Overview

In this unit your students should:

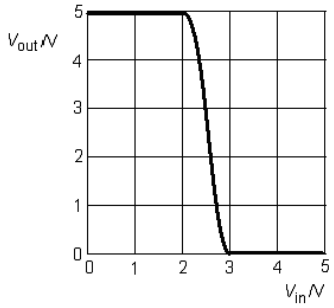
- investigate the electrical behaviour of a NOT gate
- understand what a truth table shows
- find out how to use LEDs as indicators
- learn the truth tables and symbols of the six basic logic gates

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

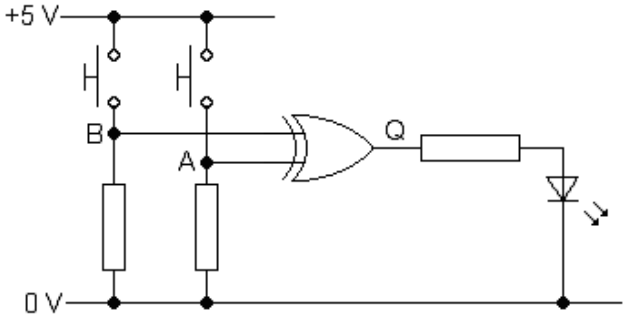
Hour	Suggested Activity
1	Launch them straight into the **Transfer characteristic of a NOT gate** practical. They will need access to the **Integrated Circuits** data sheet, and advice on keeping pin 1 at the bottom left-hand corner of the i.c. Discuss their answers to the first two questions of the **Combining Signals** exercises. Show students how to calculate a suitable value for the current-limiting resistor of an LED. Ask students to answer question 1 on page 15 of the text book before the next session.
2	Students should do the **Current-voltage graph for an LED** practical. Let them choose the colour of the LED that they are investigating. Discuss the simple model of an LED, and the use of the terms forward and reverse bias. Ask students to answer questions 3, 4 and 5 of the **Combining Signals** exercises before the next session.
3	Discuss their answers questions 3 to 5 of the **Combining Signals** exercises before setting them questions 6 and 7. As they finish the exercises, let them start the **Truth tables of logic gates** practical. They will be able to finish the practical next session. Ask students to answer questions 2 and 3 on page 15 of the text book before the next session.
4	Let the students finish off the practical from the last session. Use question 9 of the **Combining Signals** exercises to test their knowledge of logic gates. Set the remaining questions (4, 5 and 6) on pages 15 and 16 of the text book. Use a small informal test to probe their knowledge of logic gate truth tables and symbols. Ask students to finish any remaining questions and study **1.3** from the text book before the next session.

Model Answers

1 A **1** is any signal which is between 3 V and 5 V and a **0** is any signal between 0 V and 2 V. This means that a 1 entering a NOT gate always results in a 0 at the output and vice versa.

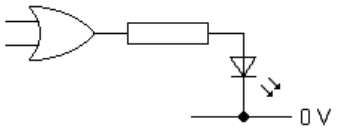


2 Leave both switches alone, so that BA = 00. If the LED glows, Q is a 1, otherwise Q is a 0. Press the left-hand switch so that BA = 10 and use the LED to determine Q. Repeat for BA = 01 and 11 ...



3 (a) The LED voltage cannot exceed 2 V without the current rising to a large enough value to result in overheating. The resistor takes 3 V, limiting the current to a low enough value for the LED power to be below its maximum rated value.

(b)

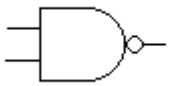


(c) $R = V/I = (5 - 1.9) / 2.2\times10^{-3} = 1.4\times10^{3}\ \Omega$ or 1.4 kΩ.

$P = VI = (5 - 1.9) \times 2.2\times10^{-3} = 6.8\times10^{-3}$ W or 7 mW, so 125 mW would be fine.

4 (a) Output only low when both inputs are high.

(b) NAND gate



5

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

6 (a) In forward bias, the anode is at a higher voltage than the cathode.

(b) There is no current in a reverse biased LED, so it does not glow. It's resistance is large. There is current in a forward biased diode when the voltage drop is 2 V, so it glows.