-SQA-SCOTTISH QUALIFICATIONS AUTHORITY

NATIONAL CERTIFICATE MODULE: UNIT SPECIFICATION

GENERAL INFORMATION

-Module Number- **2150196** **-Session-1996-97**

-Superclass- **VE**

-Title- **CONTROL SYSTEMS 1**

-DESCRIPTION-

GENERAL COMPETENCE FOR UNIT: Applying the principles of control to mechatronic systems and monitoring performance using a data logging system.

OUTCOMES

1. describe the control concepts used in mechatronic and computer control systems;

2. describe the operation of a control system;

3. use software to control a mechatronic system;

4. use data logging software to monitor the performance of a mechatronic system.

CREDIT VALUE: 1 NC Credit

ACCESS STATEMENT: Access to this unit is at the discretion of the centre. However the candidate would normally be expected to have completed the following NC modules:

2330036 Energy;
2150156 Introduction to Control Systems;
2130036 Fundamentals of Technology: Mechanical Systems;
2150176 Introductory Applied Analogue and Digital Electronics.

For further information contact: Committee and Administration Unit, SQA, Hanover House, 24 Douglas Street, Glasgow G2 7NQ.

Additional copies of this unit may be purchased from SQA (Sales and Despatch section). At the time of publication, the cost is £1.50 (minimum order £5.00).

NATIONAL CERTIFICATE MODULE: UNIT SPECIFICATION

STATEMENT OF STANDARDS

UNIT NUMBER: 2150196

UNIT TITLE: CONTROL SYSTEMS 1

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

OUTCOME

1. DESCRIBE THE CONTROL CONCEPTS USED IN MECHATRONIC AND COMPUTER CONTROL SYSTEMS

PERFORMANCE CRITERIA

(a) The operation of an open loop control system is described clearly.
(b) The operation of a closed loop control system is described clearly.
(c) The graphic representation of the control system is correct with respect to current standards.

RANGE STATEMENT

Open loop control: on/off; sequential;

Closed loop control: digital; analogue; proportional.

EVIDENCE REQUIREMENTS

Graphical, written and/or oral evidence showing that the candidate can clearly describe the operation of a control system and represent it diagrammatically.

OUTCOME

2. DESCRIBE THE OPERATION OF A CONTROL SYSTEM

PERFORMANCE CRITERIA

(a) The graphical representation of the system is correct.
(b) The type of control applied to a mechatronic system is correctly identified.
(c) The graphic representation of the mechatronic system is correct.

(d) The operational characteristics of output devices are correctly interpreted using data sheets.
(e) The operation of a control system is clearly described.

RANGE STATEMENT

Type of control: open loop control; closed loop control.

EVIDENCE REQUIREMENTS

Graphical, written and oral evidence of the candidate's ability to evaluate the performance of a specified control system.

OUTCOME

3. USE SOFTWARE TO CONTROL A MECHATRONIC SYSTEM

PERFORMANCE CRITERIA

(a) The need for software control is correctly explained in terms of the specified control task.
(b) A specified control sequence is correctly represented graphically with the use of a flow chart with respect to current standards.
(c) The need for and operation of interfacing devices is clearly described.
(d) Interfacing devices required to provide computer control of a mechatronic system are used correctly.
(e) A specified control sequence is developed in a high level programming language to successfully operate a mechatronic system.
(f) Evidence collected to show successful operation is complete and accurate.

RANGE STATEMENT

Interfacing devices: relay driver; stepper motor driver.

EVIDENCE REQUIREMENTS

Graphical, written and/or oral evidence of the candidate's ability to carry out an assignment to construct a control programme in a high level language. Performance evidence of a candidate's ability to use the programme to control the operation of a mechatronic system on a minimum of one occasion.

OUTCOME

4. USE DATA LOGGING SOFTWARE TO MONITOR THE PERFORMANCE OF A MECHATRONIC SYSTEM

PERFORMANCE CRITERIA

(a) The operation of a data logging system is correctly described.
(b) The need for and purpose of signal processing subsystems is correctly described.
(c) Calculations to determine the specified operation of a signal processing subsystem are correct.
(d) A data logging system is successfully used to monitor the performance of a mechatronic system.
(e) Evidence collected to show successful monitoring of a mechatronic system is complete and accurate.

RANGE STATEMENT

Signal processing subsystems: voltage divider; amplifier; multiplexer; analogue to digital converter.

Calculations: gain of OP-AMPS (input/output voltage signals); attenuation (voltage divider); A-D (decimal to binary conversion).

EVIDENCE REQUIREMENTS

Graphical, written and/or oral evidence of the candidate's ability to monitor the performance of a mechatronic system.

ASSESSMENT

In order to achieve this unit, candidates are required to present sufficient evidence that they have met all the performance criteria for each outcome within the range specified. Details of these requirements are given for each outcome. The assessment instruments used should follow the general guidance offered by the SQA assessment model and an integrative approach to assessment is encouraged. (See references at the end of support notes).

Accurate records should be made of the assessment instruments used showing how evidence is generated for each outcome and giving marking schemes and/or checklists, etc. Records of candidates' achievements should be kept. These records will be available for external verification.

SPECIAL NEEDS

In certain cases, modified outcomes and range statements can be proposed for certification. See references at end of support notes.

NATIONAL CERTIFICATE MODULE: UNIT SPECIFICATION

SUPPORT NOTES

UNIT NUMBER: 2150196

UNIT TITLE: CONTROL SYSTEMS 1

SUPPORT NOTES: This part of the unit specification is offered as guidance. None of the sections of the support notes is mandatory.

NOTIONAL DESIGN LENGTH: SQA allocates a notional design length to a unit on the basis of time estimated for achievement of the stated standards by a candidate whose starting point is as described in the access statement. The notional design length for this unit is 40 hours. The use of notional design length for programme design and timetabling is advisory only.

PURPOSE To develop the ability to evaluate and record the performance of control systems.

SQA publishes summaries of NC units for easy reference, publicity purposes, centre handbooks, etc. The summary statement for this unit is as follows:

'On completion of this unit you will have achieved the level of competence of someone who is able to understand and apply basic control theory and use data logging software to monitor the performance of a system'.

CONTENT/CONTEXT The candidate should achieve the level of competence of someone who is able to understand and apply basic control theory and use data logging software system to monitor the performance of a system.

Corresponding to outcomes 1-4:

The outcomes would be best undertaken in the context of assignments which bring industrial/domestic perspectives to the applications of control systems. The electronic concepts used in the unit should consolidate work undertaken in the NC module 2150206 'Applied Electronics 1'.

1. Current Standard: BS1646

   It is anticipated that candidates will be familiar with the concepts of open and closed loop control and have experience of the application of these concepts at GSVQ (level II). Systems representation and the use of block diagrams should be revised. Candidates should be familiarised with the standard representation of closed loop control systems and the concepts of feedback (negative and positive) and lag.

Understanding should be developed through a series of exercises in which candidates evaluate the operation of systems which illustrate applications of different forms of control.

Examples of activities could include control of a linear actuator, using an S-R latch based electronic control system, in which feedback is provided by means of limit switches. Analogue closed loop control could be considered using an automatic temperature control system, based on a comparator OP-AMP, and using a thermistor to provide a feedback signal. Proportional closed loop control could be introduced through evaluation of a servo-system applied to positional control. A potentiometer could be used to provide a feedback signal to a difference amplifier based control system. In a similar manner speed control applications could be considered using a tachogenerator to provide feedback.

It is envisaged that the activities could be undertaken using simple fixed rigs. Control systems could be constructed using electronic systems boards. Candidates should be able to represent systems graphically using control diagrams. Electronic control systems should additionally be represented using circuit diagrams. This approach should review and consolidate work previously undertaken on the course in the NC module 'Applied Electronics 1'.

2. A typical activity would require candidates to analyse the operation of a system which could involve the transmission of rotary motion and torque through gear and/or belt drive systems. Candidates would be required to determine the output characteristics of a motor (torque/rotary speed) using a data sheet. One of the systems analysed could utilise closed loop control of the electromechanical system, either electronic or programmable, in which a feedback sensor is used to monitor the performance of the output.

   Candidates would be required to represent the system in control diagram form, block diagram form and use schematic diagrams to represent mechanisms.

3. Current Standard: BS4058

   It is anticipated that candidates may have experience of developing simple control programmes, using high level languages such as 'logo', and constructing and interpreting simple flow charts. Candidates should be familiarised with the basic layout and operation of a microprocessor system. Although programme development will be limited to using high level language, candidate should be familiar with the advantages and applications of programming in low level language. It would be advantageous for candidates to have some experience in using a microprocessor system which uses a basic interpreter to enable programmes written in high level to be run in machine code. Candidates will be expected to construct programmes in a high level language such as 'basic'. They should be capable of configuring the system, addressing output lines, reading input lines, setting loops, using time delays, generating and using programme subroutine. Candidates should understand the need for system protection and the application of output

driver circuits. Devices such as A-D and D-A convertors should be treated
as 'black boxes' which provide a function. Programme subroutines could be developed to control output devices such as stepper motors and the control of d.c. motors, could be investigated using D-A conversion and P.W.M.

A typical activity would involve controlling a model of a washing machine, over part of the wash/spin cycle. This activity could be integrated with learning outcome 2. The speed of the drum could be controlled using PWM and a vibration sensor could be used to detect an unbalanced load, thus providing feedback to the control system.

From a given specification, candidates would be required to construct a flow chart, verify operation of the programme on a model and produce a programme listing.

4. Candidates should be familiarised with the need for and applications of industrial data logging systems. Although candidates are not required to use a dedicated data logging device in the context of overtaking this learning outcome, it is expected that candidate will be familiar with the application of these systems. Candidates will be required to explain, in systems terms, the operation of a data logger and be familiar with the main subsystems within a microprocessor based logging system. This will involve representing the system in block diagram form and explaining the need for and application of A-D conversion and multiplexing.

Candidates will require to be familiarised with the basic operation of the data logging software to be used but do not require to become experts in its use.

A typical activity could involve the candidate in recording a voltage signal produced by a sensing subsystem. For example, the rotary speed of the drive motor and drum of a washing machine model could be monitored using tachogenerators. The signals may have to be conditioned to bring them within a range acceptable to the logging interface. Candidates would be required to identify an appropriate configuration of amplifier, calculate gain and identify suitable resistor values to construct the amplifier. This part of the activity will provide an opportunity to review and consolidate OP-AMP work previously undertaken on the course in the NC module 'Applied Electronics 1'. The signals would then be recorded using the software and processed to produce graphical and tabulated data. Hard copy of this data should be obtained by the candidate.

APPROACHES TO GENERATING EVIDENCE A candidate-centred, resource-based approach to learning should be adopted in which candidates are encouraged to complete assignments in an independent manner.

Corresponding to outcomes:

1-4. The candidates could be given a series of practical assignments in which control systems were modelled to operate mechatronic systems.

The candidates would be expected to evaluate at least one example of each of the control techniques identified in the range statements. The performance of at least one of these systems could be monitored using a data logging system.

The candidates would be expected to keep written and graphic evidence of the work undertaken in completing each assignment.

ASSESSMENT PROCEDURES Example of Instruments of Assessment which could be used for each outcome are as follows:

1-4. The candidate could produce a brief report in a standard format which contains evidence of the work undertaken in completing each assignment.

An observation checklist could be kept by the tutor as evidence of a candidate completing practical assignment successfully.

PROGRESSION This unit forms part of the GSVQ in Engineering at level III.

Candidates successfully completing the GSVQ in Engineering at level III will be able to progress to an HNC/D programme in related disciplines.

RECOGNITION Many SQA NC units are recognised for entry/recruitment purposes. For up-to-date information see the SQA guide 'Recognised Groupings of National Certificate Modules'.

REFERENCES

1. Guide to unit writing. (A018).
2. For a fuller discussion on assessment issues, please refer to SQA's Guide to Assessment. (B005).
3. Procedures for special needs statements are set out in SQA's guide 'Candidates with Special Needs'. (B006).
4. Information for centres on SQA's operating procedures is contained in SQA's Guide to Procedures. (F009).
5. For details of other SQA publications, please consult SQA's publications list. (X037).