2016 Suite

OCR
Oxford Cambridge and RSA

Cambridge **TECHNICALS LEVEL 2**

Cambridge TECHNICALS 2016

ENGINEERING

Unit 5

Engineering systems control - operations and application

R/615/2135

Guided learning hours: 60

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LEVEL 2

UNIT 5: ENGINEERING SYSTEMS CONTROL - OPERATIONS AND APPLICATION
R/615/2135

Guided learning hours: 60

Essential resources required for this unit: Programmable device and programming software (e.g. PIC, PLC), suitable sensors and actuators, electrical interconnections, suitable mechanical components (e.g. pulleys, levers, gears, linkages)

This unit is internally assessed and externally moderated by OCR.

Unit aim

Automation control systems exist in every area of engineering and can also be found in numerous other domestic and commercial applications. These automation control systems are fundamental to the effective operation of most aspects of the built environment and require engineers to programme, operate or maintain them.

The aim of this unit is for learners to implement an automated control system including the electrical/electronic and mechanical aspects of the system.

Learners will develop both knowledge and skills of:

- the key components, applications and basic architecture of programmable devices
- construction of an automated control system using sensors/ transducers, actuators and mechanical devices
- programming an identified automated control system
- testing the operation of an automated control system.

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

Learning Outcome **The Learner will:**		**Teaching Content** **The Learner must be taught:**
1. Understand the key components, applications and basic architecture of programmable devices	1.1	key component parts of a programmable system i.e. • input devices (e.g. switch, temperature sensor, position sensor, light sensor, flow sensor , pressure sensor) • control device (e.g. microprocessor, microcontroller) • output device (e.g. motor, lamp, sounder/speaker, solenoid, relay)
	1.2	applications of programmable devices i.e. • microprocessor/ microcontroller (e.g. production assembly systems, engine control, office machines, domestic appliances) • Programmable Logic Controllers (PLCs) (e.g. industrial electromechanical processes, control of assembly line machinery, amusement rides, light fixtures)
	1.3	basic architecture of a programmable device i.e. • inputs / outputs • processing (central processing unit CPU) • programme/OS (Operating System), storage (e.g. programming software, programming panel, computer language, ladder logic) • feedback systems (open and closed loop) (e.g. relationship between input sensors, and output actuators via the user programme of a programmable device, feedback/ non-feedback)

Learning Outcome The Learner will:		Teaching Content The Learner must be taught:
2. Be able to construct an automated control system using sensors/ transducers, actuators and mechanical devices	2.1	the interaction of sensors/ transducers, actuators and mechanical devices in a control system (e.g. sensor detects an object's position on an assembly line; actuator controls movement of an arm, mechanical device picks up the object) i.e. • sensors/ transducers i.e. o sensor/ transducer categories i.e. ▪ input/ output i.e. - analogue (e.g. sensors that produce an analogue input/ output - tachogenerator) - digital (e.g. sensors that produce a digital input/ output - rotary pulse encoder) ▪ power i.e. - active (e.g. sensors that require a power supply to operate - ultrasonic transducer) - passive (e.g. sensors that do not require a power supply to operate - switch) ▪ signal command i.e. - inhibiter (e.g. used to stop, limit travel, stop rotation, detect position) - initiator (e.g. used to start, carry on, establish proximity, new stage or sequence) o sensor/ transducer applications i.e. ▪ switch (e.g. counter, end of travel, activation, stop) ▪ proximity sensor (e.g. reversing sensors, travel, contact) ▪ rotary position sensor (e.g. timing, speed) ▪ light sensor (e.g. PIR lights, dawn to dusk, optical switch) ▪ temperature sensor (e.g. water, air) chemical sensor (e.g. to measure pH balance, salinity, lambda (oxygen)) • actuators i.e. o actuator inputs/ outputs i.e. ▪ sound (e.g. warning, information) ▪ light (e.g. warning, information, signal) ▪ movement (e.g. rotary, linear, oscillating, reciprocating) ▪ temperature (e.g. heating element)

Learning Outcome The Learner will:		Teaching Content The Learner must be taught:
		o actuator categories i.e. ▪ mechanical (e.g. convert hydraulic, pneumatic or electrical power into mechanical motion, by gears, belt, levers, pulleys) ▪ electric (e.g. powered by motors that convert electrical energy to mechanical torque) ▪ fluid power i.e. - hydraulic (e.g. a cylinder or fluid motor that utilizes hydraulic power to facilitate mechanical process) - pneumatic (e.g. compressed gas motor that utilizes pneumatic power to facilitate mechanical process) o actuators applications i.e. ▪ electrical as a i.e. - switch - relay - solenoid - servo - stepper motor - motor ▪ fluid power as a i.e. - cylinder - motor - switch/ valve • mechanical devices i.e. o mechanical device applications i.e. ▪ parallel linkage (oscillating/reciprocating) ▪ gears/ pulleys ▪ levers ▪ belts ▪ components (e.g. standard, pre-manufactured, hand manufactured, machine manufactured)
	2.2	to implement an automated control system using sensors/ transducers, actuators and mechanical devices i.e. • interpret designs, components and symbols • apply structures/ layouts for identified designs • construct control system to a given design
3. Be able to programme an identified automated control system	3.1	to identify the functions and processes needed to meet the requirements of an automated control system i.e. • functions (e.g. start/ stop, process, decision, actuation) • use of block diagrams to represent control systems functions, i.e.: o components of block diagrams o input, process (including feedback/variables) and output • design sets of instructions for control system functions i.e. o repeat loops and subroutines o flow charts to map logic flow o logical instructions in programming (e.g. logic operations, comparison operations, arithmetic operations)

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

	3.2	to write code for an automated control system programme to consider criteria, i.e.
		• language choice i.e.
		  o object-oriented (e.g. VB, VBA, Scratch, App inventor, iPhone Apps)
		  o procedural (e.g. basic)
		  o Scripting languages (e.g. VB Script, Action Script, JavaScript, Game Maker)
		• break down solutions into simple steps
		• declaring and using different types of variables and constants
		• use assignment operators to store data in variables and constants
		• use relational operators to compare the values in variables
		• use mathematical operators to perform calculations using variables
		• use the programming constructs of sequence, selection and iteration to produce working routines.
		• annotate and document code to explain how it works and to assist in maintenance and debugging.
		• present solutions using algorithms (e.g. flow diagrams and structured English)
		• identify measurable success criteria.

	3.3	to implement control system programme from designs which use a range of sensors and actuators i.e. • transfer/load programme to programmable device (e.g. transfer computer programme code from computer to a microcontroller)
4. Be able to test the operation of an automated control system	4.1	to develop a test plan to ensure correct functionality of an automated control system (e.g. turn off water feed to container when correct fluid level reached) i.e. • devise test plans to ensure functionality of control systems • test control systems using a test plan to evaluate the performance of the system • interpret test results (e.g. recognise different types of errors, syntax, logic and run-time) • evaluate test results against the expected outcomes and success criteria • make system corrections/refinements based on results of test plan

GRADING CRITERIA

Learning Outcome	Pass	Merit	Distinction
The learner will:	The assessment criteria which 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. Understand the key components, applications and basic architecture of programmable devices	P1: Explain the inputs, outputs and functions for control systems	M1: Describe the architecture and applications for programmable devices	
	P2: Explain the relationships of feedback systems		
2. Be able to construct an automated control system using sensors/ transducers, actuators and mechanical devices	P3: Construct a designed automated control system to include identified components	M2: Enhance constructed control system using different components to extend or improve functionality	D1: Produce an annotated design solution for a complete control system solution justifying the components used
3. Be able to programme an identified automated control system	P4: Create block diagrams to represent system functions	M3: Implement the transfer or load of a programme to operate the identified programmable device	D2: Interpret and document results of testing detailing corrections and refinements that have been made in an automated control system
	P5: Create instruction sets for identified automated control system functions		
	P6: Write programme code for an identified automated control system		
4. Be able to test the operation of an automated control system	P7: Develop a test plan for an identified control system		
	P8 Test identified control system against test plan		

ASSESSMENT GUIDANCE

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/.

P1/2
Learners could produce a report or presentation (including detailed speaker notes) to explain inputs, outputs and functions for control systems, and the relationships of feedback systems.

M1
Learners could produce a report or presentation (including detailed speaker notes) to describe the architecture and applications for programmable devices.

P3
Learners must be able to select appropriate sensors/ transducers, actuators and/or mechanical devices to construct an identified system design. Tutors should ensure that the identified system design allows learners to demonstrate appropriate selection of input and output components. Evidence of the construction could be in the form of a documentary record (e.g. log) which must include diagrams, procedures and photographs of construction taking place.

M2
Learners must evidence where they have made improvements or enhancements to the identified system which will benefit the functionality. Evidence of the improvements could be in the form of a documentary record (e.g. log) which must include diagrams, procedures and photographs of construction taking place.

D1
Learners must ensure that any documentation on which they have based their system is annotated and extended to include the justification of components used. Evidence of the improvements could be in the form of an annotated diagram (including the justification of components used) and photographic evidence of construction taking place.

P4- P6
Learners must represent system functions in the form of a block diagram or flow chart, accompanied by an instruction set. Learners should write the programme code for the identified system integrating instruction sets as appropriate. Evidence could be in the form of annotated block diagrams or flow charts, annotated screen shots, printed written code, but it must be sufficient to show that all three LO3 pass criteria have been covered.

M3
Learners should know how to transfer or upload the programme they have created to the identified programmable device. Evidence could be in the form of annotated screen shots or photographic evidence.

P7
Evidence should be in the form of a formal test plan and should include relevant tests to fully test the new programme that learners have created.

P8
Learners must show how they have tested the new programme against the test plan created in P7. Evidence could be in the form of annotated screen shots and/or annotated photographs.

D2
Learners must show how they have interpreted and documented the results of the tests, showing where corrections and refinements have been made. Evidence of the testing and refinements could be in the form of a documentary record (e.g. log) which should include procedures and photographs of testing taking place, test results and refinements made.

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 5 LO1 Understand the key components, applications and basic architecture of programmable devices	Unit 1	LO1 1.1, 1.2, 1.3, 1.4 LO5 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, LO6 6.1, 6.2
	Unit 2	LO4 4.1, 4.2, 4.3, 4.4, 4.6, 4.7 LO5 5.1, 5.2, 5.3
	Unit 3	LO3 3.1
	Unit 4	LO2 2.1, 2.2, 2.3, 2.4
Unit 5 LO2 Be able to construct an automated control system using sensors/ transducers, actuators and mechanical devices.	Unit 1	LO1 1.1, 1.2, 1.3, 1.4 LO5 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, LO6 6.1, 6.2
	Unit 2	LO4 4.1, 4.2, 4.3, 4.4, 4.6, 4.7 LO5 5.1, 5.2, 5.3
	Unit 3	LO3 3.1
	Unit 4	LO2 2.1, 2.2, 2.3, 2.4
Unit 5 LO4 Be able to test the operation of an automated control system	Unit 4	LO3 3.1, 3.2
	Unit 8	LO4 4.2

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.

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.	Placements with engineering employer working with the manufacturing or maintenance department responsible for programming and maintaining automated control systems.
2. Students undertake project(s), exercises(s) and/or assessments/examination(s) set with input from industry practitioner(s).	A project set by a systems programmer to produce an automated control system using industry standard equipment/software, to enable simple operations to be performed.
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.	Lecture from a practicing engineer involved in specifying, maintenance, and development and testing of programming for control systems.
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.	Review by practicing Automation Control engineer of an automated control system programme written by students and its appropriateness for use in the intended application.

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**