

Cambridge **TECHNICALS LEVEL 3**

Cambridge
TECHNICALS
2016

ENGINEERING

Unit 16

Systems and programming

J/506/7282

Guided learning hours: 60

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LEVEL 3

UNIT 16: SYSTEMS AND PROGRAMMING

J/506/7282

Guided learning hours: 60

Essential resources required for this unit: suitable programming software, embedded system*, Programmable Logic Controller (PLC)*

* physical hardware/software or simulation tools are possible alternatives

This unit is internally assessed and externally moderated by OCR.

UNIT AIM

Industrial automation control systems are run by engineers who can program them to perform the tasks needed in industries such as manufacturing or power generation. These engineers need an understanding of programming methods and techniques in the specific context of industrial control systems.

The aim of this unit is for learners to develop an understanding of these programming techniques, and the ability to program Programmable Logic Controllers (PLCs) (including the principles of ladder logic programming), and other embedded devices for a control system.

They will also gain an understanding of commercial validation strategies for automation control programs, and the levels and types of testing carried out.

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, although 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 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. Understand programming techniques	1.1 basic architectures of devices, i.e. <ul style="list-style-type: none"> • Programmable Interface Controllers (PICs) • microprocessor • microcontroller 1.2 use of logical instructions in programming 1.3 conversion of high level programming languages to machine code and then to binary/hexadecimal 1.4 Boolean algebra in logic programming 1.5 how to use flow charts to map logic flow 1.6 how to use modules to break down complex programs 1.7 how to use subroutines in programs 1.8 how to use comments for maintenance and debugging
2. Be able to program embedded devices in a system	2.1 how embedded devices (e.g. Programmable Interface Controllers (PICs) and microcontrollers) differ from microprocessors 2.2 practical applications for embedded devices (e.g. vehicle engine control unit, washing machine) 2.3 how to apply programming technique for an embedded device (e.g. PIC or microcontroller) including the testing and validation of programs
3. Be able to program Programmable Logic Controllers (PLCs)	3.1 historical development of ladder logic programming for PLCs 3.2 the structure of ladder logic, i.e. <ul style="list-style-type: none"> • inputs/outputs – contacts/coils • counters and timers • subroutines • latching operations • how to construct ladder diagrams to achieve control functions • how to configure program logic to achieve Boolean operations 3.3 how to load and operate PLC programs 3.4 sequential cycling and speed of execution issues 3.5 how to use simulation software to model, test and validate PLC programs

Learning outcomes	Teaching content
The Learner will:	Learners must be taught:
4. Understand commercial testing and validation strategies	<p>4.1 limitations of software validation</p> <p>4.2 structured approaches to testing of software in order to minimise defects (bugs)</p> <p>4.3 the four accepted levels of testing, i.e.</p> <ul style="list-style-type: none"> • unit testing • integration testing • system testing • acceptance testing <p>4.4 acceptance testing for software systems, i.e.</p> <ul style="list-style-type: none"> • Alpha testing (internal) • Beta testing (external) <p>4.5 metrics used to assess quality of software (e.g. defect density)</p>

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. Understand programming techniques	P1: Interpret the basic architectures of devices.	M1 Explain the conversion of high level programming languages to machine code and then to binary/hexadecimal.	D1: Produce a well-structured and documented program for an embedded device applying appropriate programming techniques.
	P2: Apply logic functions derived from Boolean operations. <i>*Synoptic link - Unit 1 Mathematics for engineering and Unit 4 Principles of electrical and electronic engineering</i>		
	P3: Explain the use of flow charts, modules, subroutines and comments in programming.		
2. Be able to program embedded devices in a system	P4: Explain how embedded devices differ from microprocessors.		
	P5: Describe practical applications for embedded devices.		
	P6: Write a program for an embedded device.		

LO	Pass	Merit	Distinction
3. Be able to program Programmable Logic Controllers (PLCs)	P7: Model a PLC program that demonstrates understanding of ladder logic.	M2: Construct ladder code to represent a latching function.	
	P8: Load and operate a PLC program.		
4. Understand commercial testing and validation strategies	P9: Explain structured approaches to the testing of software.	M3: Analyse the differences between the commercial use of alpha and beta testing.	D2 Evaluate how metrics are used commercially to assess quality of software.
	P10: Explain the four accepted levels of testing.		

*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, 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: Understand programming techniques

Learners should interpret the basic architecture of programmable devices, and be able to apply a range programming techniques. They should also demonstrate a structured approach to programming (e.g. through the use of flow charts etc.). Teachers may adopt a suitable programming language for learners to use. Learners could develop programs for different scenarios to demonstrate a range of programming techniques.

LO2: Be able to program embedded devices in a system

Learners should develop programs for embedded programmable devices. Ideally, learners should develop programs to run on physical (low cost) hardware although simulation tools might be used. Teachers might present learners with scenarios for which to develop programs.

LO3: Be able to program Programmable Logic Controllers (PLCs)

Learners should develop programs for Programmable Logic Controllers (PLCs). Ideally, learners should program a physical PLC, although it is feasible to demonstrate programs using simulation tools. Teachers might present learners with scenarios for which to develop programs.

LO4: Understand commercial testing and validation strategies

Learners should investigate commercial software testing and validation strategies.

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 Automation, Systems and Control 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 the manufacturing or maintenance department responsible for programming and maintaining PLC related equipment and software, researching the programming of embedded devices.
2. Learners 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 a PLC program(s) using industry standard equipment/software, to enable simple operations to be performed.
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 a practicing Manufacturing/Maintenance engineer involved in specifying, maintenance, and development and testing of programming for control systems. Content to include their own examples of the methodology, calculations, logic diagrams and working documentation used within their professional commercial 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 by practicing Manufacturing/Maintenance engineers of a PLC program written by students and its appropriateness for use in the intended application.

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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