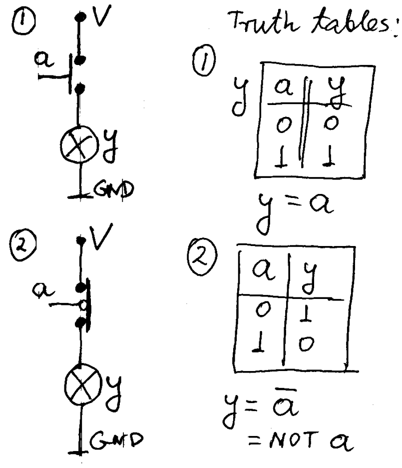
# 1 Introductory concepts

## 1.1 Switches. NOT operation

At the beginning there was THE SWITCH

- Switches come in two versions: “normally open” (1) (open when in-active) and “normally closed” (2) (closed when in-active)
- When a switch, say $a$, is in its neutral position, we say that $a = 0$. When a switch is activated, we say that $a = 1$,
- **V** indicates a supply voltage (one end of battery). **GND** indicates the ground terminal (the other end of a battery). The crossed circle symbolizes a bulb.
- The symbols $\{0, 1\}$ will be synonymously used with words like { off, on }, { false, true }, { low, high }, etc.
- If we consider $a$ as an **input variable** (argument), and $y$ as an **output variable** (function value) then




the first circuit (1) performs the **identity operation** (function) $y = a$
and the second circuit (2) performs the **NOT operation** (function) $y = \bar{a} =$ NOT $a = a'$
also known as the **complement** or the inversion operation





## 1.2 Parallel connection of switches

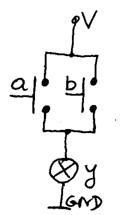
- Two switches can be connected in parallel:
- The operation performed by the circuit can be described by the following logical expression

$$\textbf{if } a = 1 \textbf{ or } b = 1 \textbf{ then } y = 1 \textbf{ else } y = 0$$

- Alternatively, the operation can be described by the following **truth table**:
- Formally we can say that if we have **two binary variables** $a, b \in \{0, 1\}$ and the operation performed can be symbolically described as

$$y = f(a, b) = a \textbf{ or } b = a + b$$

- Hence we say that the circuit performs the **or** operation, also known as a **logic sum** operation




| b | a | y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

### 1.3 Serial connection of switches

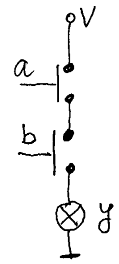
- Two switches can be connected serially:
- The operation performed by the circuit can be described by the following logical expression

$$\textbf{if } a = 1 \textbf{ and } b = 1 \textbf{ then } y = 1 \textbf{ else } y = 0$$

- Alternatively, the operation can be described by the following **truth table**:
- Formally we can say that if we have **two binary variables** $a, b \in \{0, 1\}$ and the operation performed can be symbolically described as

$$y = f(a, b) = a \textbf{ and } b = a \cdot b$$

- Hence we say that the circuit performs the **and** operation, also known as a **logic multiplication** operation




| a | b | y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |





### 1.4 Exercise

- Consider serial-parallel connections of **three** switches, $a, b, c$
- Draw related **circuit diagrams** and **truth tables**.
- Describe circuits by relevant logic expressions **if** ...