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# CAMBRIDGE NATIONALS IN ENGINEERING

R101 - ENGINEERING PRINCIPLES

## DELIVERY GUIDE

JANUARY 2015



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# INTRODUCTION

This Delivery Guide has been developed to provide practitioners with a variety of creative and practical ideas to support the delivery of this qualification. The Guide is a collection of lesson ideas with associated activities, which you may find helpful as you plan your lessons.

OCR has collaborated with current practitioners to ensure that the ideas put forward in this Delivery Guide are practical, realistic and dynamic. The Guide is structured by learning objective so you can see how each activity helps you cover the specification.

We appreciate that practitioners are knowledgeable in relation to what works for them and their learners. Therefore, the resources we have produced should not restrict or impact on practitioners' creativity to deliver excellent learning opportunities.

Whether you are an experienced practitioner or new to the sector, we hope you find something in this guide which will help you to deliver excellent learning opportunities.

If you have any feedback on this Delivery Guide or suggestions for other resources you would like OCR to develop, please email [resourcesfeedback@ocr.org.uk](mailto:resourcesfeedback@ocr.org.uk).

## PLEASE NOTE

The activities suggested in this Delivery Guide **MUST NOT** be used for assessment purposes. (This includes the Consolidation suggested activities).

The timings for the suggested activities in this Delivery Guide **DO NOT** relate to the Guided Learning Hours (GLHs) for each unit.

Assessment guidance can be found within the Unit document available from [www.ocr.org.uk](http://www.ocr.org.uk).

The latest version of this Delivery Guide can be downloaded from the OCR website

## OPPORTUNITIES FOR ENGLISH AND MATHS SKILLS DEVELOPMENT

We believe that being able to make good progress in English and maths is essential to learners in both of these contexts and on a range of learning programmes. To help you enable your learners to progress in these subjects, we have signposted opportunities for English and maths skills practice within this resource. These suggestions are for guidance only. They are not designed to replace your own subject knowledge and expertise in deciding what is most appropriate for your learners.

### KEY



English



Maths

See the **Maths and Science in Engineering** resource for Units R101, R102, R103, R104 which will give you suggestions for a holistic approach to delivery.

# UNIT R101 - ENGINEERING PRINCIPLES

Guided learning hours : 30

## PURPOSE OF THE UNIT

This unit provides learners with the opportunity to gain knowledge and understanding of the principles of operation of mechanical, electrical and fluid power used in engineering systems. It considers the relationships between power and energy and how mechanical advantage and efficiency are evident through mechanical, electrical and fluid terms.

Potential and kinetic energy, forces and torque as well as velocity and acceleration can be understood through practical activities and experiment. Learners will understand how mechanical, electrical and fluid principles are applied to real life examples used in everyday engineered products such as fork lift trucks, excavators, aircraft and manufacturing production.

On completion of this unit, learners will understand the principles behind mechanical, electrical and fluid power and be able to apply these in a practical context.

Learners studying for the certificate will be able to apply knowledge and understanding gained in this unit to help develop their skills further during the completion of units R103 and R104.

Learning Outcome — The learner will:
LO1 Understand physical properties and mechanical principles
LO2 Understand physical properties and electrical principles
LO3 Understand physical properties and fluid power principles
LO4 Know about the systems used to transmit power in engineering



## LO1: UNDERSTAND PHYSICAL PROPERTIES AND MECHANICAL PRINCIPLES

### Learning Outcome — The learner will:

LO1 Understand physical properties and mechanical principles

Suggested content	Suggested activities	Activity duration	Links to other units
1 Physical Properties	Learners could be introduced to the physical properties as energy in the form of mechanical, electrical, chemical, light, sound, and heat by the teacher. Learners could be asked to work in groups to discuss examples of where the physical properties of energy forms are evident, such as a bicycle in use. Working in groups, learners could identify examples of kinetic energy and conversion of the bicycle being pedalled, the types of energy used and resulting from the brakes being applied, the use of lighting on a bicycle and two ways how the light energy could be produced.	2 hours	R113
2 Physical Properties	Teachers could ask learners to consider examples of where chemical energy is converted to mechanical energy.	15 minutes	
3 Mechanical principles ie power, work and efficiency	Teachers could introduce learners to mechanical principles of power, work and efficiency with examples of where this can be applied and measured.	2 hours	
	Learners could be introduced to formula for Work done with examples of a heavy item being dragged or loaded. Teachers could use practical examples to introduce units and measurements such as Nm, m/s, joule.	3 hours	
	Teachers could give learners examples to work through lever calculations using Force, newtons, Moment.	2 hours	
	Learners could explore the design projects to gain practical experience of using gears, linkages and levers.	1 hour	
	Working in pairs, learners could with basic supplies, use card to make models of different types of motion.	1.5 hours	
	Teachers could use examples of acceleration and velocity with learners producing graphs of a vehicle accelerating.	1.5 hours	



Suggested content	Suggested activities	Suggested timings	Possible relevance to
4 Mechanical principles using calculation	Teachers could introduce learners to gears using simple models of spur gear trains either through worksheets or practical models. Learners could be given examples of gear trains including with idler gears to work out direction of travel and calculations using simple and compound gears.	2 hours	
	Learners could access the 'Gears and Pulleys' from the following web link: <a href="http://www.technologystudent.com/gears1/geardex1.htm">http://www.technologystudent.com/gears1/geardex1.htm</a>	1.5 hours	
	Teachers could give learners some gear calculations (ratio) exercises.	1 hour	
	See Lesson Element: Mechanical Principles	1.45 hours	





## LO2 - UNDERSTAND PHYSICAL PROPERTIES AND ELECTRICAL PRINCIPLES

### Learning Outcome — The learner will:

LO2 Understand physical properties and electrical principles

Suggested content	Suggested activities	Activity duration	Links to other units
1 Physical Properties ie electrical power and energy, electrical values. EMF	Learners could be introduced to the physical properties of electrical power and energy with examples of everyday uses in engineered appliances.		
	Teachers could introduce electrical values through practical exercise with learners using multi meters and basic resistor and LED circuit to measure ohms, volts and amps/milliamps.	1.5 hours	R113
	Teachers could introduce concepts of EMF with Faraday's laws of electromagnetic induction. Learners could be shown Fleming's left hand rule and principles of a motor - parts of the motor and its function and a dynamo (AC and DC). Learners could work in small groups to experiment with electromagnetic induction with a coil of wire and iron core to create a EMF.	1.5 hours	R113
2 Electrical principles ie Alternating and Direct Current /voltage, series and parallel circuits.	Learners could be introduced to electrical principles of AC and DC applications with examples of power tools and other portable/non portable applications of engineered products.	30 minutes	
	Learners could be taught to use circuit simulation software to create a AC circuit and use a bridge rectifier to convert to DC.	1 hour	
	Learners could be introduced to series and parallel circuits using the interactive resource from the following web link: <a href="http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_21c/electric_circuits/parallelandseriesact.shtml">http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_21c/electric_circuits/parallelandseriesact.shtml</a>	30 minutes	R113
3 Ohm's Law and power law	Learners could be introduced to electrical principles of using values of voltage, current, resistance, power by making simple circuits and using multimeters to measure the values used, either through bread boarding, on paper or circuit simulation software.	2 hours	R113
	See Lesson Element: Series and Parallel Circuits.	1 hour	R113




Suggested content	Suggested activities	Suggested timings	Possible relevance to
4 Operation of DC electromagnetic devices	Learners could be introduced to relays giving example uses of relays, and different contact arrangements.		R113
	Teachers could get learners to work in small groups with a project board to create a reversing circuit using a DC motor and relay. Learners could identify common applications of reversing circuits using motors and relays.	1.5 hours	R113, R114
	Learners could watch a video about making a simple generator and in small groups make a similar simple generator from the following web link: <a href="https://www.youtube.com/watch?v=k7Sz8oT8ou0#t=217">https://www.youtube.com/watch?v=k7Sz8oT8ou0#t=217</a>	1.5 hours	



## LO3 - UNDERSTAND PHYSICAL PROPERTIES AND FLUID POWER PRINCIPLES

### Learning Outcome — The learner will:

LO3 Understand physical properties and fluid power principles

Suggested content	Suggested activities	Activity duration	Links to other units
1 Physical properties, ie pressure/vacuum, flow, forces, compressibility	Learners could be introduced to the physical properties of fluid power by asking learners to consider common uses of compressed air.		
	Teachers could devise an exercise to show learners the different methods of how compressed air is supplied and distributed.	30 minutes	
	Teachers could introduce simple fluid power components used in everyday applications to show how movement/ motion is achieved.	30 minutes	
	Teachers could give learners examples of how fluid power is used in linear motion to hold, move, form and process in production and other operations.	30 minutes	
	Learners should be taught about the safety precautions when working with pneumatics and compressed air and fluids. This could be small group exercise where learners identify the risks involved and prevention.	30 minutes	R104
2 Fluid power principles 	Learners could be introduced to fluid power principles of values for pressure and force by giving examples of a fluid power application and learners carry out calculation using Force, Pressure and Area including instroking and outstroking applications.	1.5 hours	
3 Operation, applications and symbols of fluid power system components	Learners could be introduced to the operation and application of fluid power by researching 3 applications of pneumatics and 3 applications of hydraulics.	45 minutes	
	Teachers could give examples of applications of hydraulic and pneumatic applications and with learners working in pairs, list the advantages and disadvantages of using either hydraulics or pneumatics for the given application.	30 minutes	
	Learners could consider how pneumatics are used in the everyday production of products i.e. food production and list their ideas, the stages of production and the types of mechanisms that may be used.	30 minutes	
	See Lesson Element: Fluid Power Components.	30 minutes	
	Teachers could introduce learners to logic functions using push button, 3/2 valves, shuttle valves, single acting cylinders.	1.5 hours	
	Teachers could set learners a task to devise a simple pneumatic circuit to lift a car park barrier, and are required to describe how the circuit works.	1 hour	

## LO4 - KNOW ABOUT THE SYSTEMS USED TO TRANSMIT POWER IN ENGINEERING

### Learning Outcome — The learner will:

LO4 Know about the systems used to transmit power in engineering

Suggested content	Suggested activities	Activity duration	Links to other units
1 Types of power sources used in engineering	Learners could be introduced to the types of power used in engineering by learners working in pairs identifying different power sources in engineering and an application of each.	30 minutes	
	Teachers could ask learners to consider a vehicle, machine or aircraft and list the different types of power used for different functions.	30 minutes	
2 Application and design of mechanical electrical and fluid power in engineering	Learners could watch the video "How Its Made - The 2 Euro Coin (€2)" from the following web link; <a href="http://www.youtube.com/watch?v=rFDsSMDeV3w">http://www.youtube.com/watch?v=rFDsSMDeV3w</a>	1 hour	
	Learners working in pairs, can list a range of processes and the associated differing types of power, such as conveyors, hydraulic presses.	1 hour	
	Learners could sketch how a cylinder and lever arrangement could be used to operate a door, and suggest how this could be controlled.	30 minutes	
	Learners could research 2 examples of each electro mechanical, elector pneumatic and hydro mechanical applications.	45 minutes	
	Learners could research and describe the advantages of using integrated power systems to perform an operation.	45 minutes	



## Contact us

Staff at the OCR Customer Contact Centre are available to take your call between 8am and 5.30pm, Monday to Friday.

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