SCOTTISH QUALIFICATIONS AUTHORITY

National Unit Specification: general information

UNIT Systems and Control (Higher)

NUMBER D187 12

COURSE Technological Studies (Higher)

SUMMARY

This unit is designed to enable candidates to apply the principles of control to mechatronic systems and to monitor and record data from a system.

OUTCOMES

1 Analyse and describe the operation of control systems.
2 Analyse the design of closed loop analogue control systems.
3 Develop a control sequence and use it to control a mechatronic system, by means of a microcontroller.
4 Develop a monitoring system based on a microcontroller, and evaluate its performance.

RECOMMENDED ENTRY

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

- Standard Grade Technological Studies at grade 1 or 2
- Intermediate 2 Technological Studies or equivalent NC modules.

CREDIT VALUE

1 credit at Higher.

Administrative Information

Superclass: VE

Publication date: December 1999

Source: Scottish Qualifications Authority

Version: 03

National Unit Specification: general information (cont)

UNIT Systems and Control (Higher)

CORE SKILLS

This unit gives automatic certification of the following:

Complete core skills for the unit	Problem Solving	H
Additional core skills components for the unit	Using Number	H

Additional information about core skills is published in *Automatic Certification of Core Skills in National Qualifications* (SQA, 1999).

National Unit Specification: statement of standards

UNIT Systems and Control (Higher)

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 the Scottish Qualifications Authority.

OUTCOME 1

Analyse and describe the operation of control systems.

Performance criteria

(a) The type of control applied to a system is identified correctly.
(b) The operation of a control system is described clearly.
(c) The use of graphical representation is appropriate in analysing the design of a control system.

Evidence requirements

Written and graphical evidence showing that the candidate can analyse and describe the operation of given control systems and represent systems graphically, on a minimum of two occasions (one open loop, one closed loop).

OUTCOME 2

Analyse the design of closed loop analogue control systems.

Performance criteria

(a) The type of closed loop analogue control applied to a system is identified correctly.
(b) The operational amplifier configuration for a specified analogue control system is selected correctly.
(c) Analogue control systems are represented correctly using block diagrams and circuit diagrams.
(d) The operation of a specified analogue control system is evaluated correctly, either by construction or computer simulation.

Evidence requirements

Written and graphical evidence for PCs (a) to (c). Performance evidence for PC (d).

National Unit Specification: statement of standards (cont)

UNIT Systems and Control (Higher)

OUTCOME 3

Develop a control sequence and use it to control a mechatronic system, by means of a microcontroller.

Performance criteria

(a) The operation and architecture of a microcontroller are described correctly.
(b) The need for and operation of interfacing devices are described clearly.
(c) A specified control sequence is represented correctly by a flowchart, using symbols from a data booklet.
(d) A specified control sequence is developed successfully in a high level programming language.
(e) A control sequence, written in a high level programming language, is used successfully to control a mechatronic system.
(f) Interfacing devices required to provide control of a mechatronic system, are used correctly.

Evidence requirements

Written and graphical evidence for PCs (a) to (d). Performance evidence for PCs (e) and (f).

OUTCOME 4

Develop a monitoring system, based on a microcontroller, and evaluate its performance.

Performance criteria

(a) The need for and operation of processing sub systems are described clearly.
(b) Calculations to determine the specified operation of a signal processing sub system are carried out correctly.
(c) The importance of sampling frequency in a monitoring system is explained correctly.
(d) A program is developed successfully, in a high level language, to enable a microcontroller to monitor and record data for specified conditions.
(e) A software based microcontroller system is used successfully to monitor specified conditions.
(f) Data from a microcontroller based monitoring system are recorded and evaluated correctly.

Evidence requirements

Written and graphical evidence for PCs (a) to (c). Performance evidence for PC (d) to (f).

National Unit Specification: support notes

UNIT Systems and Control (Higher)

This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the 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

Prior work in Applied Electronics (H) is assumed. Guidance for each outcome is listed below.

Outcome 1	Principles of operation of control systems. Open loop control; closed loop control: digital, analogue. Graphical representation: system diagrams, block diagrams, detailed control diagrams, flowcharts.
Outcome 2	Examples of closed loop analogue control systems, to include proportional, positional, push-pull. Application of op-amp configurations to control systems. Graphical representation of circuit elements such as voltage dividers, op-amps and output transducers. Evaluation of control systems.
Outcome 3	Introduction to microcontrollers including RAM, ROM, ALU, EEPROM, bus, clock. Advantages and applications of microcontrollers. Comparison with hard-wired alternatives. Binary and decimal systems of counting; conversion from one number system to the other. Creating input signals to a microcontroller from analogue and digital devices. Control routines: systems with up to 4 inputs and 4 outputs. Use of flowcharts as the basis of a structured, top-down approach to programming. Writing control programs in a high level language, such as PBASIC; inputs, outputs, loops and time delays. Setting up loops; looping through a sequence or program 'N' times and looping continuously. Controlling a motor by a microcontroller using pulse-width modulation: 'soft start'; speed; position. Stepper motor control; structure and operation of stepper motors; applications; data sheets on coil energising; control problems involving stepper motors – position and speed control; reversing a stepper motor.

National Unit Specification: support notes (cont)

UNIT Systems and Control (Higher)

Outcome 4	Signal conditioning.
	A-D conversion; the need for A-D conversion in microcontroller systems.
	Simple A-D and D-A calculations.
	Data logging; applications of data logging; microcontroller based data logging systems; manipulation and presentation of recorded data.
	Multiplexing.

Candidates are required to develop an understanding of closed loop analogue control systems and of the function and operation of microcontroller control and monitoring systems.

Candidates are also required to develop a program to control the operation of a mechatronic system.

Understanding of electronic systems developed in the Applied Electronics (Higher) unit should be reinforced through application within this unit.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

Every opportunity should be taken to ensure that the learning and teaching contexts are of an industrial nature and are seen to be relevant by the candidate. Candidates are expected to develop control sequences to control mechatronic systems and to monitor and record data from systems. An example is the design of a temperature control and monitoring system used in an office block. This allows sensing circuits, signal conditioning and data logging to be used in an integrated assignment.

In presenting courses, teachers and lecturers should ensure that there is a balance between direct teaching and candidate-centred activities.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

National Assessment Bank materials have been created specifically to assess knowledge and understanding for each outcome. Assessments can take place either at the completion of an outcome or as an end of unit test. Centres must ensure that tests are conducted under appropriate conditions. Candidates should be allowed to use the Technological Studies data booklet. Candidates should be issued with clean copies of this booklet for use during tests.

Outcomes 2, 3 and 4 require candidates to carry out practical activities. It is the responsibility of the centre to ensure that evidence of candidate performance is recorded in an appropriate way. All evidence of performance must be retained by the centre. The assessment of this unit is subject to central moderation by the SQA.

Candidates generate evidence by means of their response to written tests, proficiency in practical activities and systems evaluation.

National Unit Specification: support notes (cont)

UNIT Systems and Control (Higher)

In order to gain success in the written test for an outcome, each candidate must achieve at least the cut-off score for that outcome. Success in each of the practical activities must be observed by the teacher or lecturer. The practical activities are based on construction or simulation of analogue closed loop systems, control of mechatronic device systems based on microcontrollers, and monitoring and recording of data based on microcontrollers. Evidence of performance must be recorded in an appropriate manner. Simulation and construction performance must be observed directly. Candidates' evaluation of a system can be in the form of either a written or oral report. Details should be recorded of the particular system(s) dealt with by each candidate.

SPECIAL NEEDS

This unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment and Certification Arrangements for Candidates with Special Needs/Candidates whose First Language is not English* (SQA, 1998).