



National Unit Specification: general information

UNIT Engineering: Complex Control Systems (SCQF level 6)

CODE F5KJ 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 complex control systems as used in process industries. The Unit is designed to develop knowledge and skills in the setting up of ratio, cascade, feed-forward and multivariable control systems as used in process industries.

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 Explain a ratio control system.
- 2 Investigate a cascade control system.
- 3 Explain a feed-forward control system.
- 4 Explain a multi-variable control system.

RECOMMENDED ENTRY

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

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

Administrative Information

Superclass: VE

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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:

Problem Solving (SCQF level 6)
Numeracy (SCQF level 6)

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

National Unit Specification: statement of standards

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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

Explain a ratio control system.

Performance Criteria

- (a) The pipe and instrumentation diagram of a ratio control system is correctly explained.
- (b) The explanation of how a ratio control system operates is correct.
- (c) The ratio factor with linear and non-linear measurements is correctly evaluated.

OUTCOME 2

Investigate a cascade control system.

Performance Criteria

- (a) The pipe and instrumentation diagram of a cascade control system is correctly explained.
- (b) The operation of a cascade control system is correctly explained.
- (c) The tuning of a cascade control system is correctly investigated.

OUTCOME 3

Explain a feed-forward control system.

Performance Criteria

- (a) The pipe and instrumentation diagram of a feed-forward control system is correctly explained.
- (b) The operation of a feed-forward control system is correctly explained.

OUTCOME 4

Explain a multi-variable control system.

Performance Criteria

- (a) The pipe and instrumentation diagram of a multi-variable control system is correctly explained.
- (b) The operation of a multi-variable control system is correctly explained.

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, Outcome 3 and Outcome 4 to the standard specified in the Outcome and Performance Criteria.

The evidence for Outcome 1, Outcome 3 and Outcome 4 should be obtained in a combined assessment carried out in controlled supervised conditions. The assessment will be closed-book and should last approximately 1 hour and 30 minutes.

Written and/or oral and performance evidence, supplemented with an assessor checklist is required to demonstrate that the candidate has achieved Outcome 2 to the standard specified in the Outcome and Performance Criteria.

The evidence for this Outcome should be obtained under controlled supervised conditions with the candidate having access to notes and reference books when collecting performance evidence for pc(c) and under closed-book supervised conditions for pc (a) and pc (b). The practical activity should last approximately 1 hour. Assessor observation/checklists must record the correct tuning and operation of a cascade control system.

National Unit Specification: support notes

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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 an optional 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.

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

Outcome 1

- ◆ Pipe and Instrumentation Diagram for a ratio control system
- ◆ Typical ratio control of two flow rates — flow measurements can either be linear or non-linear
- ◆ Evaluation of the flow ratio factor for linear and non-linear measurements
- ◆ System operation

Outcome 2

- ◆ Pipe and Instrumentation Diagram for a cascade control system
- ◆ Typical cascade control systems eg level/flow, temperature/flow, temperature/temperature
- ◆ Cascade control system as having one control valve, two process value measurements, two process parts and a master controller and slave controller, process characteristics
- ◆ Advantages and improved system performance of cascade control over single loop control
- ◆ Tuning of the system by either open loop or closed loop methods
- ◆ System operation

Outcome 3

- ◆ Pipe and Instrumentation Diagram for a feed-forward control system
- ◆ Typical feed-forward control systems eg heat exchangers and process characteristics
- ◆ Need for feed-back control in a feed-forward control system
- ◆ Advantages of feed-forward control over feed-back control
- ◆ System operation

Outcome 4

- ◆ Pipe and Instrumentation Diagram for a multi-variable control system
- ◆ Typical multi-variable systems eg pressure/flow, level/flow, temperature/density
- ◆ Interactions between process variables and controllability
- ◆ System operation

National Unit Specification: support notes (cont)

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GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

There is a progressive nature to the learning and teaching of Measurement and Control Engineering and every opportunity should be taken to revise and consolidate prior knowledge, eg the NQ Units in *Engineering: Process Control*, *Engineering: Process Control Systems* and *Engineering: Measurement Technology* contain knowledge and skills which form a foundation for this Unit.

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 complex control systems and optimisation methods etc on the internet. Computer simulation packages could also be used.

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

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

Elements of the Core Skill of *Problem Solving*, that is, critical thinking, planning and organising, reviewing and evaluating, will be naturally developed and enhanced as candidates explain the functions of a number of complex control systems and complete an investigation into the tuning of a cascade control system. Identifying and interpreting a range of factors will be essential as will working efficiently and safely to complete the task. Discussing and evaluating the process in a measurement and control engineering laboratory will be a routine aspect of formative work.

Numeracy skills in using graphic information will be naturally enhanced, with the focus on practical analysis of data as candidates interpret and explain a series of pipe and measurement diagrams. Formative practical activities should be designed to develop accuracy and confidence in handling graphic concepts in an engineering context.

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).

National Unit Specification: support notes (cont)

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Achievement of the 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 Outcomes not previously achieved.

Outcome 1, Outcome 3 and Outcome 4 should be assessed by a closed-book test. The closed-book test should last 1 hour 30 minutes and consist of a series of short answer, restricted response and structured questions. This assessment can be taken after the completion of the delivery of Outcome 1, Outcome 3 and Outcome 4.

The assessment evidence for Outcome 2 could be in the form of a case study which includes a practical exercise involving the setting up and tuning of a cascade control system and determining the optimum operation of the system. An observation checklist should be used to record candidate performance. The assessment also requires a brief report on the setting up, tuning and system operation. This assessment can be taken after the completion of the delivery of Outcome 2.

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).