5 Physical Computing

This chapter will cover the following:

- Basic logic gates
- Use of software to identify a logic function
- Constructing simple circuits using logic gates
- Showing the functions of logic gates by using them practically

5.1 Basic logic gates

There are three basic logic gates as AND, OR and NOT.

AND Gate

Let us consider the following analogy to understand function of the AND gate.

The following diagram of a water tank in a house is to fill water without overflowing. Two valves are used to prevent water waste.

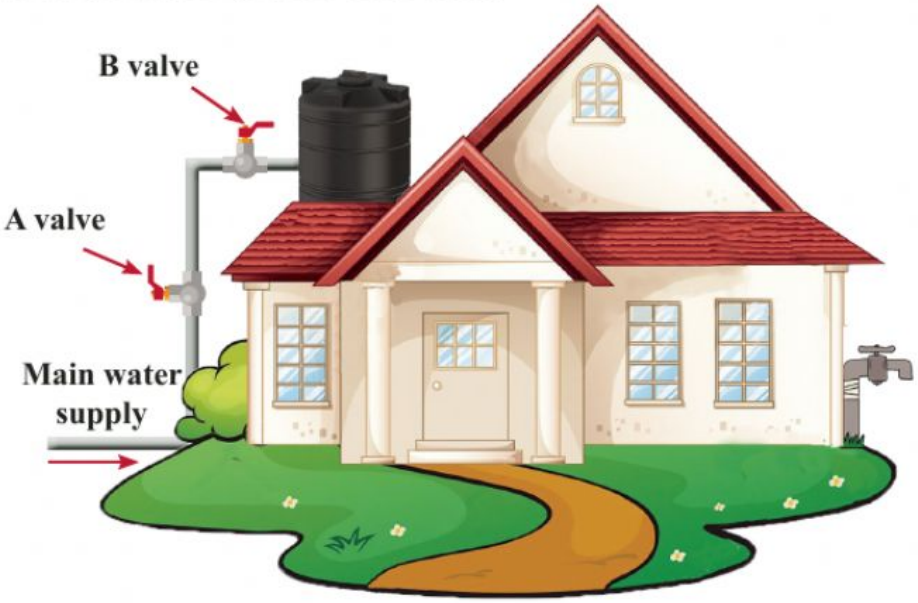


Figure 5.1 : Analogy for AND gate

The following table shows whether the tank receives water or not from the main supply based on whether the A and B valves are closed or open. (Table 5.1)

Table 5.1 : Water supply by valves A and B

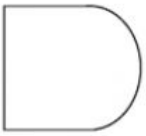
A valve	B valve	Water supply to tank
Closed	Closed	does not receive water
Closed	Open	does not receive water
Open	Closed	does not receive water
Open	Open	receives water

The following table using 1 for 'open' state, 0 for 'closed' state, and 1 for 'receives' state and 0 for 'does not receive' state (See Table 5.2).

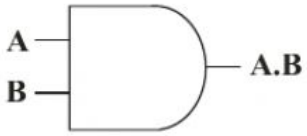
Table 5.2 : Indicating water supply by 0 and 1

A valve	B valve	Water supply to tank
0	0	0
0	1	0
1	0	0
1	1	1

The table above indicates whether the valves supply water or not. Similarly, the AND gate decides whether an electric signal is present or not. Availability of an electric signal is shown by state "1" and the unavailability is by state "0".



The standard symbol for AND Gate



When A and B are inputs

Inputs of a Gate is shown in capital letters. The output of AND gate is denoted by A.B when inputs are A and B.

The following truth table shows the function of the AND gate.

Input		Output
A	B	A.B
0	0	0
0	1	0
1	0	0
1	1	1

In order to obtain the output 1, both inputs should be 1 in an AND gate.

OR Gate

Let us consider the following analogy to understand the function of the OR gate. As shown in the illustration below, the house has a water tank in addition to the regular main water supply. The tank is to ensure uninterrupted water supply. There are two valves A and B. (See Figure 5.2)

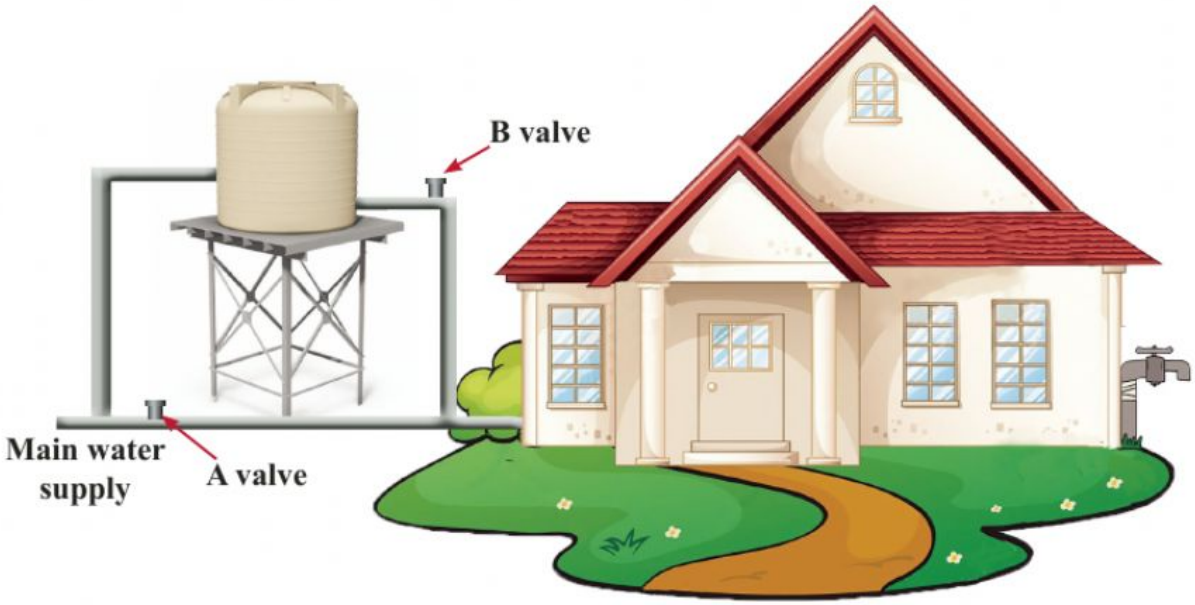


Figure 5.2 : An analogy for OR gate

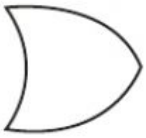
The following table shows if the house receives water or not based on whether A and B gates are open or closed.

A valve	B valve	Water supply to house
Closed	Closed	does not receive water
Closed	Open	receives water
Open	Closed	receives water
Open	Open	receives water

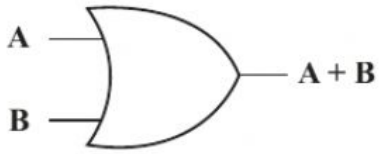
When the above table is replaced with value 1 for " open" state, 0 for closed state, 1 for receives state and '0' for "does not receive" state;

A valve	B valve	Water supply to house
0	0	0
0	1	1
1	0	1
1	1	1

The valves used in the above water tank control the supply of water to the house. Similarly OR gate controls the availability and unavailability of electric signal in a circuit. The availability of an electric signal is shown by '1' state whereas '0' state indicates the unavailability.



The standard symbol of the OR Gate



When A and B are inputs

The illustration above shows OR Gate as it appears on circuits. When A and B are inputs, output of OR gate is A+B. Truth table related to OR Gate is as follows;

A	B	A+B
0	0	0
0	1	1
1	0	1
1	1	1

Output of OR Gate is state '1' when at least one input is in '1' state.

NOT Gate

Let us consider the following analogy to understand the function of NOT gate. It shows a street with street lamps that are switched off during day time and switched on at night.

Figure 5.3 : Lighting street lamps automatically

Sunlight	Electric lamp
available	OFF
unavailable	ON

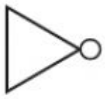
Consider state '1' as there is day light and state '0' as there is no day light. Street lamp's OFF state as 0, and 'ON' state on as 1.

Sunlight	Electric lamp
1	0
0	1

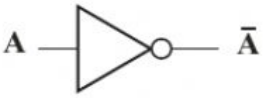
The output of the NOT gate is the opposite of its input.

Input	Output
receives day light	bulb OFF
receives no day light	bulb ON

The symbol of NOT gate is as follows;



Standard Symbol of NOT gate



When A is its input

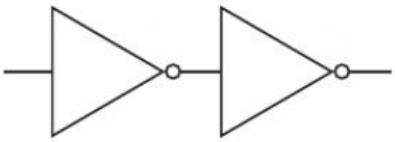
The above illustration shows a NOT gate in an electric circuit with A as input and $\overline{A}$ as output. The equivalent truth table is as follows;

A	$\overline{A}$
1	0
0	1

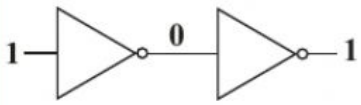
A particular voltage is shown by state1 and another voltage is shown by state '0'.

Connecting logic gates in circuits

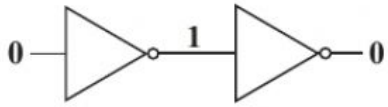
e.g.1 - Obtaining output from the circuit below where input is 1 or 0.



When input is 1

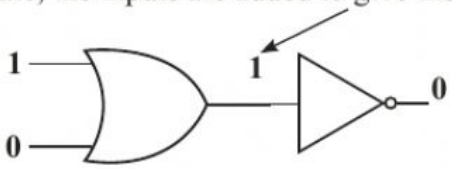


When input is 0



e.g. 2 - Obtaining the relevant output according to the input given.

In OR gate, the inputs are added to give the output (1 + 0 = 1)



Refer to workbook for Activities 5.1, 5.2, 5.3 and 5.4