2016 Suite

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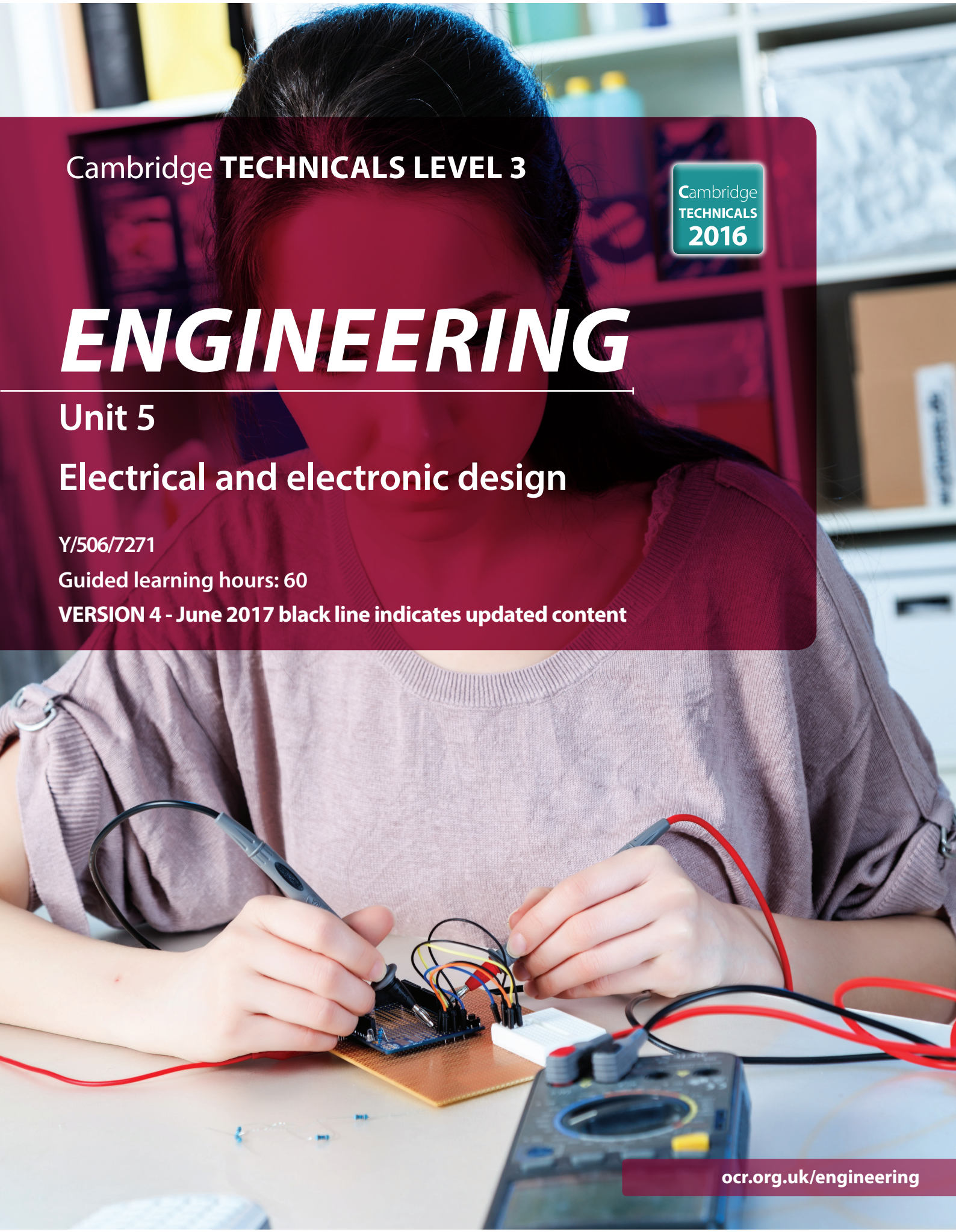

Cambridge **TECHNICALS LEVEL 3**

Cambridge TECHNICALS 2016

ENGINEERING

Unit 5

Electrical and electronic design

Y/506/7271

Guided learning hours: 60

VERSION 4 - June 2017 black line indicates updated content

ocr.org.uk/engineering

LEVEL 3

UNIT 5: ELECTRICAL AND ELECTRONIC DESIGN

Y/506/7271

Guided learning hours: 60

Essential resources required for this unit: none

This unit is internally assessed and externally moderated by OCR.

UNIT AIM

All electrical and electronic devices rely on their components working effectively. This in turn relies on effective manufacture, and ultimately on the successful design of electrical components.

The aim of this unit is for learners to develop the ability to be able to apply knowledge of AC and DC circuit theory to circuit design, and to apply a systems approach to electrical design, developing knowledge of the component devices needed to be able to do this.

Learners will develop an understanding of the applications of electromagnetism in electrical design, and the ability to be able to use both semi-conductors and programmable process devices in their designs.

TEACHING CONTENT

The teaching content in every unit states what has to be taught to ensure that learners are able to access the highest grades.

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, it should be noted that where e.g. is used, learners must know and be able to apply relevant examples in their work, though these do not need to be the same ones specified in the unit content.

For internally assessed units you need to ensure that any assignments you create, or any modifications you make to an assignment, do not expect the learner to do more than they have been taught, but they must enable them to access the full range of grades as described in the grading criteria.

Please note – if learners are completing this unit as part of the Extended Diploma qualification they will be required to complete the synoptic unit 25: Promoting continuous improvement. Before your learners complete the assessment of this unit, you must refer to the specification and model assignment requirements for unit 25, so if applicable you can ensure learners gather the appropriate feedback on their own performance and performance of the system, process or artefact that they may have produced in this unit.

Learning outcomes	Teaching content
The Learner will:	**Learners must be taught:**
1. Be able to apply AC and DC circuit theory to circuit design	1.1 IET circuit symbols 1.2 how to design DC circuits i.e. • circuit layout (e.g. DC power source, resistors in series, resistors in parallel, series and parallel combinations, potential divider) • application of Ohm's law, power calculations (e.g. V = IR, P = IV, P = I^2R) • application of Kirchhoff's voltage and current laws • DC networks i.e. o potential divider network o networks with one DC power source and at least five components e.g. DC power source with two series resistor and three parallel resistors connected in a series/parallel arrangement • application and function of resistor/capacitor circuits i.e. RC time constant 1.3 how to design AC circuits i.e. • using phasor and algebraic representation of alternating quantities e.g. graphical and phasor addition of two sinusoidal voltages, reactance and impedance of pure R, L and C components • power factor • passive filters i.e. o low-pass o high-pass 1.4 how to apply power sources i.e. • cell, battery (i.e. alkaline, rechargeable (NiMh, Lithium-ion)) • solar cell • rectification (i.e. full wave diode bridge, half wave diode bridge) • capacitor smoothing • voltage regulators (e.g. zener diode, 3-terminal voltage regulators e.g. LM7805, LM7812) • stabilised power supply configurations (i.e. linear, switch mode) 1.5 how to apply circuit protection i.e. fuse, diode, resettable thermal fuse, circuit breaker (e.g. over current and earth leakage types)

Learning outcomes	Teaching content
The Learner will:	**Learners must be taught:**
2. Understand the application of electromagnetism in electrical design	2.1 How to apply electromagnetism in electrical design i.e. • transformer i.e. primary and secondary current and voltage ratio, turns ratio • application of Faraday's and Lenz's laws (e.g. for coil, inductor, solenoid, relay) • electric motor/generator i.e. o DC motor and generator (i.e. series and shunt motor/generator) o AC motor (i.e. single phase motor, 3-phase motor) • magnetic screening • electromagnetic compatibility (EMC) i.e. o radiated o conducted
3. Be able to apply a systems approach to electrical design	3.1 how to apply a systems approach to electrical design i.e. • open and closed loop • input, process and output • feedback • development of system block diagrams 3.2 function, application and operation of input devices i.e. • switches (i.e. latched and momentary action) • photodiode • phototransistor • LDR • NTC thermistor • microphone 3.3 function, application and operation of output devices, i.e. • piezo-electric buzzers/sounders • lamp • Light Emitting Diode (LED) • LED 7 segment display • Dot matrix display • Liquid Crystal Display (LCD) display module • solenoid • relay • speaker

Learning outcomes	Teaching content
The Learner will:	**Learners must be taught:**
4. Be able to use semi-conductors in electrical and electronic design	4.1 function, application and operational analysis of semiconductor devices and associated circuits, i.e. • diodes • NPN transistors, i.e. o analysis of single transistor as a switch o analysis of single transistor as a common emitter amplifier • Darlington Pair configuration (i.e. single Darlington Pair transistor, Darlington Pair arrays) • transistor arrays 4.2 function, application and operational analysis of integrated circuits and associated circuits, i.e. • operational amplifier (op-amp) circuits i.e. o comparator o summing amplifier • logic gates - singly and in combinational logic functions i.e. o AND o OR o NAND o NOR o NOT o XOR o NAND/NOR equivalent circuits o truth tables • flip-flop circuits i.e. o SR-NOR o SR-NAND o JK-type o D-type o T-type • Binary and Decimal Counters • 7 segment display decoders
5. Understand the application of programmable process devices in electronic design	5.1 applications of programmable process devices in electronic systems (e.g. production/assembly systems, engine control systems, office machines, domestic appliances) 5.2 system layout of programmable process devices in electronic systems i.e. • microprocessor • microcontroller • programmable interface controller (PIC) • programmable logic controller (PLC) 5.3 function and interrelationship of component parts of programmable control systems i.e. • input devices (e.g. switch, temperature, position, light, flow, pressure) • control/process device (e.g. microprocessor, microcontroller, PIC, PLC) • output devices (e.g. lamp, sounder/speaker, solenoid, relay) 5.4 operational analysis of control systems within a product or system that uses a programmable control device

GRADING CRITERIA

LO	Pass	Merit	Distinction
	The assessment criteria are the Pass requirements for this unit.	To achieve a Merit the evidence must show that, in addition to the Pass criteria, the candidate is able to:	To achieve a Distinction the evidence must show that, in addition to the pass and merit criteria, the candidate is able to:
1. Be able to apply AC and DC circuit theory to circuit design	P1: Use DC circuit theory to calculate current, voltage and resistance in DC networks. **Synoptic links to Unit 2 Science for engineering **and** to Unit 4 Principles of electrical and electronic engineering*	M1: Use Kirchhoff's laws to determine the current in a network .	D1: Design a power supply circuit that includes a transformer, rectifier, smoothing capacitors, voltage regulator and circuit protection.
	P2: Determine the relationship between the voltage and current for a charging and discharging capacitor.	M2: Explain the application and operation of low-pass and high-pass filters.	
	P3: Compare the results of adding and subtracting two sinusoidal AC waveforms graphically and by phasor diagram. **Synoptic link to Unit 4 Principles of electrical and electronic engineering*		
	P4: Explain the significance of power factor in AC circuits.		
	P5: Explain different power sources and their applications and features .		

LO	Pass	Merit	Distinction
	P6: Compare methods of circuit protection for different applications. **Synoptic link to Unit 4 Principles of electrical and electronic engineering*		
2. Understand the application of electromagnetism in electrical design	P7: Calculate primary and secondary current, voltage ratio and turns ratio in a transformer.	M3: Explain electromagnetic compatibility (EMC).	D2: Evaluate the performance of a motor and a generator with reference to electrical theory.
	P8: Explain the reasons for magnetic screening in electrical design and how it can be achieved.		
3. Be able to apply a systems approach to electrical design	P9: Explain with examples the systems approach to electrical and electronic design.		
	P10: Explain applications, function and operation of a range of input and a range of output devices.		
4. Be able to use semi-conductors in electrical and electronic design	P11: Explain the function and application of semi-conductor process devices and integrated circuits in circuit design.	M4: Analyse the operation of a diode and a single NPN transistor amplifier within a circuit.	D3: Analyse the operation of individual circuits containing a single op-amp, single flip-flop and combinational logic functions.
5. Understand the application of programmable process devices in electronic design	P12: Explain the function and layout of diverse applications which use programmable devices.	M5: Analyse the operation of diverse applications which use programmable devices.	

*SYNOPTIC ASSESSMENT AND LINKS BETWEEN UNITS

When learners are taking an assessment task, or series of tasks, for this unit they will have opportunities to draw on relevant and appropriate knowledge, understanding and skills that they will have developed through other units. We've identified those opportunities in the grading criteria. Learners should be encouraged to consider for themselves which skills/knowledge/understanding are most relevant to apply where we have placed an asterisk.

ASSESSMENT GUIDANCE

LO1: Be able to apply AC and DC circuit theory to circuit design
Learners should be able to apply appropriate theory and techniques to solving problems involving AC and DC circuits. For D1 learners might design a power supply circuit theoretically or practically if access to suitable resources is available.

LO2: Understand the application of electromagnetism in electrical design
Learners should perform calculations in order to determine transformer ratios, and explain electromagnetic compatibility and screening. For D2 the evaluation of the performance of a motor and a generator can be undertaken theoretically or as a practical activity if access to suitable resources is available.

LO3: Be able to apply a systems approach to electrical design
Learners should use suitable examples in order to apply a systems approach to electrical design. Teachers may select suitable examples for learners to use.

LO4: Be able to use semi-conductors in electrical and electronic design
Learners should explain and analyse the semiconductor devices specified. For M4 and D3 circuit analysis might be undertaken as a theoretical activity, through simulation or might be as the result of a practical experiment.

LO5: Understand the application of programmable process devices in electronic design
Learners should explain and analyse the function, layout and operation of systems using programmable process devices (i.e. microprocessor microcontroller, programmable interface controller (PIC), programmable logic controller (PLC)). They should not unduly focus on the internal architecture of these devices which is considered in more detail in another unit.

Feedback to learners: you can discuss work-in-progress towards summative assessment with learners to make sure it's being done in a planned and timely manner. It also provides an opportunity for you to check the authenticity of the work. You must intervene if you feel there's a health and safety risk.

Learners should use their own words when producing evidence of their knowledge and understanding. When learners use their own words it reduces the possibility of learners' work being identified as plagiarised. If a learner does use someone else's words and ideas in their work, they must acknowledge it,

and this is done through referencing. Just quoting and referencing someone else's work will not show that the learner knows or understands it. It has to be clear in the work how the learner is using the material they have referenced to inform their thoughts, ideas or conclusions.

For more information about internal assessment, including feedback, authentication and plagiarism, see the centre handbook. Information about how to reference is in the OCR Guide to Referencing available on our website: http://www.ocr.org.uk/i-want-to/skills-guides/.

MEANINGFUL EMPLOYER INVOLVEMENT - a requirement for the Foundation Diploma, Diploma and Extended Diploma (tech level) qualifications

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

The minimum amount of employer involvement must relate to at least one or more of the elements of the mandatory content (this unit is a mandatory unit in the Electrical and Electronic Engineering pathway).

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 engagement	Suggestion/ideas for centres when delivering this unit
1. Learners undertake structured work-experience or work-placements that develop skills and knowledge relevant to the qualification.	Placements with engineering firms working with electrical/electronic design or maintenance department researching common system standards and the impact of electronic design on manufacture in the real world.
2. Learners undertake project(s), exercises(s) and/or assessments/examination(s) set with input from industry practitioner(s).	Project set on product design or re-design of electrical components, using industry standard equipment and design standards, to determine if the design of a product (such as a PCB) is suitable for a given application.
3. Learners 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.	Lecture from practicing electrical design engineers involved in product design, development and testing. Content to include examples of electrical/electronic design principles, a formal systems approach and how electronic devices are used within professional commercial electrical/electronic engineering practice.
4. Industry practitioners operating as 'expert witnesses' that contribute to the assessment of a learner'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.	Review from practicing electronic design engineers relating to the accuracy of circuit design and appropriate proposed use of devices during learners' project work and documentation

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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