SCOTTISH QUALIFICATIONS AUTHORITY

National Unit Specification: general information

UNIT Robotic and Automated Systems (Higher)

NUMBER D148 12

COURSE Mechatronics (Higher)

SUMMARY

The purpose of this unit is to develop an understanding of the anatomy, senses and control mechanisms of a typical industrial robot.

OUTCOMES

1 Compare the anatomy of typical robotic devices.
2 Analyse the sensory systems used in typical robotic devices.
3 Describe the control strategies used in typical automation systems.
4 Program a typical robotic system to carry out repeatable actions.

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 Technological Studies or Physics at grade 2 or above
- equivalent National units
- Intermediate 2 course Electronic and Electrical Fundamentals or Technological Studies
- Scottish Group Award at Intermediate 2 in an appropriate area.

Note: It is recommended that all candidates should have attained a minimum of Standard Grade Mathematics at grade 3 or equivalent National units.

Administrative Information

Superclass: VE

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Version: 03

National Unit Specification: general information (cont)

UNIT Robotic and Automated Systems (Higher)

CREDIT VALUE

1 credit at Higher.

CORE SKILLS

There is no automatic certification of core skills or core skills components in this unit.

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 Robotic and Automated Systems (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

Compare the anatomy of typical robotic devices.

Performance criteria

(a) The axes of motion and degrees of freedom of a typical robot are correctly described.
(b) Operation of end-effector grippers is correctly described.
(c) Pneumatic, hydraulic and electrical drive systems are critically compared for a specified application.

Note on range for the outcome

Anatomy: revolute, cartesian, cylindrical, polar, SCARA geometries.
Degrees of freedom: robotic joints, work envelope volume; safety.
End-effector grippers: mechanical, electromagnetic, pneumatic.
Comparison: range of movement, position control, safety, cost, force, torque, speed, power.

Evidence requirements

Written and graphical evidence of the candidate's ability to compare the anatomy of typical robotic devices, as specified in PCs (a) to (c).

National Unit Specification: statement of standards (cont)

UNIT Robotic and Automated Systems (Higher)

OUTCOME 2

Analyse the sensory systems used in typical robotic devices.

Performance criteria

(a) Description of incremental and absolute encoders is accurate.
(b) Pure Binary Codes, (PBC), Binary Coded Decimal (BCD) and Gray codes are accurately compared.
(c) Positional accuracy is accurately calculated.
(d) Tactile sensing is correctly explained.

Note on range for the outcome

Encoders: linear, rotary.
Positional accuracy: resolution, effective bit length.
Tactile sensing: end-effector application.

Evidence requirements

Written and graphical evidence of the candidate's ability to analyse the sensory systems used in typical robotic devices, as specified in PCs (a) to (d).

OUTCOME 3

Describe the control strategies used in typical automation systems.

Performance criteria

(a) Sequential control strategy is correctly described.
(b) Open-loop and closed-loop control systems are accurately compared.
(c) The output responses of proportional control are accurately described.
(d) The influence of the constituent elements of a PID control strategy is accurately described.

Note on range for the outcome

Sequential control strategy: time based, event based.
Comparisons: ease of application, cost, stability, accuracy.
Responses: time domain plots.
PID control: speed of response, stability, accuracy.

Evidence requirements

Written and graphical evidence of the candidate's ability to describe the control strategies used in typical automation systems, as specified in PCs (a) to (d).

National Unit Specification: statement of standards (cont)

UNIT Robotic and Automated Systems (Higher)

OUTCOME 4

Program a typical robotic system to carry out repeatable actions.

Performance criteria

(a) Programming methods are correctly described.
(b) Analysis of task for a given pick and place sequential operation is correct.
(c) Translation of task analysis into functional software is correct.
(d) Verification of software operation on hardware is correct.

Note on range for the outcome

Methods: lead-by-nose, walkthrough (point-to-point).
Analysis of task: sequential description, flowchart.

Evidence requirements

Written and performance evidence of the candidate's ability to program a typical robotic system to carry out repeatable actions, as specified in PCs (a) to (d).

National Unit Specification: support notes

UNIT Robotic and Automated Systems (Higher)

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

It is recommended that you refer to the SQA Arrangements document for Higher Mechatronics before delivering this unit.

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

The purpose of this unit is to develop an integrated understanding of typical robotic and automated systems.

Safety should be emphasised throughout the delivery of this unit. In particular, safety in the application of robotic and automated systems should be reviewed prior to their use.

GUIDANCE ON CONTENT AND CONTEXT FOR THIS UNIT

The candidate should achieve the level of competence of someone who understands the functions and operation of robotic and automated systems. This unit is part of Higher Mechatronics and would be best delivered in an integrated manner in conjunction with the other units of the course.

The outcomes would be best undertaken in the context of assignments which embed the principles within an industrial context. The work undertaken by candidates in Outcome 1 should allow them to differentiate between differing robotic anatomies. The candidates would be expected to distinguish between cartesian and polar geometries.

The candidate will be introduced in a qualitative manner to pneumatic, hydraulic and electric drive systems. This will be considered in the unit Mechatronics Systems: An Introduction (H); however, a contextualised approach within this unit will be required. The candidates will be expected to be able to critically assess differing drive systems for specific situations. Typical criteria will be range of movement, position control, power, torque, force, speed, safety and cost.

Outcome 2 introduces the candidate to the sensory systems employed in typical robotic manipulators and end-effectors, with a focus on the linear and rotary encoders. The candidate will be expected to be able to differentiate between incremental and absolute encoders. The candidate will be expected to be able to use PBC, BCD and Gray codes in calculating angles of rotations. The calculation of resolution from a given bit length will also be required.

Outcome 3 introduces the candidate to the concepts of sequential, open-loop and closed-loop control. The candidates will be expected to be able to compare open-loop and closed-loop responses.

The strategies of proportional control and the effects of error and gain will be introduced to the candidates. The candidates will be expected to reproduce block diagrams and use these to describe a proportional control strategy.

Derivative and integral control will be introduced to the candidates in a qualitative manner. Candidates should have an understanding of the constituent parts of a PID control strategy which will enable them to choose the most suitable strategy for a robotic application.

Outcome 4 is the culmination of the unit. The candidate will be given a specific repetitive pick and place task and will be required to break down the task into the constituent robotic movements and thus derive a sequence for the task. Once the sequence has been derived and proven, the candidate will convert it into the functional code of the particular robotic system available at the centre. Verification will consist of ensuring the robotic system performs the original task given to the candidate.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

It is recommended that you refer to the Subject Guide for additional information. The Subject Guide is intended to support the information contained in the Arrangements document. The SQA Arrangements documents contain the standards against which candidates are assessed.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Outcomes 1, 2 and 3 could consist of written questions with Outcome 4 consisting of a practical exercise.

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).