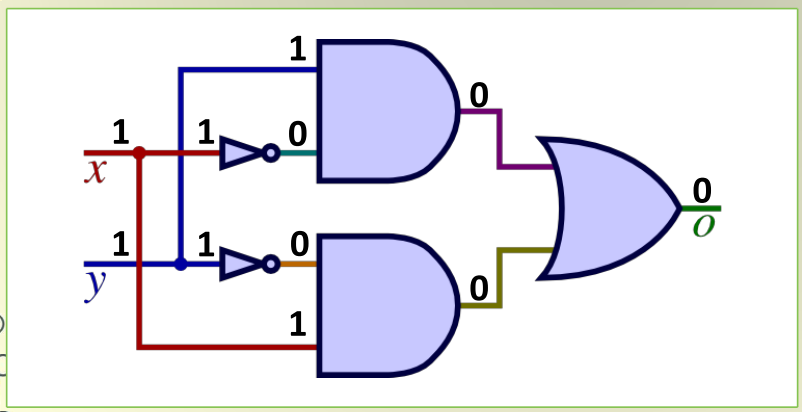
Write out a truth table for the following circuit



A	B	Q
0	0	0
0	1	1
1	0	1

LOGIC GATES AND TRUTH TABLES - EXAMPLE

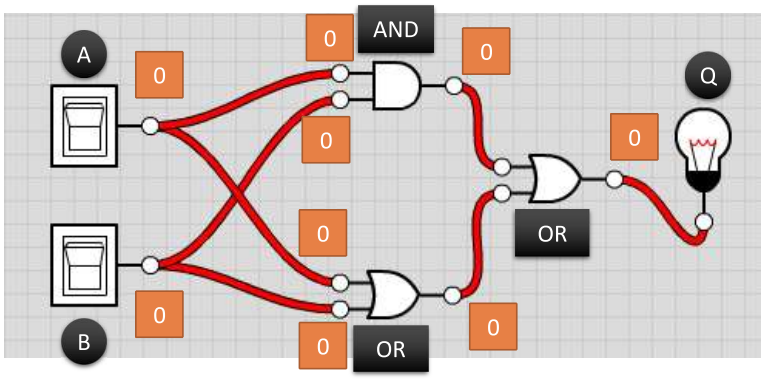
Write out a truth table for the following circuit



A	B	Q
0	0	0
0	1	1
1	0	1
1	1	0

LOGIC GATES AND TRUTH TABLES - EXAMPLE

Write out a truth table for the following circuit

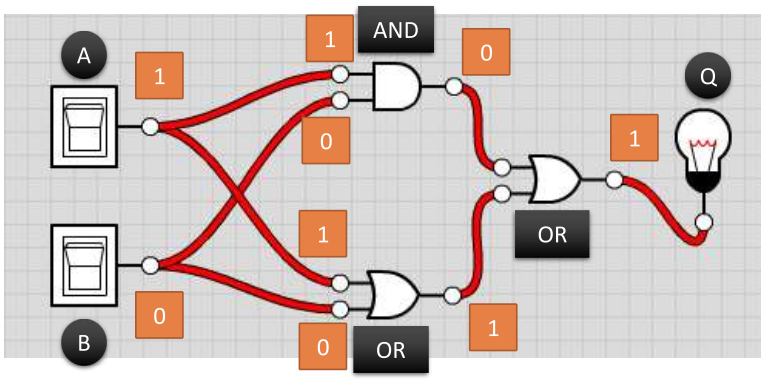


A	B	Q
0	0	0

http://logic.ly/demo/

LOGIC GATES AND TRUTH TABLES - EXAMPLE

Write out a truth table for the following circuit

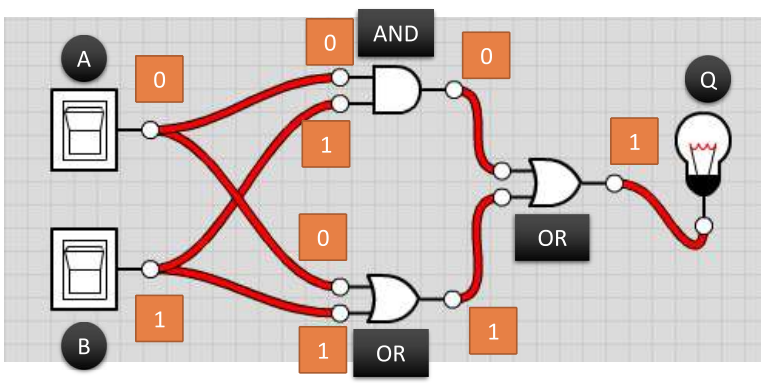


A	B	Q
0	0	0
1	0	1

http://logic.ly/demo/

LOGIC GATES AND TRUTH TABLES - EXAMPLE

Write out a truth table for the following circuit

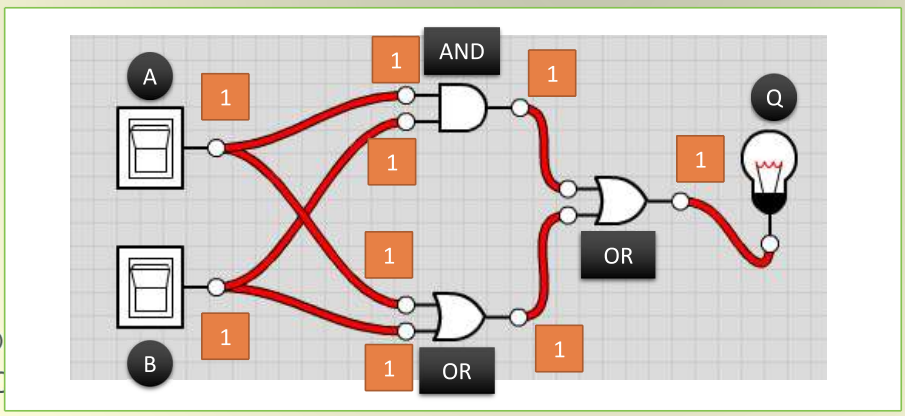


A	B	Q
0	0	0
1	0	1
0	1	1

http://logic.ly/demo/

LOGIC GATES AND TRUTH TABLES - EXAMPLE

Write out a truth table for the following circuit

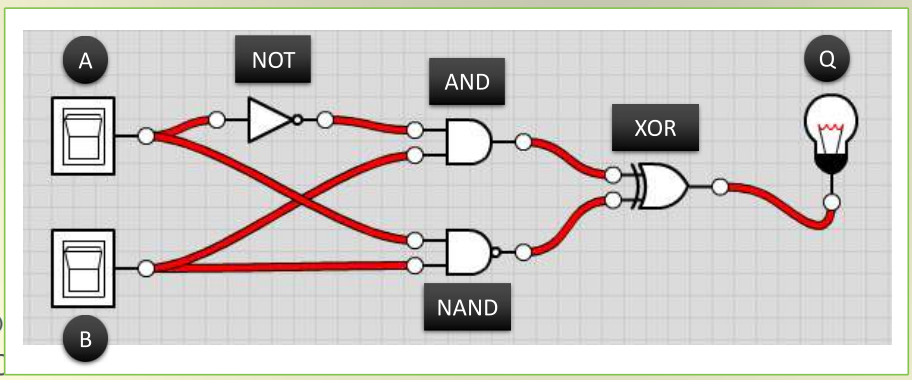


A	B	Q
0	0	0
1	0	1
0	1	1
1	1	1

http://logic.ly/demo/

LOGIC GATES AND TRUTH TABLES – TRY THIS YOURSELF

Write out a truth table for the following circuit



A	B	Q
0	0	1
1	0	1
0	1	0
1	1	0

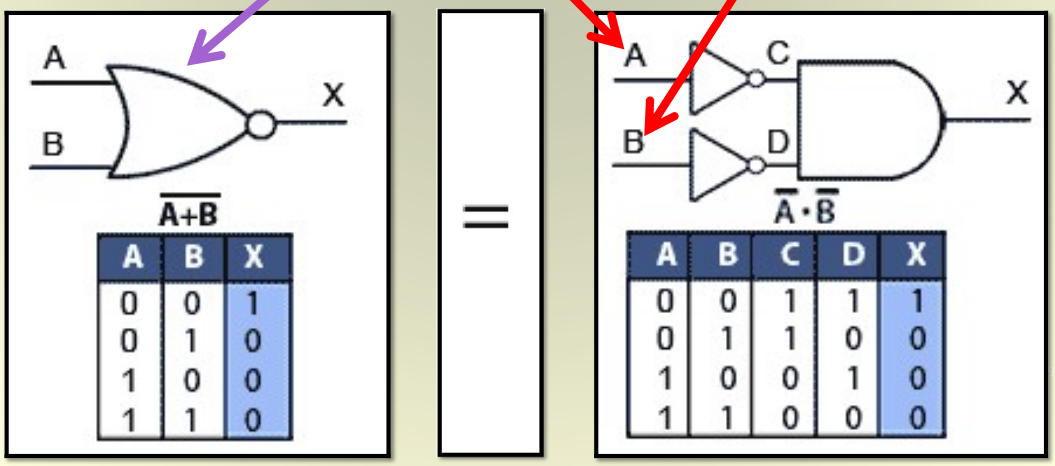
LOGIC GATES AND TRUTH TABLES

- Logical Equivalences – De Morgan's Laws
  - We saw De Morgan's laws in Sets but they apply in Boolean logic also

- $NOT(A\ AND\ B) \equiv NOT(A)\ OR\ NOT(B)$
- $NOT(A\ OR\ B) \equiv NOT(A)\ AND\ NOT(B)$

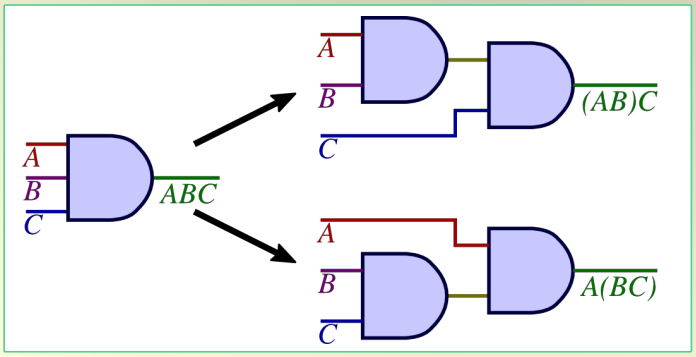
LOGIC GATES AND TRUTH TABLES

$$NOT(A\ OR\ B) \equiv NOT(A)\ AND\ NOT(B)$$



WHAT ABOUT MORE THAN 2 INPUTS?

- In circuitry AND and OR gates (and NAND, NOR, XOR) can only take 2 inputs
- However, we can represent a gate that takes 3 inputs using a combination of 2 input gates



A	B	AB
0	0	0
0	0	0
0	1	0
0	1	0
1	0	0
1	0	0
1	1	1
1	1	1

AB	C	Q
0	0	0
0	1	0
0	1	0
0	0	0
0	0	0
0	1	0
1	0	0
1	1	1

WHAT ABOUT MORE THAN 2 INPUTS?

- Check that the following two circuits are equivalent by writing out their truth tables