



National Unit Specification: general information

UNIT Engineering Material Removal Principles (SCQF level 5)

CODE F5WD 11

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 a basic knowledge and understanding of engineering material removal principles. During delivery of the Unit, candidates will learn to identify cutting tool geometries for a range of tools and state the different factors affecting tool life. They will also learn to identify tool shapes according to the forms they create. Candidates will also develop the knowledge and understanding to calculate speeds and feeds for cutting tools used on different materials.

This Unit is suitable for candidates training to be manufacturing, mechanical or multi-disciplinary engineering fitters or technicians but may also be delivered to candidates who are being introduced to material removal principles for the first time.

OUTCOMES

- 1 State cutting tool terminology and explain the principal factors affecting tool life.
- 2 Identify tool shapes according to the forms they create.
- 3 Determine speeds and feeds for given cutting tools and materials.

RECOMMENDED ENTRY

Entry to the Unit is at the discretion of the centre. While candidates do not require any previous knowledge of material removal principles some practical engineering craft experience would be an advantage.

Administrative Information

Superclass: XF

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CREDIT VALUE

1 credit at SCQF level 5 (6 SCQF credit points at SCQF level 5*).

**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 5)
- ◆ Numeracy (SCQF level 5)
- ◆ Problem Solving (SCQF level 5)

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

State cutting tool terminology and explain the principal factors affecting tool life.

Performance Criteria

- (a) State correctly the meaning of tool geometry terms commonly applied to cutting tools.
- (b) State correctly typical materials used in the construction of cutting tools.
- (c) State correctly the factors that affect tool life when used on different materials.
- (d) Explain correctly the influence of machine tool conditions on cutting tool performance and explain the importance of correct tool selection and setting on tool performance.
- (e) State correctly the advantages and disadvantages of using cutting fluids in machining operations.

OUTCOME 2

Identify tool shapes according to the forms they create.

Performance Criteria

- (a) Identify correctly the selection of tools for manufacturing profiles.
- (b) Identify correctly the selection of tools for generating shapes.
- (c) Identify correctly the selection of tools for combined forming and generating.
- (d) Identify correctly tools for both right and left hand operations.

OUTCOME 3

Determine speeds and feeds for given cutting tools and materials.

Performance Criteria

- (a) Calculate correctly a speed for a given machine cutting tool and material.
- (b) Calculate correctly a feed for a given machine cutting tool and material.
- (c) Use information correctly from a chart and a nomogram to determine a speed and a feed.

National Unit Specification: statement of standards (cont)

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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, 2 and 3 may be assessed on an individual basis, as a combination of Outcomes (eg Outcomes 1 and 2 assessed together and Outcome 3 separately), or as a single, holistic assessment covering all three Outcomes. 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. Total assessment time must not exceed 2 hours. Candidates should be allowed to use a non-programmable scientific calculator during assessment.

With regard to Outcome 1:

- ◆ candidates must state **three** tool geometry terms for a lathe tool and **two** terms for any other two tool types (eg milling cutter, files, chisels, drill, taps, dies, punch, hacksaw etc.)
- ◆ candidates must state **three** different materials used in lathe cutting tool construction and **one** material used in the construction of any other two tool types
- ◆ candidates must state **three** factors that affect tool life when used with different materials
- ◆ candidates must state **two** advantages and **two** disadvantages of cutting fluids (eg cutting oils, emulsions and pastes) in manufacturing operations

With regard to Outcome 2:

- ◆ candidates must identify **two** hand tools and **two** machine cutting tools for manufacturing profiles
- ◆ candidates must identify **two** hand tools and **two** machine cutting tools to generate shapes
- ◆ candidates must identify **two** tools for combined forming and generating

With regard to Outcome 3:

- ◆ candidates must calculate a speed for a given cutting tool (eg drill, milling cutter, lathe tool) for a given material (eg mild steel, brass, aluminium, non-metallic etc)
- ◆ candidates must calculate a feed for a given cutting tool (eg drill, milling cutter, lathe tool) for a given material (eg mild steel, brass, aluminium, non-metallic etc)
- ◆ candidates must use a chart and a nomogram to determine a speed and a feed for a given cutting tool and material

The Assessment Support Pack for this Unit provides sample assessment material. Centres wishing to develop their own assessments should refer to the Assessment Support Pack to ensure a comparable standard.

National Unit Specification: support notes

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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 forms part of the National Qualification Group Award (NQGA) in Manufacturing Engineering at SCQF level 5, but may also be offered on a free-standing basis.

The aim of this Unit is to provide candidates with a basic knowledge and understanding of engineering material removal principles. On successful completion of this Unit candidates will be able to identify cutting tool geometries for a range of tools and state the different factors affecting tool life. They will also be able to identify tool shapes according to the forms such tools create. Candidates will also have developed knowledge and understanding to calculate speeds and feeds for cutting tools and materials.

This Unit provides a solid foundation of study for candidates who wish to proceed to the Unit *Engineering Material Removal Principles* SCQF level 6.

In Outcome 1 candidates should be introduced to a range of engineering tool geometries. The exact number of tools considered is left to centres to decide although must include lathe tools and at least two hand tools. In analysing tool geometries due regard should be paid to the different materials used in the construction of each tool and the factors affecting tool life. Examples of tools that may be considered are shown below

Lathe/milling tools

- ◆ basic tool geometry (eg clearance, top rake, back rake, lead angle etc)
- ◆ influence of machine tool conditions on cutting tool performance
- ◆ the need for correct tool selection and setting in ensuring correct cutting operations
- ◆ advantages and disadvantages of using cutting oils, emulsions and pastes in machining operations

Files

- ◆ file classification (eg flat, round, half-round, triangular etc)
- ◆ file teeth grading (eg rough, second cut, smooth etc.) and patterns (eg single-cut, double cut etc)

Drill/reaming bits

- ◆ twist drill features (eg point angle, lip angle and helix)
- ◆ centre drill geometry
- ◆ basic reamer geometry

National Unit Specification: support notes (cont)

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Taps and dies

- ◆ different types of hand and machine taps
- ◆ different types of hand and machine dies

Punches

- ◆ different types of punch (eg centre, prick, pin, letter etc)
- ◆ basic punch geometries

Hacksaws

- ◆ different types of hacksaw (eg standard, engineer's, junior, etc)
- ◆ construction of different saw types including blade teeth configurations

Outcome 2 requires candidates to identify both hand and machine tools for forming profiles, generating shapes and tools for combined forming and generating. Candidates should also learn how to recognise tools for both right and left hand operations.

In Outcome 3 candidates should learn to calculate speeds and feeds for selected machining processes (eg lathe, drilling machine, milling machine) and materials and also use charts and nomograms to determine speeds and feeds.

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 primarily in a classroom using a mixture of lectures, tutorial work and group discussions but should include visits to engineering workshops to examine different tool geometries. Such visits should also include practical demonstrations where the impact of using different tool geometries (eg the use of different files, the use of different rake angles) on shaping and cutting operations is examined. With regard to lathe tools the difference between high speed steel, brazed tipped and inserted carbide tools, speeds and feeds may also be demonstrated. Practical demonstrations may also investigate the effects of oils, emulsions and pastes on tool life and surface finish.

Wall charts and tool displays illustrating different cutting tool geometries can be very useful learning and teaching aids.

The Unit should be fully supported with relevant learning materials (eg handouts in paper and electronic form, textbooks, on-line materials etc).

National Unit Specification: support notes (cont)

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OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

Opportunities to develop the Reading Communication Core Skill component at SCQF level 5 may be developed in Outcome 1 while candidates are reading materials on tool geometries, factors affecting tool life, the use of cutting oils, emulsions and pastes in machining operations etc. from paper based and electronic sources.

Opportunities to develop the Using Number Core Skill component at SCQF level 5 may occur in Outcome 3 while candidates are performing speed and feed calculations associated with the use of cutting tools used with machine tools.

The Critical Thinking Core Skill component at SCQF level 5 may be developed in Outcome 2 while, for example, candidates are identifying tool forms to create different profiles and tools to generate different shapes.

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 can play a particularly important role in helping candidates to develop their knowledge and understanding of aspects of engineering material removal principles, including the geometries of different tool types, materials used in tool construction, the factors affecting tool life, the calculation of speeds and feeds etc.

Outcomes 1, 2 and 3 may be assessed by a single assessment paper taken at a single assessment event lasting 2 hours. The assessment paper may include appropriate charts and nomograms and may comprise a suitable balance of short answer, restricted response and structured questions or objective questions (eg multi-choice questions) or a combination of both. This assessment paper may be suitable for on-line delivery. Centres may develop questions such that the speed and feed obtained by calculations are confirmed by use of nomogram and chart.

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