SQA Advanced Unit specification

General information for centres

Unit title: Robotic Systems

Unit code: HT80 48

Unit purpose: This Unit is designed to provide candidates with a knowledge and understanding of the main elements of robotic systems and the factors influencing their selection for general industrial applications. Candidates will also be provided with an opportunity to programme a robotic system.

On completion of the Unit the candidate should be able to:

1   Describe and compare the main attributes of robotic systems.
2   Select and justify suitable robotic systems for a given industrial application.
3   Program and operate a robotic system to perform a given industrial task.

Credit points and level: 1 SQA Credit at SCQF level 8: (8 SCQF credit points at SCQF level 8*)

*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 National 1 to Doctorates.

Recommended prior knowledge and skills: Completion of the Level 7 unit Transducers and Control Fundamentals or equivalent knowledge or experience is assumed. Possession of the Units Process and Equipment Selection and CNC, or equivalent knowledge or experience, would provide a useful addition and contextual setting.

Core Skills: There may be opportunities to gather evidence towards the following listed Core Skills components in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Written Communication	SCQF level 6
Use of Numbers	SCQF level 6
Critical Thinking	SCQF level 6
Reviewing and Evaluating	SCQF level 6
Working with Others	SCQF level 6

Context for delivery: If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

Assessment: Assessment of Outcomes 1 and 2 must be combined together into a single assessment paper based around a case study which covers a situation requiring the description, selection and justification of appropriate robotic systems for particular tasks. Candidates will be provided with a copy of the case study and robotic systems topic areas relevant to the study at least 20 days before they sit the written assessment during which time they will be able to research information from text books, the Internet and other sources. The written assessment, which should last no more than two hours, must be conducted under controlled, supervised conditions. Candidates will be permitted to bring into the assessment information they have gathered as a result of their research. Outcome 3 must be assessed by practical assignment. Candidates must complete the practical assignment in two hours under supervised conditions.

SQA Advanced Unit specification: statement of standards

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The sections of the Unit stating the Outcomes, knowledge and/or skills, and evidence requirements are mandatory.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the knowledge and/or skills section must be taught and available for assessment. Candidates should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Describe and compare the main attributes of robotic systems

Knowledge and/or skills

- Robot anatomies
  - articulated arm
  - Cartesian
  - gantry
  - cylindrical
  - polar
  - SCARA
  - mobile robots
- End effectors
  - gripper
  - magnetic
  - suction pads
  - special tooling
- Drive systems
  - electrical
  - pneumatic
  - hydraulic
- Sensors
  - tactile
  - non-tactile
- Encoders
  - incremental
  - absolute
- Control techniques
  - point to point
  - continuous
- Programming approaches
  - lead-by-nose
  - teach pendant
  - off-line

♦ Factors contributing to safe working
— work envelope
— lifting capacity
— barriers
— work practices

Evidence Requirements

Evidence for the knowledge and/or skills in this Outcome should be provided on a sample basis. The evidence may be presented in response to specific questions. Each candidate will need to demonstrate that she/he can answer questions correctly based on a sample of the items shown above. In any assessment of this Outcome **five out of eight** knowledge and/or skills items should be sampled.

In order to ensure that the candidates will not be able to foresee what items they will be questioned on, a different sample of five from eight knowledge and/or skills items is required each time the Outcome is assessed. Candidates must provide a satisfactory response to all five items.

Where sampling takes place, a candidate's response can be regarded as satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

♦ **Robot anatomy:** Determine the robot anatomy, joint movements and degrees of freedom for three from seven anatomies
♦ **End effectors:** Compare end effectors used for specific applications for two from four types
♦ **Drive Systems:** Compare at least two different types of drive systems used for particular applications for two from three types
♦ **Sensors:** Describe and compare tactile and non-tactile sensors
♦ **Encoders:** Describe the operation of one type of encoder from the two types
♦ **Control techniques:** Describe and compare point to point and continuous control techniques
♦ **Programming approaches:** Describe two different programming techniques used in robotic systems out of the three types
♦ **Factors contributing to safe working:** Describe two factors contributing to safe working from four issues

The assessment for this Outcome must be combined together with that for Outcome 2. Details of assessment are given in the Evidence Requirements for Outcome 2.

Assessment guidelines

Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response or structured questions within the context of a case study.

Outcome 2

Select and justify suitable robotic systems for a given industrial application

Knowledge and/or skills

♦ appropriate robots and associated equipment for a given industrial application
♦ safety considerations associated with a given industrial application

Evidence Requirements

Both knowledge and/or skills items should be assessed in this Outcome. Candidates must be able to provide appropriate responses involving the selection and justification of at least two robotics systems with associated safety considerations for a given industrial application.

For each knowledge and/or skills item candidate responses can be regarded as satisfactory if they cover the following areas:

♦ Selection and justification of at least two robots and associated equipment for given industrial applications to include details of the anatomy, accuracy, repeatability, resolution, end effectors, drive systems, sensors, control techniques and programming approaches.
♦ Description of safety considerations associated with given industrial applications to include issues surrounding work envelope, lifting capacity, barriers and working practice.

Assessment of Outcomes 1 and 2 must be combined together into a single assessment paper based around a case study which covers a situation requiring the description, selection and justification of appropriate robotic systems for particular tasks. Candidates will be provided with a copy of the case study and robotic systems topic areas relevant to the study at least 20 days before they sit the written assessment during which time they will be able to research information from text books, Internet and other sources. The written assessment, which should last no more than two hours, must be conducted under controlled, supervised conditions. Candidates will be permitted to bring into the assessment information they have gathered as a result of their research.

Assessment guidelines

The types of questions used to assess candidates on the case study should be an appropriate balance of short answer, restricted response and structured questions.

Note that the selection, justification and application of a robotic system and components for a given application are not a simplistic task. Not only does it involve knowledge and understanding of the diverse aspects but there is also considerable scope for varied and diverse solutions if appropriately supported by justification.

Outcome 3

Program and operate a robotic system to perform a given industrial task.

Knowledge and/or skills

♦ programming a robot
♦ download programme into robot memory
♦ verify programme
♦ documentation
♦ safety

Evidence Requirements

Candidates must be assessed on all knowledge and/or skills items in this Outcome.

A candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing the candidate is able to:

♦ write a robot program designed to perform a given industrial task
♦ download the program into robot memory
♦ operate the program to initialise the robot and perform the given industrial task
♦ provide brief documentation covering programme structure and operation
♦ list and discuss relevant safety issues

This Outcome must be assessed by candidates undertaking a practical assignment meeting the requirements of the bullet points above. Candidates are required to produce documentation which should include the following:

♦ outline program sequence using appropriate written and/or graphical approach
♦ program listing with appropriate comments
♦ comments on programming process including problems during programming, robot system performance and possible areas of improvement
♦ description of relevant safety issues

The practical assignment should be completed in no more than two hours under supervised conditions. Reports can be written up in the candidate's own time. Centres should make every reasonable effort to ensure the report is the candidate's own work. Where copying or plagiarism is suspected candidates may be interviewed to check their knowledge and understanding of the subject matter. A checklist should be used to record oral evidence of the candidate's knowledge and understanding.

Assessment guidelines

Centres are strongly advised to develop a checklist to assess the candidates during the practical exercise and with the written report.

Administrative information

Unit code: HT80 48

Unit title: Robotic Systems

Superclass category: VE

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SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of SQA Advanced qualifications.

FURTHER INFORMATION: Call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our Centre Feedback Form.

SQA Advanced Unit specification: support notes

Unit title: Robotic Systems

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 Unit is an optional unit within the SQA Advanced Diploma in Manufacturing Engineering. The Unit provides a good basic coverage of robots used within manufacturing and should be delivered in the context of manufacturing as experienced in the modern business environment. Given the content of the Unit, it is recommended that the Unit be delivered towards the middle or end of the SQA Advanced Diploma in Manufacturing Engineering when the candidate has already developed some understanding of the technical terms and issues.

Due to the nature of the unit, a bank of exemplar materials should be accumulated for the candidate to handle and discuss. This might include technical articles, interface specifications, block diagrams, products, case studies, engineering documentation, application descriptions, etc. This could be introduced at appropriate points in the coverage to help the candidate get a feel for these and their scope. Lecturers should be alert to opportunities to use the candidates' own knowledge and experiences to inform particular topics and the subject area in general. Candidates who have knowledge or access to associated information should be encouraged to share such information. Topics/work undertaken could be contextualised to include local applications such as 'high-tech' assembly, flexible manufacture, precision operations, AGVs. **Safety issues should be emphasised throughout the delivery of this Unit.**

Guidance on the delivery and assessment of this Unit

This Unit should be delivered by a combination of lecturing and whole class and group discussions. In order to make the subject as interesting as possible, centres are encouraged to use practical examples, manufacturers' data sheets and videos. Candidates should also be encouraged to explore the Internet for information on various materials. Centres should also use group discussions to allow candidates to select and justify materials for different applications.

Simulators and simulation should be considered as useful tools to help in understanding, programming and operation of robotic systems but it is unlikely that a true appreciation of the topic could be gained without the use of a physical robotic system (albeit a laboratory scale version).

Details on approaches to assessment are given under Evidence requirements and Assessment guidelines under Outcomes 2 and 3 in the SQA Advanced Unit specification: statement of standards section. It is recommended that these sections be read carefully before proceeding with assessment of candidates. With many units, lecturers will generally expect to receive back responses which correspond to the communicated information from the lecturer. However, owing to the diverse and sometimes specialised nature of this topic, lecturers should remain alert to accept other valid responses which students may provide. This may flow from the candidate's personal knowledge, reading or experience although they have not been covered to such depth by the Unit. The written assessment based on the case study should take place after Outcomes 1 to 2 have been completed and the programming assignment would normally be undertaken following the written assessment.

Candidates should be supplied with the required report format. Candidates should complete written reports in their own time. It is important that candidates' progress is closely monitored to ensure work is their own. Where copying or plagiarism is suspected candidates may be interviewed to check their knowledge and understanding of the subject matter.

Opportunities for developing Core Skills

There may be opportunities to gather evidence towards the following listed Core Skills components in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Written Communication	SCQF level 6
Use of Numbers	SCQF level 6
Critical Thinking	SCQF level 6
Reviewing and Evaluating	SCQF level 6
Working with Others	SCQF level 6

Open learning

The majority of this Unit could be delivered by distance learning, and may incorporate a degree of on-line support. However, with regard to assessment, planning would be required by the centre concerned to ensure the sufficiency and authenticity of candidate evidence. Arrangement would be required to be put in place to ensure that assessment whether done at a single or at multiple events was conducted under controlled, supervised conditions.
The candidate would require the use of:

♦   PCs or computing
♦   Access mechanisms to robotic systems

Assessment of Outcomes 1 and 2 will require the centre to ensure that written evidence is sufficient and authentic. Assessment of outcomes should be conducted under supervised conditions. It is unlikely that Outcome 3 could be assessed outwith the main centre without issues of authenticity being addressed.

To keep administrative arrangements to a minimum, it is recommended that for distance learning candidates the assessment paper is taken at a single assessment event.

Arrangements would also have to be made for candidates to have supervised access to robotic and associated equipment.

Equality and inclusion

This Unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website www.sqa.org.uk/assessmentarrangements.

General information for candidates

Unit title: Robotic Systems

This Unit has been designed to help you to learn about Robotic Systems in an industrial context. The Unit builds on general engineering work in manufacturing and extends this to cover the use of robotic systems for manufacture. The Unit has theoretical, application and practical aspects.

You will need to learn the language (terms) used, key elements that make up a robotic system and some of the strengths and weaknesses of alternatives.

The unit starts with the anatomy (types) of arm robots, the parts that form a robot and ways they are programmed. Next, it progresses to cover issues that affect the choice of robots for a given task. Finally, it covers the practical aspects of getting a robot to do a task by carrying out a simple task.

As you learn about robots then the issue of safety and safe working will be emphasised and at all times you should keep safety in mind when working with robots.

It is likely that during the teaching of the Unit you will be provided with basic information on the topic. You may find it valuable to supplement this with additional information relevant to the subject area. For the selection of robots to do a particular task, you will be required to analyse this information and judge its value in supporting any views you wish to put forward. Thus, another benefit of taking the Unit is that you will be encouraged to develop or enhance new skills in research, analysis and critical thinking. There is no single right way to solve a particular technical issue or to solve a business problem, so you need to develop judgement as to which may be the most appropriate in practice and for a particular situation.

During the Unit, you will be provided with case study and background materials to illustrate how the various aspects are important. If you do have previous experience, or knowledge in this subject area then your lecturer or instructor may encourage you to use this knowledge to set in context the information you receive during the teaching of the Unit. They may also ask you to share this knowledge with the rest of your class so that others can benefit from your experiences.

The precise form that assessment will take will depend on the centre where you are taking the Unit. The Unit involves two assessments. The first is a case study in which you are required to respond to and provide answers — this covers Outcomes 1 and 2. The second is a practical programming exercise — this covers Outcome 3. Assessment will take place towards the end of the associated learning and will take place under supervised, controlled conditions. You are likely to be required to produce a report or respond to questions though you will have been provided with appropriate mini-case study information prior to the actual assessment event. Please ask your lecturer or instructor to explain precisely what form assessment will take and the precise timetable. You will be provided with details of the assessment well before it is due to take place so that you have time to prepare properly for it.