Cambridge NATIONALS

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CAMBRIDGE NATIONALS IN ENGINEERING

R116 - PROCESS CONTROL SYSTEMS

DELIVERY GUIDE

VERSION 1

OCR
Oxford Cambridge and RSA

CONTENTS

To give us feedback on, or ideas feedback text the OCR resources you have used, email resourcesfeedback@ocr.org.uk

INTRODUCTION

This Delivery Guide has been developed to provide practitioners with a variety of creative and practical ideas to support the delivery of this qualification. The Guide is a collection of lesson ideas with associated activities, which you may find helpful as you plan your lessons.

OCR has collaborated with current practitioners to ensure that the ideas put forward in this Delivery Guide are practical, realistic and dynamic. The Guide is structured by learning objective so you can see how each activity helps you cover the specification.

We appreciate that practitioners are knowledgeable in relation to what works for them and their learners. Therefore, the resources we have produced should not restrict or impact on practitioners' creativity to deliver excellent learning opportunities.

Whether you are an experienced practitioner or new to the sector, we hope you find something in this guide which will help you to deliver excellent learning opportunities.

If you have any feedback on this Delivery Guide or suggestions for other resources you would like OCR to develop, please email resourcesfeedback@ocr.org.uk.

PLEASE NOTE

The activities suggested in this Delivery Guide MUST NOT be used for assessment purposes. (This includes the Consolidation suggested activities).

The timings for the suggested activities in this Delivery Guide DO NOT relate to the Guided Learning Hours (GLHs) for each unit.

Assessment guidance can be found within the Unit document available from www.ocr.org.uk.

The latest version of this Delivery Guide can be downloaded from the OCR website

OPPORTUNITIES FOR ENGLISH AND MATHS SKILLS DEVELOPMENT

We believe that being able to make good progress in English and maths is essential to learners in both of these contexts and on a range of learning programmes. To help you enable your learners to progress in these subjects, we have signposted opportunities for English and maths skills practice within this resource. These suggestions are for guidance only. They are not designed to replace your own subject knowledge and expertise in deciding what is most appropriate for your learners.

KEY

English

Maths

UNIT R116 - PROCESS CONTROL SYSTEMS

Guided learning hours : 30

PURPOSE OF THE UNIT

This unit will develop learners' knowledge of microprocessor/microcontroller control systems in engineering systems such as production, engine control, domestic appliances and office equipment. Learners will study a range of systems designs and consider how each system uses appropriate input and output devices.

Learners will develop knowledge and understanding of the design, simulation and testing of microprocessor/microcontroller control systems and consider how a systems design problem is best solved through the use of appropriate sensor, transducer and programmable logic controllers (PLC)/programmable interface controllers (PIC) devices. Learners are required to test the performance of their design system and be able to transfer their program to a programmable device.

On completion of this unit, learners will understand how microprocessor/microcontroller control systems are used in engineering systems and be able to design and test a simple control system.

Learning Outcome — The learner will:
LO1: Understand the application and operation of microcontrollers and microprocessors in engineered products
LO2: Be able to design, develop and simulate a control system solution
LO3: Be able to test control systems

LO1 - UNDERSTAND THE APPLICATION AND OPERATION OF MICROCONTROLLERS AND MICROPROCESSORS IN ENGINEERED PRODUCTS

Learning Outcome — The learner will:
LO1: Understand the application and operation of microcontrollers and microprocessors in engineered products

Suggested content	Suggested activities	Suggested timings	Possible relevance to
1 Lesson Element: System layouts 	Teachers could set learners a research-based activity to explore the layout of microprocessors and microcontrollers in commercial products or systems. Manufacturer's websites might prove a useful starting point with the following showing the system layout of a Texas Instruments microcontroller in a microwave oven application: http://www.ti.com/solution/microwave_oven Learners could explore a range of applications and produce a poster of their findings. They might draw simple block diagrams, summarise key features and compare similarities and differences between systems using a microprocessor and microcontroller. See Lesson Element: System layouts.	2 hours	
2 Applications of microprocessors and microcontrollers 	Learners could extend their knowledge by continuing to research a range of applications of microprocessors and microcontrollers in products and systems (eg production/assembly systems, engine control systems, office machines, domestic appliances, children's toys). Web-based resources may prove useful with the following explaining microcontroller applications: http://www.electronicshub.org/microcontrollers/ The following video provides a very thorough introduction to microcontroller and comparison with microprocessor: https://www.youtube.com/watch?v=CmvUY4S0UbI Learners should focus on features and applications rather than the internal workings of the microprocessor or microcontroller.	2 hours	R115 (LO1)
3 Basic function of component parts of a control system 	Basic function of component parts within micro-based system include: input devices (eg switch, temperature, position, light, flow, pressure), control device (eg microprocessor, microcontroller) and output device (eg lamp, sounder/speaker, solenoid, relay). Again, web-based resources might prove useful in explaining the function and application of input and output devices (eg http://music.columbia.edu/~douglas/classes/microcontrollers/part3.html). Teachers might have access to physical devices whose operation could be demonstrated to reinforce learning.	2 hours	R113 (LO2)

Suggested content	Suggested activities	Suggested timings	Possible relevance to
4 Operation of a control system 	Operation of a control system within a product using a microprocessor or microcontroller could be demonstrated with physical systems if available. Alternatively simulation or web-based sources could be used to explain or demonstrate system operation. The following website for Bosch Automotive explains the overall operation of a number of automotive electronic systems that use a microcontroller. The following is for a start-stop system and includes web-based videos: http://de.bosch-automotive.com/en/parts/parts_and_accessories/motor_and_sytems/start_stop_system/functionality_start_stop_system/functionality_start_stop_system	2 hours	R115 (LO1)

LO2 - BE ABLE TO DESIGN, DEVELOP AND SIMULATE A CONTROL SYSTEM SOLUTION

Learning Outcome — The learner will:
LO2: Be able to design, develop and simulate a control system solution

Suggested content	Suggested activities	Suggested timings	Possible relevance to
1 Producing control system solutions 	Learners and teachers will most likely take a practical approach throughout this learning outcome by developing a complete system solution using a microprocessor or microcontroller. Teachers might begin by explaining techniques (including hardware and software) that are going to be used by learners to develop their control system solution to a given problem. Teachers could demonstrate a solution to a different problem to give an overview of the process that learners will utilise using specific hardware and software.	2 hours	
2 System diagrams 	Developing system diagrams prior to or alongside producing a working solution can sometimes be useful, and can aid with troubleshooting and fault finding. The teacher could introduce learners to how to develop diagrams including: use of block diagrams to define control systems, diagrams showing input, process (including feedback and variables) and output and ones showing system instructions for control systems (ie repeat loops and subroutines). Learners could then use diagrams to represent their solution.	2 hours	R113 (LO2)
3 Input sensors and output actuators 	The use of input and output devices (eg sensors for temperature, position, light, flow, pressure, light and indicators/actuators such as light emitting diodes, solenoids, and motors) might be introduced to learners for a particular system set-up theoretically and through undertaking practical experimentation. Learners could undertake practical experiments to explore the function and operation of a range of different sensors and actuators that they might use on their own control system problem. Teachers could use suitable examples supported by data sheets to explain application and technical aspects of sensors and actuators in greater detail.	2 hours	R113 (LO2)

Suggested content	Suggested activities	Suggested timings	Possible relevance to
4 Using programming tools 	Teachers could introduce learners to a range of programming tools to create a control system programme (eg linear, symbolic, flow-chart) Learners could be tasked to produce flow charts for everyday problems before producing one for a control system problem. Web-based resources might prove useful, with the following explain how to produce flow charts: http://www.mindtools.com/pages/article/newTMC_97.htm Depending on the system being used, learners might also use linear or symbolic programming techniques. See Lesson Element: Using Programming tools.	2 hours	
5 Simulating a control system and device programming 	Learners will most likely bring together skills at developing system diagrams and programming tools and their knowledge of sensors and actuators to simulate and construct a physical control system. This will also include the transfer of the control program from software to a physical hardware-based system. Teachers will most likely support learners throughout this activity when required.	6 hours	

LO3 - BE ABLE TO TEST CONTROL SYSTEMS

Learning Outcome — The learner will:
LO3: Be able to test control systems

Suggested content	Suggested activities	Suggested timings	Possible relevance to
1 Developing test plans 	Learners and teachers might again adopt a practical approach throughout this learning outcome by developing test plans to evaluate and refine their own control system. Learners might begin to develop a test plan alongside system development which could include sub system test and full system testing. Web-based resources might prove useful such as the following which explains software test plans: http://www.teach-ict.com/as_a2_ict_new/ocr/A2_G063/331_systems_cycle/testing/miniweb/index.htm Teachers might provide learners with a template to use, or develop this through a class-based activity. See Lesson Element: Developing test plans.	3 hours	R113 (LO3)
2 Evaluating system performance 	Learners will most likely use their plan to test a control system solution in order to evaluate its correct operation against a set of performance criteria. Learners might record and document results and findings against their test plan. Learners could compare their findings in terms of system performance against that of colleagues (if identical systems have been developed) with an overall performance ranking table being produced. The class could compare and discuss this, including any reasons for systems that perform better or worse.	3 hours	
3 Interpretation and refinement 	Learners could interpret results of their own system against performance and test data, and also against that of colleagues if similar systems have been developed. This information might be discussed and used to refine the control system. This could involve a number of iterations of testing, evaluation and further refinement. Teachers could task learners to present their final solutions along with discussion of refinements as a class-based presentation activity. Alternatively, this could be a poster presentation with questions.	2 hours	

POSSIBLE CIRCUIT SIMULATION SOFTWARE AND HARDWARE

Source	Website
EdSim51	http://www.edsim51.com/
Circuitstoday (software review)	http://www.circuitstoday.com/8051-simulator
MicroChip	http://www.microchip.com/
Maplin	http://www.maplin.co.uk/p/pic-microcontroller-programmer-kit-k8048-n36ac

POSSIBLE INTERNET SOURCES

Source	Website
Texas Instruments	www.ti.com
Bosch Automotive	http://de.bosch-automotive.com/en/parts/startpage_1/startpage_1
MindTools	www.mindtools.com
Electronics Hub	www.electronicshub.com
YouTube	www.youtube.com

Contact us

Staff at the OCR Customer Contact Centre are available to take your call between 8am and 5.30pm, Monday to Friday.

Telephone 02476 851509

Email cambridgenationals@ocr.org.uk