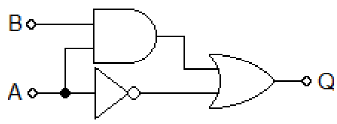
Overview

In this unit your students should:

- meet the use of truth tables to analyse the behaviour of logic systems
- learn to use Boolean algebra to represent truth tables of logic gates and systems
- learn to use simple rules to simplify Boolean algebra expressions
- understand how to use basic gates to design systems which obey a given expression

This should not require more than 4 hours of class time.

Hour	Suggested Activity
1	You could start by testing their knowledge of the six basic logic gate symbols and truth tables. Work through a simple example of working out the behaviour of a combination of logic gates with a truth table. You could use this system.  Set them to do the **NOT-AND-OR circuits** practical. This should give them some practice in working out truth tables of combinations of logic gates. Ask them to study **4.1** of the text book before the next session.
2	Get them to work through page 1 of the **Truth Tables** exercises. They will probably need to consult **4.1** of the text book. Work through an example of eliminating brackets and using basic rules for simplifying. You could show how the expression $Q = A.(\overline{A} + B) + B$ reduces to Q = B. Get them to work through page 2 of the **Truth Tables** exercises. Encourage them to work out the answers together, as the discussion will help to reinforce their understanding. Ask them to answer question 3 on page 64 of the text book before the next session.
3	Launch them straight into the **Logic system design** practical. They should already have the switches, LEDs and resistors on their breadboard. Not all of the students will finish the second task in the time available. Ask them to memorise the rules of Boolean algebra on page 142 of the text book before the next session.
4	You could start the session with a quick informal test to probe their recall of the basic rules of Boolean algebra introduced so far. Students should use the rest of this session to answer questions 1, 2 and 4 on page 64 of the text book. They may need some hints. Encourage them to make up their own expressions for NAND and NOR gates based on their truth table. Some students may need to omit the last (and hardest) part of each question. Ask them to study **4.2** of the text book before the next session.

Model Answers

1 (a)

C	B	A	X	Y	Z	Q
0	0	0	1	1	1	1
0	0	1	1	1	0	0
0	1	0	1	0	0	0
0	1	1	1	0	0	0
1	0	0	0	1	1	1
1	0	1	0	1	0	0
1	1	0	0	1	0	0
1	1	1	0	1	0	0

(b) $X = \overline{C}, Y = \overline{X}.\overline{B} + \overline{X}.B + X.\overline{B}, Z = \overline{B}.\overline{A}$

(c) $Q = Y.Z = (C.\overline{B} + C.B + \overline{C}.\overline{B}).\overline{B}.\overline{A}$

$Q = C.\overline{B}.\overline{B}.\overline{A} + C.B.\overline{B}.\overline{A} + \overline{C}.\overline{B}.\overline{B}.\overline{A}$

$Q = C.\overline{B}.\overline{A} + 0 + \overline{C}.\overline{B}.\overline{A} = (C + \overline{C}).\overline{B}.\overline{A}$

$Q = 1.\overline{B}.\overline{A} = \overline{B}.\overline{A}$ (a NOR gate)

2 (a) $X = \overline{B}.A + C + B.A$

(b) $X = A.(\overline{B} + B) + C = A.1 + C = A + C$

(c) $Y = \overline{C}.B.A + \overline{B}.A$

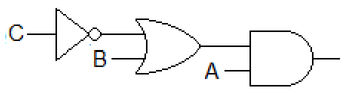
(d) $Y = A.(\overline{C}.B + \overline{B}) = A.(\overline{C}.B + \overline{B}.1) = A.(\overline{C}.B + \overline{B}.(C + \overline{C})) = A.(\overline{C}.B + \overline{C}.\overline{B} + \overline{C}.\overline{B} + \overline{B}.C)$

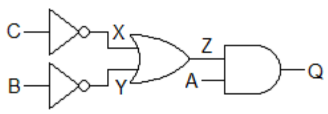
$Y = A.(\overline{C}.(B + \overline{B}) + \overline{B}.(\overline{C} + C)) = A.(\overline{C}.1 + \overline{B}.1) = A.(\overline{C} + \overline{B})$

3 (a) $Q = \overline{C}.\overline{B}.A + \overline{C}.B.A + C.B.A$

(b) $Q = \overline{C}.\overline{B}.A + \overline{C}.B.A + \overline{C}.B.A + C.B.A = \overline{C}.A.(\overline{B} + B) + B.A.(\overline{C} + C)$

$Q = \overline{C}.A.1 + B.A.1 = \overline{C}.A + B.A = A.(\overline{C} + B)$

(c) 

4 (a) 

(b)

C	B	A	X	Y	Z	Q
0	0	0	1	1	1	0
0	0	1	1	1	1	1
0	1	0	1	0	1	0
0	1	1	1	0	1	1
1	0	0	0	1	1	0
1	0	1	0	1	1	1
1	1	0	0	0	0	0
1	1	1	0	0	0	0

(c)

C	B	A	P
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	0

(d) $Q = A.\overline{B} + A.\overline{C}$