



National Unit Specification: general information

UNIT Engineering Manufacturing Processes (SCQF level 6)

CODE F5KC 12

SUMMARY

This Unit may form part of a National Qualification Group Award or may be offered on a free-standing basis.

This Unit is designed to provide candidates with an opportunity to develop their knowledge and understanding of both traditional manufacturing processes such as forming, joining and machining and modern manufacturing processes such as electro-discharge machining and rapid prototyping. Candidates will also learn how to select the appropriate manufacturing processes for the manufacture of given components and plan the sequence of operations for the manufacture of components.

This Unit is suitable for candidates training to be manufacturing, mechanical, fabrication and welding, or multi-disciplinary engineering technicians. It is also suitable for craftspersons who wish to develop more advanced knowledge and understanding in engineering manufacturing processes.

OUTCOMES

- 1 Describe the characteristics of a range of traditional manufacturing processes.
- 2 Outline the characteristics of a range of modern manufacturing processes.
- 3 Select and explain engineering manufacturing processes suitable for the manufacture of given engineering components.
- 4 Plan the sequence of operations for the manufacture of given components.

Administrative Information

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RECOMMENDED ENTRY

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

- ◆ the NQ Unit *Engineering Manufacturing Processes* at SCQF level 5
- ◆ Standard Grade Craft and Design at Credit level

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.

The Unit provides opportunities for candidates to develop aspects of the following Core Skills:

Communication (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

Describe the characteristics of a range of traditional manufacturing processes.

Performance Criteria

- (a) Describe correctly the characteristics of forming processes.
- (b) Describe correctly the characteristics of joining processes.
- (c) Describe correctly the characteristics of traditional machining processes.

OUTCOME 2

Outline the characteristics of a range of modern manufacturing processes.

Performance Criteria

- (a) Outline correctly the characteristics of non-traditional machining processes.
- (b) Outline correctly the characteristics of Rapid Prototyping processes.

OUTCOME 3

Select and explain engineering manufacturing processes suitable for the manufacture of given engineering components.

Performance Criteria

- (a) Describe correctly the principal factors influencing process selection.
- (b) Select correctly the most suitable manufacturing processes for given components.
- (c) Explain correctly, for given components, the principal factors that influence process selection.

OUTCOME 4

Plan the sequence of operations for the manufacture of given components.

Performance Criteria

- (a) Identify correctly tooling and equipment requirements for the manufacture of given components.
- (b) Complete correctly the sequence of operations for the manufacture of given components.

National Unit Specification: statement of standards

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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 recorded oral evidence should be produced to demonstrate that a candidate has achieved all Outcomes and Performance Criteria.

Outcomes 1 and 2

Outcomes 1 and 2 may be assessed on an individual basis or as a single assessment covering both Outcomes. The Outcomes must be assessed under supervised, open-book conditions in which candidates are allowed to access their notes, handouts, textbooks or other relevant materials.

With regard to Outcome 1:

- ◆ the characteristics of two forming processes must be described from the following list: die casting, injection moulding, vacuum forming or forging
- ◆ the characteristics of two joining processes must be described from the following list:
 - manual metal arc welding (MMA)
 - metal inert gas welding (MIG)
 - adhesion, soldering or mechanical fastening
- ◆ the characteristics of two traditional machining processes must be described from the following list:
 - milling
 - turning
 - grinding or drilling

With regard to Outcome 2:

- ◆ the characteristics of two non-traditional machining processes must be outlined from the following list: electro-chemical machining (ECM), electro-discharge machining (EDM), laser cutting, abrasive flow machining (AFM), water jet machining or ultra-sonic machining (USM)
- ◆ the characteristics of two Rapid Prototyping processes must be outlined from the following list: stereolithography, 3D printing, selective laser sintering or fused deposition modelling

Outcomes 3 and 4

Outcomes 3 and 4 may be assessed on an individual basis or as a single assessment covering both Outcomes. The total assessment time for Outcomes 3 and 4 must not exceed 2 hours. The assessment(s) must be conducted under supervised, closed-book conditions in which candidates may use reference materials provided by the centre but are not allowed to bring their own notes, handouts, textbooks or other materials into the assessment.

National Unit Specification: statement of standards (cont)

UNIT Engineering Manufacturing Processes (SCQF level 6)

With regard to Outcome 3:

- ◆ a minimum of five principal factors influencing process selection should be described from the following list:
 - material
 - size
 - weight
 - manufacturing time
 - quality
 - material properties
 - cost
 - repeatability
 - quantity
- ◆ for each of four given components and/or assemblies the most suitable manufacturing process must be correctly identified. Two manufacturing processes must be traditional while the other two processes must be modern.
- ◆ a minimum of three principal factors should be used to justify each process selection.

With regard to Outcome 4:

- ◆ the tooling and equipment requirements for two given components and/or assemblies must be correctly identified. One manufacturing process associated with the tooling and equipment requirements must be traditional while the other process must be modern.
- ◆ a sequence of operations must be completed for the manufacture and/or assembly of two components. One sequence of operations must relate to a traditional manufacturing process while the other must relate to a modern manufacturing process.

National Unit Specification: support notes

UNIT Engineering Manufacturing Processes (SCQF level 6)

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 has been developed for the National Qualification Group Award in Manufacturing Engineering at SCQF level 6 but may also be offered on a free-standing basis.

The aim of the Unit is to provide candidates with an opportunity to develop their knowledge and understanding of both traditional manufacturing processes such as forming, joining and machining and modern manufacturing processes such as electro-chemical machining and rapid prototyping. On successful completion of the Unit candidates will be capable of outlining a range of traditional and modern manufacturing processes. They will also be able to select the appropriate manufacturing processes (both traditional and modern) for the manufacture of components and be able to plan the sequences of operations for the manufacture of components.

In Outcome 1 centres should teach candidates a range of traditional engineering manufacturing processes. In the Evidence Requirement section of this Unit specification these processes have been grouped together under the three main headings of forming, joining and machining. It is left to centres to decide which manufacturing processes they are going to teach although a minimum of two processes must be taught under each of the three headings to satisfy assessment requirements. Centres may choose manufacturing processes on the basis of local industry requirements, progression to other awards and/or candidate interests.

Recommendations as to what processes may be delivered are shown below although the list is not intended to be exhaustive.

- ◆ Forming Processes: die casting, injection moulding, vacuum forming or forging
- ◆ Joining Processes: manual metal arc welding (MMA), metal inert gas welding (MIG), adhesion, soldering or mechanical fastening
- ◆ Traditional Machining Processes: milling, turning, grinding or drilling

In Outcome 2 centres should teach candidates a range of non-traditional machining and Rapid Prototyping processes. As in Outcome 1 a minimum of two processes must be taught from both non-traditional machining processes and Rapid Prototyping processes to satisfy assessment requirements. The manufacturing processes chosen to be taught by centres will largely be dictated by the same factors as identified in Outcome 1: namely, local industry requirements, progression to other awards and/or candidate interests.

National Unit Specification: support notes (cont)

UNIT Engineering Manufacturing Processes (SCQF level 6)

Recommendations as to what processes may be delivered are shown below although the list is not intended to be exhaustive.

- ◆ Non-traditional Machining Processes: electro-chemical machining (ECM), electro-discharge machining (EDM), laser cutting, abrasive flow machining (AFM), water jet machining or ultrasonic machining (USM)
- ◆ Rapid Prototyping Processes: stereolithography, 3D printing, selective laser sintering or fused deposition modelling

In Outcome 3 candidates should consider what is involved in selecting suitable manufacturing processes for the manufacture of given components. Candidates should be encouraged to investigate the factors that influence manufacturing process selection. These can include material, size, weight, manufacturing time, quality, material properties, cost, repeatability or quantity. Candidates should then apply their knowledge of these factors to decide, for given components, what are the most appropriate manufacturing processes. Candidates should be encouraged to justify their process selections in terms of the key factors that influenced their choices.

In Outcome 4 candidates should plan the sequence of operations for the manufacture of given components. In particular candidates should look at the tooling and equipment requirements and the sequence of operations involved in manufacturing components or assemblies using both traditional and modern manufacturing processes.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

It is recommended that the Unit is delivered in the same sequence the Outcomes are presented in the National Unit Specification: statement of standards section of the Unit. This Unit may be delivered by a combination of lectures, tutorial work, group discussions, investigations using paper based and electronic sources, industrial visits and demonstrations of some of the processes mentioned in the previous section.

During demonstrations of processes adequate supervision should be given to candidates at all times to ensure that Health and Safety requirements are being complied with.

Industrial visits to engineering manufacturing organisations may also prove useful in enhancing candidates' knowledge and understanding of both traditional and modern manufacturing processes.

It should be noted that the Internet contains a rich source of information on different types of manufacturing processes and candidates should be encouraged to explore these sources to learn more about different engineering manufacturing processes.

CDs, DVDs and videos detailing different engineering manufacturing processes may also enhance candidate learning.

National Unit Specification: support notes (cont)

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OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

Although skills in *Communication* are not formally assessed candidates have to be able to analyse, summarise and convey complex technical information on traditional and current manufacturing processes. Practical formative activities could provide opportunities to research and discuss manufacturing processes and to develop oral skills in an engineering environment. Guidance should be given to ensure that evidence is formally communicated to acceptable industry standards.

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 Communication 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)*.

Formative assessment exercises involving candidates in investigating and describing manufacturing processes, selecting and explaining engineering manufacturing processes suitable for the manufacture of components and planning the sequence of operations for the production of components can play a particularly important role in building candidate knowledge, understanding and confidence of Unit content.

Outcomes 1 and 2

The assessment of Outcomes 1 and 2 may take the form of an investigation where, with the aid of sketches, candidates outline/describe the characteristics of two processes from each of the following five categories: forming, joining, traditional machining, non-traditional machining and Rapid Prototyping.

National Unit Specification: support notes (cont)

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Outcomes 3 and 4

The assessment of Outcomes 3 and 4 may take the form of a single assessment paper comprising a balance of short answer, restricted response and structured questions where the candidate is given four components and/or assemblies and is asked to select and give basic justification of the most suitable manufacturing processes (two traditional processes and two modern processes) to produce each of the components or assemblies. The candidate could then be asked to select the tools and equipment required to manufacture two of the components/assemblies and outline the processes (one of which should be traditional and the other modern) used to manufacture the two components/assemblies using a sequence of operations.

DISABLED CANDIDATES AND/OR THOSE WITH ADDITIONAL SUPPORT NEEDS

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website www.sqa.org.uk/assessmentarrangements