

**Overview**

In this unit your students should:

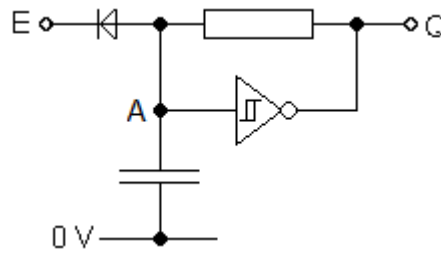
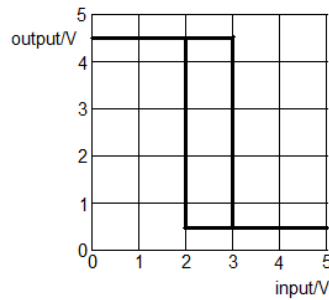
- be able to draw the transfer characteristic of a Schmitt trigger NOT gate
- understand the operation of a relaxation oscillator
- be able to design oscillators to produce a given frequency
- understand how to use an oscilloscope to measure amplitude and frequency

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

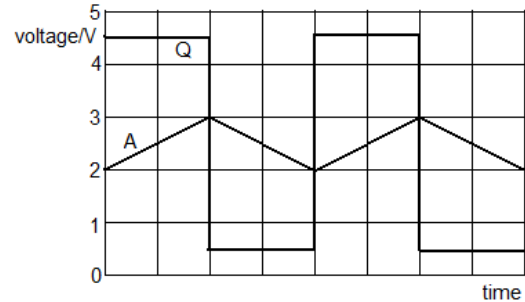
Hour	Suggested Activity
1	<p>Launch students straight into the <b>Schmitt trigger NOT gates</b> practical.</p> <p>As they finish, they could go straight into the <b>Relaxation Oscillator</b> practical. Only a minority of students get all six steps done in the time available, but all should get as far as step 4.</p> <p>Ask them to answer questions 1 and 2 of the <b>Oscillators</b> exercises before the next session.</p>
2	<p>Discuss their answers to questions 1 and 2 of the <b>Oscillators</b> exercises.</p> <p>Introduce them to the use of an oscilloscope.</p> <p>Let them work through the <b>Fast oscillators</b> practical.</p> <p>Ask them to answer questions 3 and 4 of the <b>Oscillators</b> exercises before the next session.</p>
3	<p>Discuss their answers to questions 3 and 4 of the <b>Oscillators</b> exercises.</p> <p>Get them to work through questions 1, 2 and 3 on pages 47 and 48 of the text book. Any unfinished questions should be answered before the next session.</p>
4	<p>Launch students straight into the <b>Light-to-sound converter</b> practical.</p> <p>As they finish, you could set them this extra challenge. Design and assemble a circuit whose output is a sound that alternates between two frequencies at a rate of 1 Hz, so that it mimics a police siren.</p> <p>Ask students to revise <b>Digital Pulses</b> for a formal test next session.</p>

**Model Answers**

- 1 (a)  
(b)

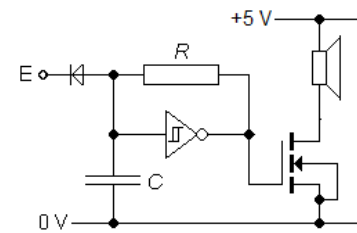


- (c)  
(d) When Q is 4.5 V, the capacitor charges up slowly through the resistor. So the voltage at A rises slowly. When it reaches 3 V, Q suddenly drops to 0.5 V. This allows the capacitor to discharge, allowing the voltage at A to drop slowly until it reaches the lower trip point of 2 V.



- 2 (a)  
(b)

The loudspeaker has a low resistance, so requires a lot of current when there is 5 V across it. A NOT gate output can only supply a few milliamps, but can control a MOSFET which can, in turn, control a current of amps in the loudspeaker.



- (c)  $T = 1/f = 1/440 = 2.3 \times 10^{-3} \text{ s}$   
 $T = 0.5RC$  so  $RC = 2.3 \times 10^{-3} / 0.5 = 4.5 \times 10^{-3} \text{ s}$   
 If  $R = 45 \text{ k}\Omega$ , then  $C = 4.5 \times 10^{-3} / 45 \times 10^3 = 1.0 \times 10^{-7} \text{ F}$  or 100 nF  
 (d) The system will only oscillate when E is +5 V, leaving the diode reverse biased. When E is 0V the diode is forward biased, holding the input of the NOT gate at +0.7 V and its output at a constant +5 V.

- 3 (a)

Each cycle is 6.0 divisions, so  $T = 6 \times 20 \times 10^{-6} = 1.2 \times 10^{-4} \text{ s}$   
 $f = 1/T = 1/1.2 \times 10^{-4} = 8.3 \times 10^3 \text{ Hz}$  or 8.3 kHz

- (b) 2.5 divisions above centre, so  $V_{\text{max}} = +2.5 \times 0.5 = +1.3 \text{ V}$  and  $V_{\text{min}} = -1.3 \text{ V}$   
 (c)

