2016 Suite

OCR
Oxford Cambridge and RSA

Cambridge **TECHNICALS LEVEL 2**

Cambridge TECHNICALS 2016

ENGINEERING

Unit 1

Fundamentals of mechanical, electrical/ electronic and fluid power engineering

D/615/2123

Guided learning hours: 60

Version 3 June 2023 - black line marks update

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LEVEL 2

UNIT 1: FUNDAMENTALS OF MECHANICAL, ELECTRICAL/ELECTRONIC AND FLUID POWER ENGINEERING

D/615/2123

Guided learning hours: 60

Essential resources required for this unit: scientific calculator

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

Unit aim

Every engineer needs to have a working knowledge of mechanical, electrical/electronic and fluid power engineering and this unit will give you the fundamental knowledge of each.

From this unit you will know:

- how to use SI units of measurement and their derivatives
- how to classify engineering materials
- the physical properties of engineering materials and how they behave in relation to mechanics, motion and forces
- the electrical and electronic principles for electronic control and electrical motion
- fluid power components and their symbols and how to calculate fluid power

You need to secure the knowledge in this unit so that you can complete the other units in the qualification. For example, you will need to use your knowledge of SI units to interpret engineering drawings in order to make components from an engineering drawing. You will also need to calculate force and motion accurately so that you can repair engineered assemblies.

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 an 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 Know what common SI units and their derivatives are and how to use them in engineering	1.1	the seven fundamental SI units (International Systems of Units), i.e.: 1. length i.e. metre (m) 2. mass i.e. kilogram (kg) 3. time i.e. second (s) 4. electric current i.e. ampere (A) 5. temperature i.e. kelvin (K) 6. luminous intensity i.e. candela (cd) 7. amount of substance i.e. mole (mol)	1.1	Learners must recognise and identify the seven base units list and derived quantities for example: • how these quantities are represented (e.g. metre – m, kilogram- kg) • how these quantities are derived (e.g. area is measured in square metres (m^2))

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
	1.2	the names and quantities represented by SI derived units with special names and symbols i.e.: 1. force/pressure i.e. a. newton (N) b. pascal (Pa) 2. temperature i.e. a. degree Celsius (°C) 3. energy/electrical i.e. a. volt (V) b. ohm (Ω) c. coulomb (c) d. farad (F) e. henry (H) f. hertz (Hz) g. joule (J) h. watt (W) 4. light/illumination i.e. a. lux (lx)	1.2	Learners must recognise and identify SI derived units for example newton is the SI unit for force and is often represented as newtons (N).

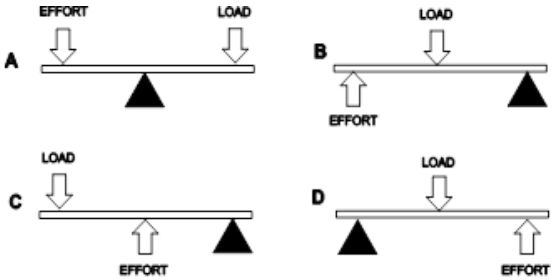
Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
	1.3	to recognise SI prefixes and scientific form including conversions i.e.: 1. kilo 10^3 (k) 2. mega 10^6 (M) 3. giga 10^9 (G) 4. tera 10^{12} (T) 5. centi 10^{-2} (c) 6. milli 10^{-3} (m) 7. micro 10^{-6} (μ) 8. nano 10^{-9} (n) 9. pico 10^{-12} (p)	1.3	For example SI prefixes 1000g = 1 kilogram 0.000001 farad = 1 micro-farad (1 μF)
	1.4	to know definitions related to measurement, i.e.: 1. accuracy 2. indicated value 3. true value 4. error 5. calibration 6. precision 7. tolerance	1.4	Learners need to know the definitions of terms related to measurements for example: - accuracy is a quality denoting how close a measured value is to the true value - a true value is the value that would be obtained in an ideal measurement, one with no errors

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
	1.5	to calculate areas and volumes i.e. 1. area of i.e. a. circle, b. square, c. rectangle d. triangle 2. surface area of i.e. a. cuboid 3. volume of i.e. a. cuboid b. cylinder		Learners need calculate the areas and volumes for the list given by recalling and using the required formulae.
2 Know how to classify common engineering materials	2.1	that metals i.e. 1. that contain iron are ferrous 2. that contain no iron are non-ferrous 3. that contain a mixture of two or more elements, at least one of which is a metal, is an alloy		
	2.2	how to classify engineering materials i.e. 1. ferrous metals (containing iron) and alloys, i.e. a. cast iron b. carbon steels c. stainless steel d. high speed steel		

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
		2. non-ferrous metals (containing no iron) and alloys, i.e. a. copper b. brass c. bronze d. aluminium alloys e. zinc f. tin g. lead h. titanium i. gold 3. polymers, i.e. a. thermoplastics, i.e. i. acrylonitrile-Butadiene-Styrene (ABS) ii. high Impact Polystyrene (HIPS) iii. polyvinyl Chloride (PVC) iv. nylon v. polycarbonate vi. polypropylene b. thermosetting plastics, i.e. i. polyester resin ii. urea-formaldehyde iii. epoxy resin 4. ceramics, i.e. a. tungsten carbide b. glass c. bearing material		

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
		5. composites, i.e. a. glass reinforced plastic (GRP) b. carbon fibre 6. smart materials, i.e. a. shape-memory alloys b. thermochromic materials c. shape-memory plastics d. quantum tunnelling composite (QTC) e. nanotechnology		
3 Know physical properties of engineering materials in relation to mechanics, motion and forces	3.1	properties of engineering materials, i.e. 1. malleability 2. ductility 3. conductivity/resistivity 4. hardness 5. toughness 6. machinability 7. corrosion resistance 8. elasticity/plasticity 9. strength (tensile, compressive)	3.1	Learners must be able to define key properties of engineering materials, e.g. a malleable material is capable of being shaped, by pressing or hammering.
	3.2	what the following terms mean in engineering i.e. 1. stress 2. strain	3.2	**Stress** is the applied force or system of forces that tends to deform a body. **Strain** is the response of a system to an applied **stress**.

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
	3.3	the characteristics on a force extension graph of the following types of material i.e. 1. brittle 2. ductile 3. polymeric	3.3	Learners should know that: A brittle material shows little elastic region on force extension graphs A ductile material has defined areas of elastic region and plastic deformation on force extension graphs Polymeric materials have no elastic limit on force extension graphs
	3.4	to identify the following on a graph of load versus extension for elastic and plastic materials i.e. 1. elastic region 2. elastic limit 3. plastic deformation 4. breaking point		
4. Know how to calculate mechanical motion and force	4.1	to identify types of motion and their characteristics i.e.: 1. linear 2. reciprocating 3. rotary 4. oscillating	4.1	Learners should know the characteristics of each motion listed and be able to identify each motion in engineering contexts (these could be shown as diagrams or images). For example, a mechanical hacksaw cuts in a linear motion, which is a straight line motion represented by a straight line with an arrow head at one end.

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
	4.2	to identify types of forces i.e. 1. compression 2. tension 3. torsion 4. bending	4.2	Be able to recognise and identify forces in action e.g. a bolt; when a nut is tightened the bolt is under tension. A piece of material in a bench vice is held under compression.
	4.3	to identify types of lever arrangements i.e.: 1. class 1 2. class 2 3. class 3	4.3	
	4.4	to calculate for a lever i.e.: 1. mechanical advantage (MA) 2. velocity ratio (VR)	4.4	Learners should identify the different types of lever arrangements (these could be shown as diagrams or images) and how they function including the position of • Effort • Load • Fulcrum Learners will need to recall and use the formulae below: MA = Load / Effort VR = Distance moved by effort / Distance moved by load

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
	4.5	to identify types of linkage system arrangements i.e.: 1. parallel 2. oscillating / reciprocating	4.5	Learners should identify the different types of linkage arrangements (these could be shown as diagrams or images) and how they function including the position of • fixed pivot • moving pivot
	4.6	to identify arrangements of types of pulley systems i.e. 1. 1:1 2. 2:1 3. 3:1 4. 4:1	4.6	Learners should identify the different arrangements for types of pulley systems (these could be shown as diagrams or images).
	4.7	to calculate for a pulley system arrangement i.e. 1. velocity ratio (VR) 2. output speed (OS) 3. input speed (IS)	4.7	Learners will need to recall and use the formulae below: **VR** = Driven pulley diameter / Driver pulley diameter **OS** = Input speed (IS) / Velocity ratio (VR) **IS** = Output speed (OS) x Velocity ratio (VR)
	4.8	to identify arrangement for types of gear system i.e.: 1. spur gear 2. worm gear 3. bevel gear 4. helical gear 5. rack and pinion	4.8	Learners should identify the different arrangements for types of gear systems (these could be shown as diagrams or images).

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
	4.9	to calculate for simple and compound gear assemblies i.e. 1. velocity ratio (VR) 2. output speed (OS) 3. input speed (IS)	4.9	Learners will need to recall and use the formulae below for simple gear assemblies: **VR** = Number of teeth on the driven gear / number of teeth on the driver gear **OS** = Input speed (IS) / Velocity ratio (VR) **IS** = Output speed (OS) x Velocity ratio (VR) Learners will need to calculate compound gear ratio for two sets of gears: Learners will need to recall and use the formula below: Compound gear ratio = Driven/ Driver x Driven/ Driver
5. Know electrical and electronic principles for electronic control and electrical motion	5.1	what is meant by direct current (DC)	5.1	Direct current – an electric current flowing in one direction only.
	5.2	what is meant by alternating current (AC)	5.2	Alternating current - an electric current that reverses its direction many times a second at regular intervals.
	5.3	to identify resistor circuits i.e. 1. resistors connected in series 2. resistors connected in parallel	5.3	Identify how resistors are connected in circuits from circuit diagrams.

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
	5.4	to calculate total resistance for resistors connected in: 1. series 2. parallel 3. series and parallel	5.4	There will only be two series resistors, two parallel resistors or one series resistor and two parallel resistors Learners will need to recall and use the following formulae: Two series resistors: $\mathbf{R_T} = R_1 + R_2$ Two parallel resistors: $\mathbf{1/R_T} = 1/R_1 + 1/R_2$ To add both answers together for series and parallel combinations
	5.5	to use Ohms Law to calculate in a series resistor circuit i.e. 1. voltage (V) 2. current (I) 3. resistance (R)	5.5	There will only be a series circuit containing one power source and one resistor. Learners will need to recall and use the Ohms Law formula: V=IR
	5.6	to use the power law to calculate in a series resistor circuit i.e. 1. power (P) 2. voltage (V) 3. current (I)	5.6	There will only be a series circuit containing one power source and one resistor. Learners will need to recall and use the power law formula: power (P) = IV
	5.7	to identify in a system block diagram i.e. 1. inputs 2. outputs 3. process 4. feedback	5.7	Learners will need to be able to read and identify inputs, process, outputs and feedback in a systems block diagram.

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
	5.8	to identify common input, process and output devices i.e. 1. input devices i.e. a. photodiode b. phototransistor c. LDR d. NTC thermistor e. switch f. microphone g. 'touch screen' 2. process devices i.e. a. diodes b. NPN transistors, i.e. i. single transistor as amplifier or switch c. Darlington Pair 3. output devices i.e. a. piezo-electric buzzers/sounders b. lamp c. Light Emitting Diode (LED) d. LED 7 segment display e. Liquid Crystal Display (LCD) display module f. solenoid g. relay	5.8	Learners should identify the different devices, these could be shown as images or circuit symbols.

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
	5.9	to identify logic gates from their symbol, i.e. 1. AND 2. OR 3. NAND 4. NOR	5.9	Identify logic gates with two inputs
	5.10	truth tables for two-input logic gates i.e. 1. AND 2. OR 3. NAND	5.10	Knows truth table for two-input logic gates to include inputs A and B and output.
	5.11	to identify key parts of a DC motor/generator i.e. 1. frame 2. field winding 3. armature / armature winding 4. commutator 5. brush	5.11	Learners should be able to identify from a sketch or drawing these key parts of a DC motor/generator
	5.12	the purpose of a commutator	5.12	Learners should know that a commutator is an attachment, connected with the armature of a motor through which electrical connection is made and which ensures the current flows as direct current.
	5.13	how motion is achieved in a DC motor i.e. 1. forward 2. reverse	5.13	Learners should know that direction of rotation of a DC motor is achieved by swapping over the supply connection to the motor.

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
	5.14	to identify DC motor winding connection configurations i.e. 1. series motor 2. shunt motor 3. compound motor	5.14	Learners should be able to identify DC motor winding connection configurations from circuit diagrams.
	5.15	to identify parts of a AC induction motor i.e. 1. frame 2. stator / electromagnets 3. rotor 4. bearings	5.15	Learners should be able to identify the parts of an AC motor.
	5.16	to identify AC motor winding connection configurations i.e. 1. star 2. delta	5.16	Learners should be able to identify AC motor winding connection configurations from circuit diagrams.
6. Know how to recognise fluid power components and their symbols and calculate fluid power	6.1	to carry out basic calculations for fluid power i.e. 1. pressure (P) 2. flow rate (Q) 3. force exerted (F)	6.1	Learners will be able to recall and use the following formulae: • Pressure (P) = force (F) /area (A) • Flow rate (Q) = volume (V) / time (t) • Force (F) = pressure (p) x area (A)

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		**The Learner must be taught:**		
	6.2	to identify common fluid power components and their symbols i.e. 1. supply and storage i.e. a. compressor / pump b. receiver 2. cylinders and actuator i.e. a. linear single acting b. linear double acting 3. valves i.e. a. directional b. reducing c. regulating d. non-return e. 3/2 f. 5/3 g. shuttle h. activation types i.e. i. push ii. lever iii. roller tip iv. solenoid	6.2	Identifies symbols within fluid power circuits for common components i.e. supply and storage, cylinders and actuators and valves Both pneumatic and hydraulic components must be considered.

SYNOPTIC ASSESSMENT AND LINKS BETWEEN UNITS

It will be possible for learners to make connections between other units over and above the unit containing the key tasks for synoptic assessment, please see section 6 of the centre handbook for more detail.

Synoptic assessment grid

This unit and specific LO	Related unit	Related LO
Unit 1 LO1 Know what common SI units and their derivatives are and how to use them in engineering	Unit 2	LO1 1.1, 1. 2 LO4 4.7
	Unit 3	LO3 3.1, 3.2, 3.3, 3.4 LO4 4.1 LO6 6.1, 6.2
	Unit 4	LO2 2.1 LO3 3.1, 3.2
	Unit 5	LO1 1.1, 1.3 LO2 2.1
	Unit 6	LO1 1.1 LO3 3.1, 3.2 LO4 4.1 LO5 5.1
	Unit 7	LO1 1.2 LO3 3.1, 3.2, 3.3 LO4 4.1, 4.2
	Unit 8	LO3 3.1, 3.2, 3.3, 3.4, 3.5

This unit and specific LO	Related unit	Related LO
Unit 1 LO2 Know how to classify common engineering materials	Unit 2	LO2 2.1, 2.2 LO3 3.1
	Unit 3	LO4 4.1
	Unit 7	LO1 1.1, 1.2 LO2 2.1 LO3 3.1, 3.2, 3.3 LO4 4.2
Unit 1 LO3 Know physical properties of engineering materials in relation to mechanics, motion and forces	Unit 2	LO1 1.1, 1. 2 LO2 2.1, 2.2 LO3 3.1
	Unit 3	LO5 5.1, 5.2 LO5 6.1, 6.2
	Unit 7	LO1 1.1, 1.2 LO3 3.1, 3.2, 3.3
	Unit 8	LO3 3.3, 3.4, 3.5
Unit 1 LO4 Know how to calculate mechanical motion and force	Unit 2	LO1 1.1, 1. 2 LO5 5.2
	Unit 3	LO6 6.1
	Unit 5	LO2 2.1
	Unit 7	LO4 4.1, 4.2

This unit and specific LO	Related unit	Related LO
Unit 1 LO5 Know electrical and electronic principles for electronic control and electrical motion	Unit 2	LO4
	Unit 4	LO1 1.1, 1.2, 1.3 LO2 2.1, 2.2, 2.3, 2.4, 2.5, 2.6 LO3 3.1, 3.2
	Unit 5	LO1 1.1, 1.2, 1.3 LO2 2.1, 2.2 LO3 3.1, 3.2 LO4 4.1
Unit 1 LO6 Know how to recognise fluid power components and their symbols and calculate fluid power	Unit 2	LO5
	Unit 5	LO2 2.1

ASSESSMENT GUIDANCE

All Learning Outcomes are assessed through externally set written examination papers, worth a maximum of 40 marks and 45 minutes in duration. Learners should study the design requirements, influences and user needs within the taught content in the context of a range of real engineered products. Exam papers for this unit will use engineered products as the focus for some questions, however it is not a requirement of this unit for learners to have any detailed prior knowledge or understanding of particular products used. Questions will provide sufficient product information to be used, applied and interpreted in relation to the taught content. During the external assessment, learners will be expected to demonstrate their understanding through questions that require the skills of analysis and evaluation in particular contexts.

LEARNING OUTCOME WEIGHTINGS

LO1	12.5%
LO2	17.5%
LO3	10%
LO4	22.5%
LO5	22.5%
LO6	15%

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.

Meaningful employer involvement – eligible activities	Suggestion/ideas for centres when delivering this unit
2. Students undertake project(s), exercises(s) and/or assessments/examination(s) set with input from industry practitioner(s).	Externally-assessed examination for this unit could be scrutinised by an industrialist being a member of the AMEC team.
3. 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.
4. Industry practitioners operating as 'expert witnesses' that contribute to the assessment of a student's work or practice, operating within a specified assessment framework. This may be a specific project(s), exercise(s) or examination(s), or all assessments for a qualification.	Industrial experts are co-opted to join the awarding team for the qualification.

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

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