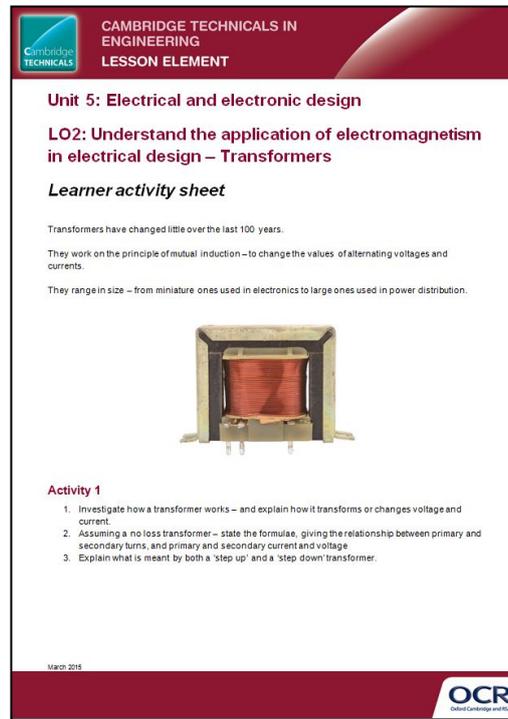


Unit 5: Electrical and electronic design

LO2: Understand the application of electromagnetism in electrical design – Transformers

Instructions and answers for teachers

These instructions should accompany the OCR resource 'Understand the application of electromagnetism in electrical design – Transformers' activity which supports Cambridge Technicals in Engineering Level 3.



Unit 5: Electrical and electronic design

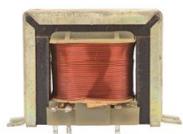
LO2: Understand the application of electromagnetism in electrical design – Transformers

Learner activity sheet

Transformers have changed little over the last 100 years.

They work on the principle of mutual induction – to change the values of alternating voltages and currents.

They range in size – from miniature ones used in electronics to large ones used in power distribution.



Activity 1

1. Investigate how a transformer works – and explain how it transforms or changes voltage and current.
2. Assuming a no loss transformer – state the formulae, giving the relationship between primary and secondary turns, and primary and secondary current and voltage.
3. Explain what is meant by both a 'step up' and a 'step down' transformer.

March 2015

OCR
Oxford Cambridge and RSA

The Activity:

In this task the students are tasked with familiarising themselves with transformers.



This activity offers an opportunity for English skills development.



This activity offers an opportunity for maths skills development.

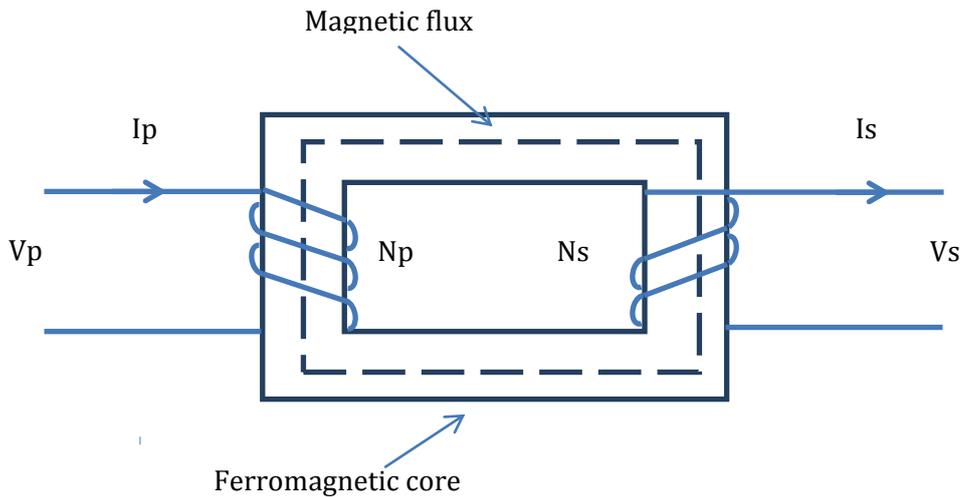
Suggested timings:

2 hours

Activity 1

- Learners might research how a transformer works – presenting their findings in a suitable format (e.g. short report, presentation or poster).

Learners might include diagrams and sketches in their explanation e.g.



Their findings should include:

- The transformer is a device that works on the principle of mutual induction.
- It consists of a ferromagnetic core and two windings – termed the primary and secondary winding.
- A voltage is applied to the primary winding, and a load to the secondary winding.
- When a voltage is applied to the primary winding a magnetic field is generated within the core that links with the secondary winding.
- The magnetic field induces an EMF (electromotive force) in the secondary winding by mutual induction.
- The induced EMF (E) is described by the formula:

$$E = -N \left(\frac{d\Phi}{dt} \right)$$

Where E is the EMF in the coil, N is the number of turns, and $d\Phi/dt$ is the rate of change of magnetic flux.

- This follows both Faraday's and Lenz's Laws. Learners may have already covered this as part of the unit.

2. The relationship between primary and secondary turns, and primary and secondary voltage and current is:
- Assuming no losses in the transformer (an ideal transformer) then $E_p = V_p$ and $E_s = V_s$ (primary and secondary voltages are the same as induced EMF).
 - Hence: $N_p/N_s = V_p/V_s$ (where V is voltage, N is number of turns and p and s are primary and secondary respectively)
 - When a load is connected to the secondary winding of a transformer a current flows.
 - For the ideal transformer: input power = output power
So: $V_p I_p = V_s I_s$ and so $V_p/V_s = N_p/N_s = I_s/I_p$

Learners will require these formulae when solving transformer problems.

3. In a transformer N_p / N_s is called the voltage ratio.

If N_s is less than N_p then V_s is less than V_p . This is called a **step-down** transformer as the voltage is reduced.

If N_s is greater than N_p then V_s is greater than V_p . The voltage from primary to secondary increases and this is called a **step-up** transformer.

Activity 2

1. $V_p = 240 \text{ V}$ and $V_s = 12 \text{ V}$

Current I_s (from the Power Law) = $P / V_s = 150 / 12 = 12.5 \text{ A}$

Using the formula to calculate turns ratio:

$$V_p/V_s = N_p/N_s = 240 / 12 = 20$$

The turns ratio is 20.

Calculate primary (supply) current using:

$$V_p/V_s = I_s/I_p$$

$$240 / 12 = 12.5 / I_p$$

Rearranging for I_p :

$$I_p = 12.5 (12 / 240) = 0.625 \text{ A}$$

2. Use the formula:

$$V_p/V_s = N_p/N_s$$

$$240 / V_s = 500 / 2000$$

Rearrange for V_s :

$$V_s = 240 (2000 / 500) = \mathbf{960 \text{ V}}$$

This is an example of a step-up transformer.

Learners could solve similar transformer problems.



We'd like to know your view on the resources we produce. By clicking on the 'Like' or 'Dislike' button you can help us to ensure that our resources work for you. When the email template pops up please add additional comments if you wish and then just click 'Send'. Thank you.

OCR Resources: the small print

OCR's resources are provided to support the teaching of OCR specifications, but in no way constitute an endorsed teaching method that is required by the Board, and the decision to use them lies with the individual teacher. Whilst every effort is made to ensure the accuracy of the content, OCR cannot be held responsible for any errors or omissions within these resources. We update our resources on a regular basis, so please check the OCR website to ensure you have the most up to date version.

© OCR 2014 - This resource may be freely copied and distributed, as long as the OCR logo and this message remain intact and OCR is acknowledged as the originator of this work.

OCR acknowledges the use of the following content: Maths and English icons: Air0ne/Shutterstock.com

Please get in touch if you want to discuss the accessibility of resources we offer to support delivery of our qualifications: resources.feedback@ocr.org.uk