3.4.2 Boolean logic 3

Lesson plan and printable activities

Materials needed

1. 3.4.2 (Lesson 3) Lesson PowerPoint.
2. Logic gate exercises (Quiz 1, Quiz 2).
3. Mini whiteboards and pens.

Lesson aims

1. To get students to think about how to identify relationships between connected logic gates and to make informed guesses as to the construction of simple combinatorial logic circuits using truth tables as the input.

Lesson objectives

1. Interpret the results of simple truth tables.
2. Create, modify and interpret simple logic circuit diagrams.

Starter activity (5 minutes)

1. This activity should use Quiz 1 which has questions based on Lesson 1 of the series. Use the opportunity to make sure that students can identify the 'common' logic gates **AND**, **OR** and **NOT**.

Main activities (25 minutes)

1. Explain that having covered two earlier topics ie creating simple truth tables for commonly recognised logic gates and also creating truth tables for more complex circuits, we are now going to make the process slightly harder by asking students to think about how to create a circuit from a given truth table.
2. We will be restricting our study to looking at circuits having a maximum of three initial inputs eg, **A**, **B** and **C**.
3. Go through the main presentation provided.
4. Give the students Quiz 2 to complete.

Plenary activity (10 minutes)

1. Distribute mini whiteboards and pens and pair up the students. Get one to specify two logic gates in combination eg AND followed by NOT, NOT and AND combined into OR.

2. Get students to draw the circuit diagrams when two identical gates are combined. Can they devise the truth tables? Is the output as expected?

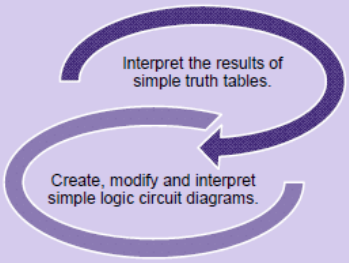
Lesson

3.4 Computer systems

3.4.2 Boolean logic

Lesson 3

Objective



Starter activity

Try Quiz 1.

Introduction

The best way to create a diagram from a truth table using combined gates is to do the following:

1. Identify the possible number of inputs e.g. 1,2,3 etc
2. Identify the relationship between the first identified gates and inputs allowing which allows you to establish the type of logic gates are being used at the left-hand side of the diagram.

We will now look at how to identify a simple circuit using a truth table.

Worked example 1

For our first step, we have only the truth table to provide us with information about the states of the inputs and output.

What do you notice about this truth table?

- *Look at the number of inputs and outputs.*
- *Look at what happens to the TRUE and FALSE values.*

Truth table				
Inputs				Output
A	B	F		Q
0	0	0		1
0	1	1		0
1	0	1		0
1	1	1		0

Worked example 2

How many inputs?

Because there are **four** total combinations of input, we can deduce that there are probably two possible initial inputs (because $2^2 = 4$).

Draw two inputs **A** and **B**:

A ●—
B ●—

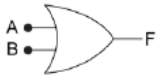
Truth table				
Inputs				Output
A	B	F		Q
0	0	0		1
0	1	1		0
1	0	1		0
1	1	1		0

Worked example 3

What gate?

If we look at inputs A and B, we can see that the output F corresponds to that of an OR gate.

Draw the gate with an output of F



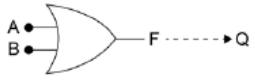
Truth table			
Inputs			Output
A	B	F	Q
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

Worked example 4

F to Q?

Finally, we have one output left for which there are two clues …

- one 'input' F to one output Q
- Q is inverse of F



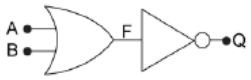
Truth table			
Inputs			Output
A	B	F	Q
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

Worked example 5

Completed circuit?

From previous deduction, we have an OR gate feeding into a NOT gate!

If we draw out the above circuit then it fits the truth table's logic state listing perfectly.



Truth table			
Inputs			Output
A	B	F	Q
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

Over to you…

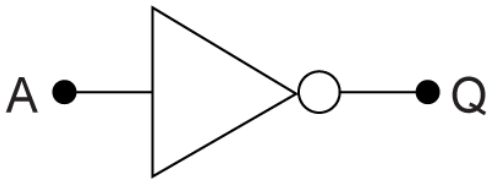
Try Quiz 2.

Quiz 1 – Recap on logic gates principles

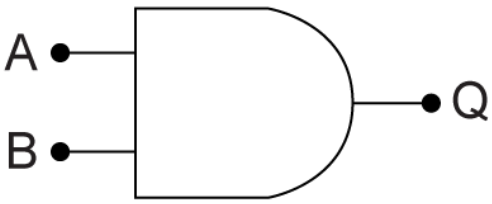
Question 1

Draw arrows identifying the three correct matches below.

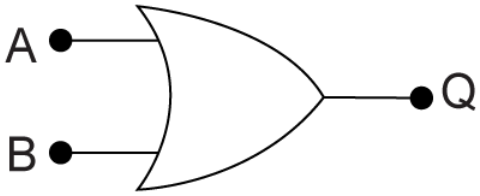
[2 Marks]



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



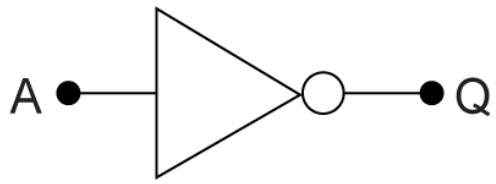
A	Q
0	1
1	0

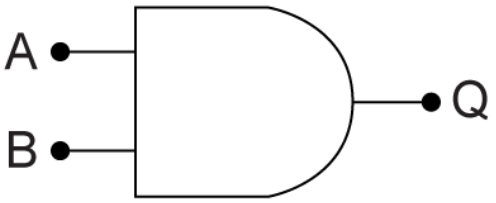


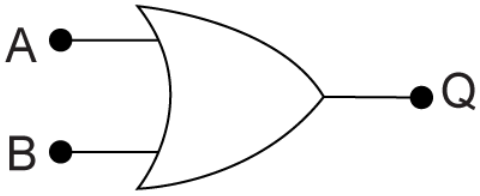
A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

Quiz 1 – Recap on logic gates principles – answers

Question 1
Draw arrows identifying the three correct matches below. **[2 Marks]**







OR		
A	**B**	**Q**
0	0	0
0	1	1
1	0	1
1	1	1

NOT	
A	**Q**
0	1
1	0

AND		
A	**B**	**Q**
0	0	0
0	1	0
1	0	0
1	1	1

Quiz 2 – Create logic gate circuits using truth tables

Question 1	Answer
Create a possible logic gate circuit that matches the following truth table. **Inputs** | **Output /input** | **Output** **A** | **B** | **F** | **Q** 0 | 0 | 0 | 1 0 | 1 | 1 | 0 1 | 0 | 1 | 0 1 | 1 | 1 | 0	**[3 Marks]**

Question 2	Answer
Create a possible logic gate circuit that matches the following truth table. **Inputs** | **Outputs/ inputs** | **Output** **A** | **B** | **C** | **E** | **F** | **Q** 0 | 0 | 0 | 1 | 0 | 1 0 | 0 | 1 | 1 | 0 | 1 0 | 1 | 0 | 1 | 0 | 1 0 | 1 | 1 | 1 | 1 | 1 1 | 0 | 0 | 0 | 0 | 0 1 | 0 | 1 | 0 | 0 | 0 1 | 1 | 0 | 0 | 0 | 0 1 | 1 | 1 | 0 | 1 | 1	**[6 Marks]**

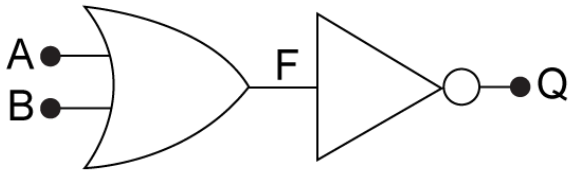
Quiz 2 – Create logic gate circuits using truth tables – answers

Question 1

Create a possible logic gate circuit that matches the following truth table.

Inputs		Output /input	Output
A	**B**	**F**	**Q**
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

Answer



OR gate follows **A / B** correct **[1 Mark]**

NOT gate following **F** correct **[1 Mark]**

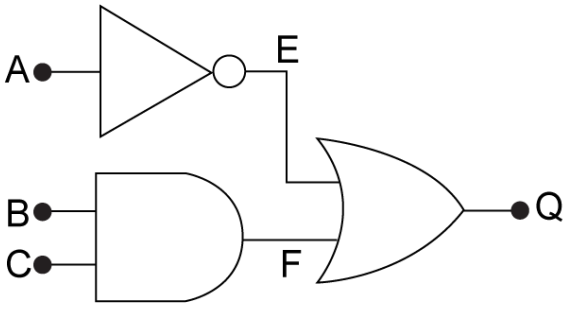
Correct position for **Q [1 Mark]**

Question 2

Create a possible logic gate circuit that matches the following truth table.

Inputs			Outputs/ inputs		Output
A	**B**	**C**	**E**	**F**	**Q**
0	0	0	1	0	1
0	0	1	1	0	1
0	1	0	1	0	1
0	1	1	1	1	1
1	0	0	0	0	0
1	0	1	0	0	0
1	1	0	0	0	0
1	1	1	0	1	1

Answer



NOT gate follows **A** correct **[1 Mark]**

AND gate follows **B / C** correct **[1 Mark]**

OR gate follows **E / F** correct **[1 Mark]**

Correct position for **E [1 Mark]**

Correct position for **F [1 Mark]**

Correct position for **Q [1 Mark]**