2016 Suite

OCR
Oxford Cambridge and RSA

Cambridge **TECHNICALS LEVEL 2**

Cambridge TECHNICALS 2016

ENGINEERING

Unit 2

Application of engineering principles

F/615/2129

Guided learning hours: 30

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LEVEL 2

UNIT 2: APPLICATION OF ENGINEERING PRINCIPLES

F/615/2129

Guided learning hours: 30

Essential resources required for this unit: none

This unit is externally assessed by an OCR set and marked examination.

Unit aim

Engineering relies on the practical application of fundamental principles in order to develop working products and systems that will fulfil their desired purpose. As an engineer you will be focused on efficiency, accuracy and tolerances and how you balance these will affect how successful the engineering output will be. Through this unit you will develop your understanding of a range of engineering applications and be tested on your ability to choose the right device/ component for the job, chose the best material to gain efficiency and accuracy in engineering systems to perform typical engineering tasks and solve problems. The typical engineering tasks and problem solving will be based around mechanical, electrical/electronic and fluid power and you will also be required you to use your knowledge from unit 1.

The knowledge, understanding and skills that you will gain from this unit will help to prepare you for future employment within the engineering sector.

From this unit you will understand:

- Efficiency of mechanical systems
- applications and processing of engineering materials
- non-destructive materials testing techniques
- methods of joining and assembly
- the application of electrical and electronic systems and devices
- fluid power applications

Once you have completed Unit 1 and Unit 2 you will have the necessary knowledge and understanding to select mechanical and fluid power systems, electrical/ electronic devices, and appropriate engineering materials in your practical teacher assessed units.

TEACHING CONTENT

The unit content describes what has to be taught to ensure that learners are able to access the highest grade.

Anything which follows an i.e. details what must be taught as part of that area of content.

Anything which follows an e.g. is illustrative.

Where teaching content contains i.e. and e.g. under specific areas of content, the following rules will be adhered to when we set questions for an exam:

- A direct question may be asked about unit content which follows an i.e.
- Where unit content is shown as am e.g. a direct question will not be asked about that example.

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
1. Understand the factors that determine efficiency in engineering systems	1.1	factors affecting the loss of efficiency in engineering systems (e.g. gears and pulleys, levers and linkages), i.e. • losses due to friction i.e. o thermal o noise (vibration) o wear • losses due to imbalances i.e. o friction o vibration (noise)	1.2	Learners must recall and use the formulae to calculate power, torque and efficiency of engineering systems (for simple gear trains (not compound), pulleys, levers, linkages) • work done = force x distance • power (P) = force x distance / time • power (P) = $2\pi NT/60$ • torque (work done in rotation) = force x distance (radius) • efficiency = output power/ input power x 100%
	1.2	how work, power, torque and efficiency is determined in engineering systems i.e. • gears and pulleys • levers and linkages		

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
2. Understand why engineering materials are suitable for specific engineering applications	2.1	the properties (i.e. malleability, ductility, conductivity/resistivity, hardness, toughness, machinability, corrosion resistance, elasticity/plasticity, strength (tensile, compressive)) of each material by classification and why the properties of materials are important for specific engineering applications i.e. • ferrous metals and their alloys i.e. o cast iron o carbon steels o stainless steel o high speed steel • non-ferrous metals and their alloys i.e. o copper o brass o bronze o aluminium alloy o zinc o tin o lead o titanium • thermoplastics o acrylonitrile-Butadiene-Styrene (ABS) o high Impact Polystyrene (HIPS) o polyvinyl Chloride (PVC) o nylon o polycarbonate o polypropylene • thermosetting plastics o polyester resin o urea-formaldehyde o epoxy resin	2.1	Learners must explain the benefits/ drawbacks of using different engineering materials for the same engineering application. Learners must understand why the properties of materials are important for specific engineering applications such as: • cast iron for machine bases because of its toughness; bronze for boat propellers because it is corrosion resistant • ABS for drain pipes because of machinability and toughness • phenol-formaldehyde for heat resistant saucepan handles, urea-formaldehyde for light switches because of low conductivity of electricity • tungsten carbide for cutting tool tips because of hardness • carbon fibre for bicycle frames because of strength and weight • shape memory alloy in alarm systems because of smart properties

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		

		• ceramics i.e.
		  o tungsten carbide
		  o glass
		• composites i.e.
		  o glass reinforced plastic (GRP)
		  o carbon fibre
		• smart materials i.e.
		  o shape-memory alloys
		  o thermochromic materials
		  o shape-memory plastics
		  o quantum tunnelling composite (QTC)		

	2.2	other considerations affecting the suitability of materials for specific engineering applications i.e. • relative cost (manufacture, material) • relative availability • safety in manufacture (e.g. release of carcinogens to atmosphere during machining) • standard forms of supply (e.g. sheet, bar, flat stock, ingot / billet, granules, liquid) • sustainable use of materials (e.g. finite/ renewable, disposal)	2.2	Learners must explain the benefits/ drawbacks of using different engineering materials for the same engineering application. Learners must understand why the other considerations are important when selecting engineering materials for specific engineering applications such as • thermoplastics are relatively low cost, reusable and recyclable, but not renewable. • copper is relatively low cost compared to gold for use in electrical conductors.

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
3. Understand materials processing techniques	3.1	materials processing techniques i.e. • material removal i.e. o drilling o milling o cutting o turning • manipulation and forming i.e. o injection moulding o extrusion o vacuum forming o forging o folding o bending o laminating • joining and assembly methods i.e. o threaded fastenings o riveting o soldering o welding o adhesive bonding		Learners must be able to explain the materials processing techniques listed and the purpose of using each one. For example galvanising is electrically coating with zinc and is used to stop ferrous metals rusting. Learners must understand that certain materials processing techniques are used for engineering materials with specific properties which are taught in LO2. For example tempered glass is not malleable and therefore cannot be easily formed by folding, unless it is heated to a specific temperature first. Aluminium alloy is malleable and can be formed by folding easily.

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
		• chemical and heat treatment i.e. o electroplating o galvanising o painting o normalising o annealing o hardening o quenching • additive manufacturing i.e. o sintering o fused deposition o rapid prototyping		
4. Understand how to select electrical and electronic devices for engineering purposes	4.1	reasons to select electrical resistors • Types and purpose i.e. o fixed-value resistor i.e. ▪ current control (e.g. reduce current flow in circuit) ▪ voltage control (e.g. lower voltage level in circuit) ▪ identification and ratings i.e. – colour code – tolerance – power rating – preferred fixed-value (E12 series)	4.1	Learners should understand the reasons for preferred resistor values, and purpose of power rating when selecting resistors. Learners must be able to determine resistor value and tolerance from colour code.

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
		o variable resistor i.e. ▪ mechanical (e.g. adjusting resistance of part of a circuit) ▪ temperature (e.g. negative temperature coefficient (NTC) thermistor) ▪ optical (e.g. light dependant resistors (LDR)) • typical application of fixed and variable resistors i.e. o fixed value resistor for controlling a time delay (e.g. energy efficient automatic light control) o adjustable resistor i.e. ▪ potentiometer (e.g. volume control) ▪ NTC thermistor for sensing temperature (e.g. cooling system) ▪ LDR for sensing light level (e.g. automatic dusk to dawn lights)		
	4.2	reasons to select electrical capacitors i.e. • types of capacitor, i.e. o polarised o non-polarised • purpose of voltage rating and tolerance • typical applications of capacitors i.e. o polarised (e.g. capacitors of larger value, power supply smoothing, filter) o non-polarised (e.g. capacitors of smaller value, signal coupling, tuning circuit)	4.2	Learners should be able to identify types of capacitor from images and circuit symbols. Learners should understand the purpose of capacitor voltage rating and tolerance. Learners should understand that polarised capacitors have larger value than non-polarised capacitors

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
	4.3	application of cable types i.e. • types of cable, i.e. o solid core o stranded o ribbon • solid core i.e. o fixed installations • stranded i.e. o flexible/moving installations • ribbon i.e. o installations requiring many flexible conductors	4.3	Learners should be able to identify cable types from photographs and diagrams. Learners should understand applications of cable types e.g. solid core in fixed installation – household wiring; stranded in moving application – domestic appliance; ribbon in application requiring multiple flexible conductors – computer disk drive.
	4.4	types of switches i.e. • activation method i.e. o toggle o slide o push button o rotary • contact arrangements and circuit operation i.e. o Single Pole Single Throw (SPST) o Single Pole Double Throw (SPDT) o Double Pole Single Throw (DPST) o Double Pole Double Throw (DPDT) o push to break (PTB) o push to make (PTM) o momentary action o latching o other types of switch i.e. ▪ reed	4.4	Learners should identify switch activation methods and contact arrangements from photographs and circuit symbols. Learners should understand the circuit operation of switches for example: ▪ SPST - interrupts current for single for single circuit ▪ DPST - interrupts current in two independent circuits ▪ SPDT - switch on in both positions switching circuit in each case (termed changeover) ▪ DPDT - pair of connected switches on in both positions (termed changeover) Pushbutton - two-position switch which either makes or interrupts an electric current when operated

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
	4.5	operation and application of motors i.e. • DC permanent magnet motor • AC induction motor • Typical applications of AC motor (e.g. pump motor) • Typical applications of DC motor (e.g. engine starter motor)	4.5	Learners should be able to explain, in simple terms, the difference between a DC permanent magnet motor and an AC induction motor, including how they operate.
	4.6	types and application of circuit protection i.e. • fuse • diode • residual current device (RCD)	4.6	Learners should be able to explain how fuses, diodes and RCD devices can be used to protect a circuit
	4.7	use of test equipment, i.e. • power supply unit • multimeter for voltage, current, resistance and continuity	4.7	Learners should be able to explain how to use test equipment when testing a circuit, including any safety precautions in its use to avoid circuit/equipment damage or injury.
5. Understand the operation and application of fluid power sources, actuators and valves	5.1	operation and application of power sources i.e. • hydraulic i.e. o positive displacement o fixed or variable displacement • pneumatic i.e. o dynamic (e.g. centrifugal, axial) o positive displacement (e.g. rotary, reciprocating)	5.1	Learners should be able to explain the basic operation of different types of power source.

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
	5.2	operation of actuator types i.e. • linear single acting • linear double acting • rotary the typical application of actuators i.e. • linear single acting (e.g. car hoist, car jack) • linear double acting (e.g. robot arm control mechanism, excavator bucket arm movement) • rotary (e.g. valve actuator)	5.2	Learners should be able to explain the operation of different types and configurations of actuator.
	5.3	operation of valve types i.e. • poppet valve • spool valve • pilot valve • check valve • rotary valve the typical applications of valve types i.e. • poppet valve (e.g. car/bike tyre valve) • spool valve (e.g. hydraulic elevator) • pilot valve (e.g. pressure relief valve, manual emergency stop valve) • check valve (e.g. pump (to ensure no back flow), fluid feed system, fluid mixing system, heating system, irrigation system)	5.3	Learners should be able to explain the operation of different valve types. For example a spool valve directs fluid flow from one port to another port. A check valve allows flow of fluid in one direction, whilst resisting fluid flow in the other direction. This is usually achieved through spring pressure.

SYNOPTIC ASSESSMENT AND LINKS BETWEEN UNITS

For the assessment of Unit 2, learners must draw on their knowledge from Unit 1. It will also be possible for learners to make other connections between other units over and above unit 1. Please see section 6 of the centre handbook for more detail. We have indicated in this unit where these links are in the grid below.

Synoptic assessment grid

This unit and specific LO	Related unit	Related LO
Unit 2 LO1 Understand the factors that determine efficiency in engineering systems	Unit 1	LO1 1.1, 1.2, 1.3, 1.4 LO3 3.2, 3.4 LO4 4.2, 4.3, 4.4, 4.9, LO6 6.1
	Unit 3	LO6 6.1, 6.2
	Unit 4	LO2 2.6 LO3 3.1, 3.2
	Unit 5	LO1 1.3 LO4 4.1
	Unit 7	LO1 1.1, 1.2 LO2 2.1 LO4 4.1, 4.2, 4.3
	Unit 8	LO1 1.1, 1.3, 1.4 LO2 2.1, 2.2 LO3 3.1

This unit and specific LO	Related unit	Related LO
Unit 2 LO2 Understand why engineering materials are suitable for specific engineering applications	Unit 1	LO2 2.1, 2.2 LO3 3.1, 3.2, 3.3, 3.4
	Unit 3	LO4 4.1 LO5 5.1, 5.2 LO 6.1, 6.2
	Unit 4	LO2 2.1, 2.2, 2.3, 2.4
	Unit 7	LO3 3.1, 3.2, 3.3
	Unit 8	LO1 1.4 LO3 3.3
Unit 2 LO3 Understand materials processing techniques	Unit 1	LO2 2.1, 2.2 LO3 3.1, 3.2, 3.3, 3.4
	Unit 3	LO4 4.1 LO5 5.1, 5.2 LO 6.1, 6.2
	Unit 7	LO1 1.1, 1.2 LO2 2.1 LO3 3.1, 3.2, 3.3 LO4 4.2
	Unit 8	LO3 3.3, 3.4

This unit and specific LO	Related unit	Related LO
Unit 2 LO4 Understand how to select electrical and electronic devices for engineering purposes	Unit 1	LO1 1.1, 1.2, 1.3, 1.4 LO5
	Unit 4	LO2 2.1, 2.2, 2.3, 2.4, 2.6
	Unit 5	LO1 1.1, 1.2, 1.3 LO2 2.1, 2.2 LO3 3.1, 3.2 LO4 4.1
Unit 2 LO5 Understand the operation and application of fluid power sources, actuators and valves	Unit 1	LO6 6.1, 6.2
	Unit 5	LO2 2.2

ASSESSMENT GUIDANCE

All Learning Outcomes are assessed through externally set written examination papers, worth a maximum of 45 marks and 50 minutes in duration. Learners should study the taught content within this unit in the context of typical engineering tasks and problem solving. The examination for this unit will include questions that will require learners to apply their understanding of engineering principles to everyday engineered products and systems.

LEARNING OUTCOME WEIGHTINGS

LO1	20%
LO2	13%
LO3	13%
LO4	27%
LO5	27%

MEANINGFUL EMPLOYER INVOLVEMENT - A REQUIREMENT FOR TECHNICAL CERTIFICATE QUALIFICATIONS

These qualifications have been designed to be recognised as Technical certificates in performance tables in England. It is a requirement of these qualifications for centres to secure employer involvement through delivery and/or assessment of these qualifications for every learner.

The minimum amount of employer involvement must relate to at least one or more of the elements of the mandatory content. This unit is mandatory.

Eligible activities and suggestions/ideas that may help you in securing meaningful employer involvement for this unit are given in the table below.

Please refer to the Qualification Handbook for further information including a list of activities that are not considered to meet this requirement.

Meaningful employer involvement – eligible activities	Suggestion/ideas for centres when delivering this unit
1. Students undertake structured work-experience or work-placements that develop skills and knowledge relevant to the qualification.	Learners could reinforce knowledge and understanding from this unit with a structured work experience placement opportunity.

2. Students take one or more units delivered or co-delivered by an industry practitioner(s). This could take the form of master classes or guest lectures.	Elements of this unit could be delivered by an industry practitioner or in an industry setting.

You can find further information on employer involvement in the delivery of qualifications in the following documents:

- Employer involvement in the delivery and assessment of vocational qualifications
- DfE work experience guidance

To find out more
ocr.org.uk/engineering
or call our Customer Contact Centre on **02476 851509**

Alternatively, you can email us on **vocational.qualifications@ocr.org.uk**

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