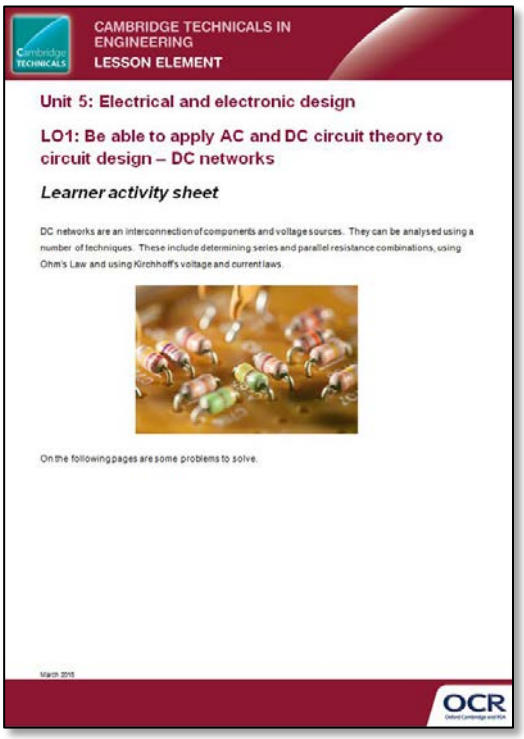
Unit 5: Electrical and electronic design

LO1: Be able to apply AC and DC circuit theory to circuit design – DC networks

Instructions and answers for teachers

These instructions should accompany the OCR resource 'Be able to apply AC and DC theory to circuit design – DC networks' *activity which supports Cambridge Technicals in Engineering Level 3.*


CAMBRIDGE TECHNICALS IN ENGINEERING
LESSON ELEMENT

Unit 5: Electrical and electronic design

LO1: Be able to apply AC and DC circuit theory to circuit design – DC networks

Learner activity sheet

DC networks are an interconnection of components and voltage sources. They can be analysed using a number of techniques. These include determining series and parallel resistance combinations, using Ohm's Law and using Kirchhoff's voltage and current laws.

On the following pages are some problems to solve.

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OCR

The Activity:

In this task the students are tasked with familiarising themselves with DC networks.

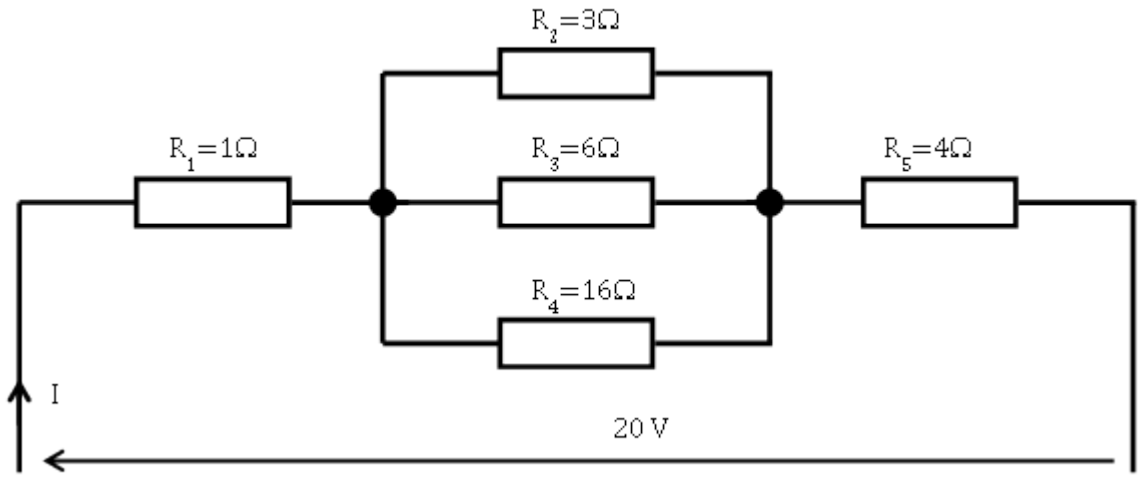
This activity offers an opportunity for English skills development.

This activity offers an opportunity for maths skills development.

Suggested timings:

1 hour

Activity 1



Activity 1 involves a circuit with series and parallel resistances, and an applied voltage. The problems can be solved by calculating overall circuit resistance and using Ohm's Law to calculate current. Learners will require some knowledge of series and parallel resistor combinations and Ohm's Law before attempting the problem.

1. Total circuit resistance involves calculating both series and parallel resistance.

   Calculating resistance of parallel combination R_2, R_3 and R_4

   $1/R_T = 1/R_2 + 1/R_3 + 1/R_4 = 1/3 + 1/6 + 1/16 = 0.5625\ \Omega$

   Therefore $R_T = 1/0.5625 = 1.78\ \Omega$

   Total circuit resistance = $R_1 + 1.78\ \Omega + R_5 = 1\ \Omega + 1.78\ \Omega + 4\ \Omega =$ **6.78 Ω**

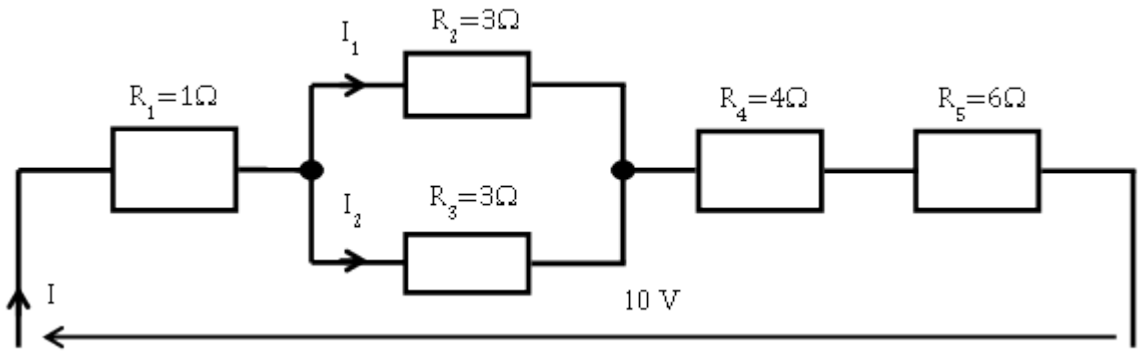
2. Current (I) can be calculated using Ohm's Law:

   $V = I/R$ and $I = V/R$ (transposing formula)

   $I = 20\ V / 6.78\ \Omega =$ **2.95 A**

Learners could solve similar problems involving series and parallel resistors, and an applied voltage.

Activity 2



Activity 2 is similar to Activity 1, but demonstrates the application of Kirchhoff's Laws. Learners will require knowledge of Kirchhoff's Laws before attempting the problem.

1. Total resistance is calculated in a similar way to Activity 1.

   To determine the total resistance of two resistors in parallel the following can be applied (rather than taking reciprocals):

   $R_T = (R_2 \times R_3) / (R_2 + R_3) = (3 \times 3) / (3 + 3) = 1.5\ \Omega$

   [Note: when two identical resistors are connected in parallel, then the overall resistance is always half the value of one of the resistors – this is a special case]

   Total circuit resistance = $1\ \Omega + 1.5\ \Omega + 4\ \Omega + 6\ \Omega =$ **12.5 Ω**

2. Total circuit current is calculated using Ohm's Law:

   $V = I/R$ and $I = V/R$ (transposing formula)

   $I = 10\ V / 12.5\ \Omega =$ **0.8 A**

3. Currents I_1 and I_2 can be determined using Kirchhoff's current law.

   At the first node in the circuit the current divides equally (as R_2 and R_3 have identical value)

   Current $I_1 = I_2 = 0.8/2 = \mathbf{0.4\ A}$

   The current divides in the ratio of R_2 and R_3.

   Alternatively, the current division rule can be used for parallel resistors:

In the circuit – the voltage across the parallel pair of resistors is 1.2 V

So – the sum of the PDs in the closed circuit loop is:

$0.8\ \text{V} + 1.2\ \text{V} + 3.2\ \text{V} + 4.8\ \text{V} = \mathbf{10\ V}$

This is equal to the applied voltage of 10 V – thereby satisfying Kirchhoff's voltage law

Learners could solve similar problems to Activity 2, using series and parallel resistors, Ohm's Law and Kirchhoff's Laws.

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