Overview

In this unit your students should:

- learn how to calculate time constants and halving-times
- find out how the voltage across a capacitor changes as it charges and discharges
- how to use RC networks to delay digital signals

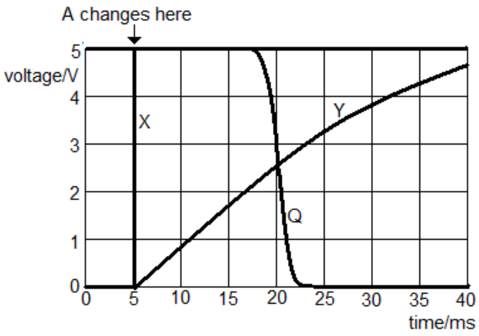
This should not require more than 3 hours of class time.

Hour	Suggested Activity
1	Set your students going on the **Charging and discharging capacitors** practical. As they finish, ask them to answer questions 1 and 2 of the **Delaying Signals** exercises. Ask them to finish off all the questions on the first page of the **Delaying Signals** exercises before the next session.
2	Discuss their answers to the questions. Get them to do the **Halving-time** practical. As they finish, get them to answer the questions on the second page of the **Delaying Signals** exercises. Ask them to answer questions 1, 2 and 3 from page 35 of the text book before the next session.
3	Discuss their answers to the questions on the second page of the **Delaying Signals** exercises. Students who have succesfully answered the questions from the text book could do the **Digital signal delay** practical. Ask students to revise **Digital from Analogue** for a formal test next session.

Model Answers

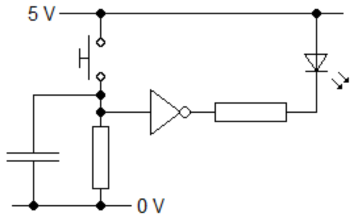
1 (a) $\tau = RC = 220\times10^3 \times 100\times10^{-9} = 2.2\times10^{-2}$ s or 22 ms

(b)



(c) As A drops to 0 V, X rises rapidly to 5 V. The capacitor starts to charge up through the resistor, reaching 2.5 V after 0.7τ. ($0.7\times 22 = 15$ ms). As Y goes above 2.5 V, the output of the second NOT gate drops to 0 V, following the signal at A with a delay of 15 ms.

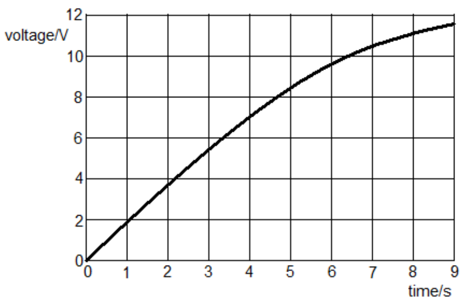
2 (a)



(b) Pressing the switch charges up the capacitor rapidly, pulling the NOT gate input high. The output goes low, putting the LED in forward bias so that it glows. When the switch is released the capacitor discharges slowly through the resistor. Once the voltage across the capacitor goes below 2.5 V, the output of the gate goes high so that there is no voltage drop across the LED and it stops glowing.

(c) $0.7RC = 10$ s, so $RC = 10 / 0.7 = 14$ s.
If $R = 140$ kΩ, then $C = 14 / 140\times10^3 = 1.0\times10^{-4}$ F or 100 μF

3 (a)



(b)