National Unit Specification: general information

UNIT Engineering: Process Control Systems (SCQF level 6)

CODE F5KW 12

SUMMARY

This Unit can be delivered as part of a National Qualification Group Award but can also be taken as a free-standing Unit.

This Unit is designed to enable candidates to develop knowledge and understanding of process control systems used in process industries. It will develop knowledge and understanding of control modes and their use and how a system is optimised. It will also develop knowledge and skills in setting up and operating a process control system with Proportional and Integral (PI), Proportional and Derivative (PD) and Proportional, Integral and Derivative (PID) control actions and will also investigate the optimisation of a process control loop.

This Unit is suitable for candidates studying the subject for the first time and acts as a basis for progression to employment and/or further study.

OUTCOMES

1 Investigate the effect of proportional, integral and derivative control action.
2 Explain the operation of proportional, integral and derivative action controllers.
3 Investigate the optimisation of a process control loop.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have attained one of the following, or equivalent:

- Standard Grade Mathematics — General/Credit Level
- Standard Grade Technological Studies and/or Science — General/Credit Level

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Administrative Information

Superclass: VE

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National Unit Specification: general information (cont)

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CREDIT VALUE

1 credit at SCQF level 6 (6 SCQF credit points at SCQF level 6*).

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.*

CORE SKILLS

There is no automatic certification of Core Skills in this Unit.

This Unit provides opportunities for candidates to develop aspects of the following Core Skills:

Numeracy	(SCQF level 6)
Information Technology	(SCQF level 6)
Problem Solving	(SVQF level 6)
Working with Others	(SQCF level 6)

These opportunities are highlighted in the Support Notes of this Unit Specification.

National Unit Specification: statement of standards

UNIT Engineering: Process Control Systems (SCQF level 6)

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit Specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

OUTCOME 1

Investigate the effect of proportional, integral and derivative control actions.

Performance Criteria

(a) Control modes output response to standard inputs for one and two term controllers are investigated correctly.
(b) Control modes in respect to gain, integral action time and derivative action time are investigated correctly.
(c) Direct and reverse controller actions are investigated correctly.

OUTCOME 2

Explain the operation of proportional, integral and derivative action controllers.

Performance Criteria

(a) Generation of analogue PID control modes are explained correctly.
(b) Generation of digital PID control modes are explained correctly.

OUTCOME 3

Investigate the optimisation of a process control loop.

Performance Criteria

(a) The explanation of process transfer lags and distance velocity lags is correct.
(b) The determination of optimum controller settings for a two and three term controller using open and closed methods is correct.
(c) The explanation of the advantages and disadvantages of the open and closed loop methods is correct.
(d) The explanation of the loop response to two and three term control action is correct.

National Unit Specification: statement of standards (cont)

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EVIDENCE REQUIREMENTS FOR THIS UNIT

Evidence is required to demonstrate that candidates have achieved all Outcomes and Performance Criteria.

Written and/or oral evidence is required which demonstrates that the candidate has achieved Outcome 1 and Outcome 2 to the standard specified in the Outcomes and Performance Criteria. The evidence for these Outcomes should be obtained under controlled, supervised conditions. The assessment will be open-book and will last no longer than 1 hour.

Performance evidence, supplemented with an assessor observation checklist and written and/or oral evidence is required which demonstrates that the candidate has achieved Outcome 3 to the standard specified in the Outcome and Performance Criteria. Evidence will be generated in controlled supervised conditions. The practical exercise should last approximately 1 hour and should be carried out towards the end of the Unit.

The Assessment Support Pack for this Unit provides sample assessment material. Centres wishing to develop their own assessments should refer to the assessment support pack to ensure a comparable standard.

National Unit Specification: support notes

UNIT Engineering: Process Control Systems (SCQF level 6)

This part of the Unit Specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT

This is a restricted core Unit within the National Certificate in Measurement and Control Engineering, but is also suitable for candidates wishing to study the Unit on a free-standing basis.

This Unit has been written in order to allow candidates to develop knowledge, understanding and skills in the following areas.

The range of topics that will be covered in the delivery of the Unit will be as follows:

Outcome 1

- Standard inputs — impulse, step and ramp
- Definition of proportional action — gain/proportional band
- Need for integral and derivative action
- Definition of integral action
- Definition of derivative action
- Integral and derivative action time
- Control mode output responses to standard inputs for one and two term controllers
- Use of direct and reverse controller actions

Outcome 2

- Generation of three term control actions (PID) using pneumatic or analogue electronic technology.
- Digital controllers: with multiple input options eg 4-20 mA, thermocouple types, RTDs, analogue voltage (1-5 or 0-10), 0-50mV and frequency
- Digital controllers: with multiple output options eg 4-20mA, 0-24V digital and PWM
- Scaling in engineering units
- reverse/direct action selection
- set point tracking
- scale expansion (-10% - 110%); up scale/down scale burnout
- low/high alarms, set point low/high limits
- set point profiling, tuning methods
- automatic/manual transfer, security modes
- PC links and upload/downloading configuration data

Outcome 3

- Definition of distance/velocity lags and transfer lags and their evaluation
- Open loop method of optimisation
- Closed loop methods of optimisation
- Advantages and disadvantages of the two optimisation methods
- System responses — over damped, critically damped, under damped and oscillatory

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

In this Unit the Outcomes should be delivered in order.

The use of ICT (Information and Communication Technology) should be used to support the delivery of this Unit. This could take the form of candidates researching different types of process controllers, systems and optimisation methods etc. on the internet. Computer simulation packages could also be used.

The Unit requires access to a measurement and control engineering laboratory with a range of process control systems, test and ICT equipment. Demonstrations and laboratory exercises can be used to improve the candidates understanding of process control systems optimisation. This will help to relate theory to practice.

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

Candidates perform a series of complex calculations and measurements as they demonstrate knowledge and understanding of Process Control Systems. *Numeracy* skills will be naturally enhanced, with the focus throughout on practical interpretation and use of number and graphics. Formative activities could be designed to develop accuracy and confidence working with figures in an engineering context.

The use *of Information Technology* and *Communication* supports delivery of the Unit. Access to on line information would encourage individual research on different types of process controllers, systems and optimisation methods and ensure currency. Computer simulation packages could also be of value. Practical technology skills should include awareness of security, safety and consideration for other users.

National Unit Specification: support notes (cont)

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All elements of the Core Skill of *Problem Solving*, that is, planning and organising, critical thinking, reviewing and evaluating, will be developed as the Unit is undertaken. Identifying and taking account of all factors influencing the practical exercise is integral to achievement. Initially, formative work in laboratory exercises and demonstrations will ensure understanding of systems and their application. Evidence will then focus on relevant investigations prior to the setting up and operating of a process control system with a range of control actions. There may be opportunities to foster skills in co-operative working during formative practical work. Candidates could be encouraged to examine proposed approaches to work and analyse a task and its component elements. They could discuss and negotiate the nature and scope of team roles and responsibilities involved, including safety issues. They could be asked to demonstrate and explain methodology and resources selected and to review and evaluate their own abilities in communicating and working with others in a laboratory environment. Feedback from the assessor can provide a context for analytical evaluation of achievement.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Opportunities for the use of e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by information and communications technology (ICT), such as e-testing or the use of e-portfolios or e-checklists. Centres which wish to use e-assessment must ensure that the national standard is applied to all candidate evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. Further advice is available in *SQA Guidelines on Online Assessment for Further Education (AA1641, March 2003), SQA Guidelines on e-assessment for Schools (BD2625, June 2005).*

Achievement of this Unit requires the Evidence Requirements for each Outcome to be met. A candidate who does not initially achieve the specified standard can have a further opportunity, attempting only the Outcome(s) not previously achieved.

Outcome 1 and Outcome 2 could be assessed by a 1 hour open-book case study which consists of a series of short answer, restricted response and structured questions. This combined assessment involves the response of the control modes to standard inputs and an explanation of how control modes are generated in various controller technologies, along with an explanation of the set up and configuration of analogue and digital controllers. This assessment can be taken after the completion of the delivery of Outcome 1 and Outcome 2.

Outcome 3 could investigate open/closed loop methods of system tuning. This could be achieved with laboratory equipment which is evidenced by a checklist and recorded data or software simulation techniques with associated data printouts. Any recorded data and data printouts should be included in a brief report. This practical assessment should be carried out towards the end of the Unit.

CANDIDATES WITH DISABILITIES AND/OR ADDITIONAL SUPPORT NEEDS

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering alternative Outcomes for Units. Further advice can be found in the SQA document *Guidance on Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs* **(www.sqa.org.uk)**.