

Next Generation Higher National Unit Specification

Mechanical Engineering: Practical Skills (SCQF level 7)

Unit code: J6D9 47
SCQF level: 7 (24 SCQF credit points)
Valid from: session 2024–25

Prototype unit specification for use in pilot delivery only (version 2.0) October 2024

This unit specification provides detailed information about the unit to ensure consistent and transparent assessment year on year.

This unit specification is for teachers and lecturers and contains all the mandatory information required to deliver and assess the unit.

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Unit purpose

This unit allows learners to develop knowledge, understanding and skills in practical mechanical engineering, with a focus on:

- ◆ measurement
- ◆ hand fitting
- ◆ turning
- ◆ milling

They experience hands-on practical mechanical manufacturing techniques, which helps them progress to further study or employment.

The target group for this unit is learners studying towards qualifications that develop core engineering skills. These skills support a career in an engineering field such as:

- ◆ mechanical engineering
- ◆ systems engineering
- ◆ manufacturing engineering
- ◆ measurement and control engineering

The unit is also for learners doing a Modern Apprenticeship or wanting to develop the practical, personal and professional skills required for a successful career as an engineering technician. It provides them with suitable knowledge and skills to progress to further study, or employment in a wide range of engineering industries.

Entry is at your discretion. However, we recommend that learners have one or more of the following:

- ◆ broad knowledge and understanding of mathematics, and mechanical engineering concepts and theorems at SCQF level 6, for example Higher Mathematics or Physics, or a National Certificate (NC) in Mechanical Engineering
- ◆ relevant, equivalent workplace experience in the mechanical engineering sector, or an equivalent qualification in Engineering at SCQF level 6

Unit outcomes

Learners who complete this unit can:

- 1 apply the concepts of dimensional control and measurement to determine the accuracy of manufactured mechanical components
- 2 produce components using hand fitting techniques
- 3 apply turning operations and techniques to manufacture mechanical components
- 4 apply milling operations and techniques to manufacture mechanical components

Evidence requirements

All outcomes can be assessed holistically using product, written and/or oral recorded evidence. Learners generate evidence under controlled or supervised, open-book conditions, and it must be authenticated as being all their own work. The evidence must contain a mix of knowledge and skills items that matches the evidence requirements of the unit, and include various forms of evidence, such as:

- ◆ assignments
- ◆ case studies
- ◆ reports
- ◆ essays
- ◆ simulations
- ◆ structured controlled tests
- ◆ practical evidence
- ◆ other relevant sources of evidence

Outcome 1

- ◆ Identify the correct units of measurement that are commonly used for linear, angular and surface measurements.
- ◆ Describe the types of error that commonly occur when carrying out engineering measurements.
- ◆ Record measurements accurately on an inspection sheet and identify any non-conformance in measurements to drawing specifications, using a variety of measuring equipment such as micrometers, Vernier protractors, slip gauges, Vernier height gauges and Vernier callipers.
- ◆ Define the term 'calibration' with respect to measuring equipment, and prove measuring equipment is accurate by carrying out calibration techniques.

Outcome 2

- ◆ Work safely at all times to comply with health and safety legislation, regulations, directives, and other relevant guidelines.
- ◆ Carry out pre-planning procedure and documentation for all fitting activities.
- ◆ Obtain the appropriate tools and equipment for the hand fitting operations, and check that they are in a safe and usable condition.
- ◆ Mark out the components for the required operations, using appropriate tools and techniques.
- ◆ Produce components that combine different operations and have features that cover each of the following:
 - flat datum faces
 - drilled through holes
 - internal threads
 - faces that are square to each other
 - reamed holes
 - external threads
 - curved profiles
 - faces that are parallel to each other
 - chamfers and radii
 - faces angled to each other
 - counterbore, countersink or spot face
 - sliding or mating parts
- ◆ Produce components to each of the following standards, as applicable to the process:
 - components to be free from false tool cuts, burrs and sharp edges
 - general dimensional tolerance $\pm 0.25\text{mm}$
 - one or more specific dimensional tolerances within $\pm 0.1\text{mm}$

Outcome 3

- ◆ Work safely at all times to comply with health and safety legislation, regulations, directives and other relevant guidelines.
- ◆ Carry out pre-planning procedure and documentation for all turning activities.
- ◆ Obtain the appropriate tools and equipment for the turning operations, and check that they are in a safe and usable condition.
- ◆ Mount and set the required work holding devices, workpiece and cutting tools.
- ◆ Mount, secure and machine components such as three-jaw chucks with hard jaws, drive plate and centres, four-jaw chucks, and faceplates.
- ◆ Produce machined components that combine different operations and have features that cover each of the following:
 - flat faces
 - stepped diameters
 - drilled holes
 - chamfers

- parallel diameters
- tapered diameters
- external threads
- parting off
- knurls or special finishes
- ◆ Produce components to each of the following quality and accuracy standards, as applicable to the operation:
 - components to be free from false tool cuts, burrs and sharp edges
 - general dimensional tolerance $\pm 0.25\text{mm}$
 - there must be one or more specific dimensional tolerances within $\pm 0.1\text{mm}$

Outcome 4

- ◆ Work safely at all times to comply with health and safety legislation, regulations, directives and other relevant guidelines.
- ◆ Carry out pre-planning procedure and documentation for all milling activities.
- ◆ Obtain the appropriate tools and equipment for the milling operations, and check that they are in a safe and usable condition.
- ◆ Mount and set the required work holding devices, workpiece and cutting tools.
- ◆ Mount, secure and machine components using two of the following work holding devices:
 - fixed vice
 - direct clamping to machine table
 - swivel or universal vice
 - angle plates
 - chucks
 - fixtures
- ◆ Produce machined components that combine different operations and have features that cover each of the following:
 - flat faces
 - parallel faces
 - open ended slots
 - square faces
 - steps or shoulders
 - enclosed slots
 - angular faces
 - drilled holes
- ◆ Produce components for each of the following quality and accuracy standards, as applicable to the operation:
 - components to be free from false tool cuts, burrs and sharp edges
 - general dimensional tolerance $\pm 0.25\text{mm}$
 - there must be one or more specific dimensional tolerances within $\pm 0.1\text{mm}$

Knowledge and skills

The following table shows the knowledge and skills covered by the unit outcomes:

Knowledge	Skills
<p>Learners should understand how to:</p> <ul style="list-style-type: none">♦ quantify and use units of measurement♦ identify and reduce sources of error in engineering measurement♦ record and analyse measurements for error♦ define and conduct calibration on measuring equipment♦ accurately use data sheets and tables for required manufacturing information♦ calculate appropriate speeds and feeds for the tool and material conditions	<p>Learners can:</p> <ul style="list-style-type: none">♦ select and use appropriate measuring equipment to suit a desired feature♦ accurately inspect components or features♦ accurately record measurement findings on an inspection sheet♦ work safely at all times♦ plan the fitting, turning and milling activities♦ mark out and produce components using hand fitting techniques♦ select, set and secure appropriate machine tooling for turning and milling activities♦ select, set and secure appropriate work holding apparatus for turning and milling activities♦ produce turned and milled components to appropriate specifications

Meta-skills

Throughout the unit, learners develop meta-skills to enhance their employability in the engineering sector.

Self-management

Learners develop their skills in adapting and initiative, specifically through critical reflection and independent thinking, as they practically apply manufacturing skills.

Social intelligence

Learners develop their skills in communication and collaborating as they work with other learners on case studies and assignments.

Innovation

Learners develop skills including critical thinking, curiosity and sense-making as they analyse problems relating to mechanical practical skills.

Literacies

Learners develop core skills in the following literacies:

Numeracy

Learners develop their numeracy skills when solving problems using applied engineering mathematical techniques.

Communication

Learners develop their communication skills by studying the course material and engaging with other learners and their teacher or lecturer.

Digital

Learners develop digital literacy when they use IT equipment to document their achievements.

Delivery of unit

This unit is part of the Higher National Certificate (HNC) in Engineering. The framework includes a number of mandatory and optional units, and you can tailor the selected combination of units specific to the engineering pathway needs.

The notional design length is 120 hours, however, the amount of time you allocate to each outcome is at your discretion. We suggest the following distribution of time, including assessment:

- Outcome 1** — Apply the concepts of dimensional control and measurement to determine the accuracy of manufactured mechanical components
(18 hours)
- Outcome 2** — Produce components using hand fitting techniques
(30 hours)
- Outcome 3** — Apply turning operations and techniques to manufacture mechanical components
(36 hours)
- Outcome 4** — Apply milling operations and techniques to manufacture mechanical components
(36 hours)

Additional guidance

The guidance in this section is not mandatory.

Content and context for this unit

This unit allows learners to develop knowledge, understanding and skills in practical mechanical engineering, with a focus on:

- ◆ measurement
- ◆ hand fitting
- ◆ turning
- ◆ milling

Apply the concepts of dimensional control and measurement to determine the accuracy of manufactured mechanical components (outcome 1)

Introduces learners to the base units, measuring scales, sources of error and control of accuracy in measuring equipment.

Produce components using hand fitting techniques (outcome 2)

Introduces learners to hand tools and manufacturing techniques associated with manufacturing components using hand fitting techniques.

Apply turning operations and techniques to manufacture mechanical components (outcome 3)

Introduces learners to manufacturing cylindrical artifacts using lathes. This consolidates and further develops the knowledge they gained in outcomes 1 and 2.

Apply milling operations and techniques to manufacture mechanical components (outcome 4)

Introduces learners to manufacturing rectangular and square objects. This develops the knowledge they gained in outcomes 1, 2 and 3.

Approaches to delivery

Take a sequential approach to delivery, where learners study and complete the outcomes in order, although you could deliver outcome 1 in conjunction with outcomes 2, 3 and 4.

You should deliver all outcomes principally in a workshop environment.

Approaches to assessment

You can assess learners holistically, in a variety of ways. We suggest using a hybrid assessment for outcomes 1, 2, 3 and 4, which involves learners manufacturing a series of components that rely on their fitting, turning and milling techniques.

Opportunities for e-assessment

Assessment that is supported by ICT, such as e-testing or the use of e-portfolios or social software, may be appropriate for some assessments in this unit.

If you want to use e-assessment, you must ensure that you apply the national standard to all evidence and that conditions of assessment (as specified in the evidence requirements) are met, regardless of the mode of gathering evidence.

Equality and inclusion

This unit is designed to be as fair and as accessible as possible with no unnecessary barriers to learning or assessment.

You should take into account the needs of individual learners when planning learning experiences, selecting assessment methods or considering alternative evidence.

Guidance on assessment arrangements for disabled learners and/or those with additional support needs is available on the assessment arrangements web page:

www.sqa.org.uk/assessmentarrangements.

Information for learners

Mechanical Engineering: Practical Skills (SCQF level 7)

This section explains:

- ◆ what the unit is about
- ◆ what you should know or be able to do before you start
- ◆ what you need to do during the unit
- ◆ opportunities for further learning and employment

Unit information

This unit provides you with knowledge of fundamental practical skills of mechanical and manufacturing engineering. It is for learners already working in the engineering sector as well as those who want to build on their engineering knowledge to progress to higher education.

Before starting this unit, we recommend that you have one or more of the following:

- ◆ broad knowledge and understanding of mathematics, and mechanical engineering concepts and theorems at SCQF Level 6, or a National Certificate (NC) in Mechanical Engineering
- ◆ relevant, equivalent workplace experience within the mechanical engineering sector, or an equivalent qualification in Engineering at SCQF level 6

Unit outcomes

- 1 apply the concepts of dimensional control and measurement to determine the accuracy of manufactured mechanical components
- 2 produce components using hand fitting techniques
- 3 apply turning operations and techniques to manufacture mechanical components
- 4 apply milling operations and techniques to manufacture mechanical components

Outcome 1 — gives you skills and knowledge in accurate measuring techniques. This includes knowledge of common sources of error and how to overcome them. You also gain an understanding of the importance of selecting appropriate measuring equipment, and the control and calibration procedures that come with accurate measuring equipment.

Outcomes 2, 3 and 4 — you manufacture components using the fundamental skills of bench fitting, turning and milling. You use the knowledge and skills you gained in outcome 1 to manufacture the components to a high standard of accuracy that meets industry training standards.

When you have completed this unit, you can:

- ◆ select and maintain appropriate measuring equipment to attain a level of accuracy to $\pm 0.1\text{mm}$
- ◆ proficiently manufacture artifacts using hand skills to $\pm 0.1\text{mm}$
- ◆ proficiently manufacture artifacts using turning skills to $\pm 0.1\text{mm}$
- ◆ proficiently manufacture artifacts using milling skills to $\pm 0.1\text{mm}$

Meta-skills

Throughout the unit, you can develop meta-skills to enhance your employability in the engineering sector.

Meta-skills include self-management, social intelligence and innovation.

Self-management

You develop skills in adapting and initiative, specifically through critical reflection and independent thinking, as you practically apply manufacturing skills.

Social intelligence

You develop the skills of communication and collaborating as you work with other learners on case studies and assignments.

Innovation

You develop skills, including critical thinking, curiosity and sense-making, as you analyse problems relating to mechanical practical skills.

Administrative information

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Superclass: XH

History of changes

Version	Description of change	Date
2.0	Evidence requirements updated to clarify conditions of assessment.	October 2024

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