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 \( \{ \text{off, on} \} \), \( \{ \text{false, true} \} \), \( \{ \text{low, high} \} \), 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) \( y = \overline{a} = \text{NOT } a = a' \) also known as the complement or the inversion operation

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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

\[
\text{if } a = 1 \text{ or } b = 1 \text{ then } y = 1 \text{ else } y = 0
\]

- 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

\[ y = f(a, b) = a \text{ or } b = a + b \]

- Hence we say that the circuit performs the or operation, also known as a logic sum operation
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:
  
  \[
  \text{if } a = 1 \text{ and } b = 1 \text{ then } y = 1 \text{ else } y = 0
  \]

- 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:

  \[
  y = f(a, b) = a \text{ and } b = a \cdot b
  \]

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

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 . . .