Next Generation Higher National Unit Specification

Manufacturing Engineering: Materials and Processes (SCQF level 7)

Unit code: J6CV 47

SCQF level: 7 (24 SCQF credit points)

Valid from: session 2023–24

Prototype unit specification for use in pilot delivery only (version 1.0) August 2023

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.

This edition: August 2023 (version 1.0)

Unit purpose

This unit provides learners with specific knowledge and skills that are fundamental to manufacturing engineering.

It is aimed at those who want to develop their core engineering design and analysis skills to support a career in an engineering field, such as manufacturing engineering. It is also for learners who want to develop the practical, personal and professional skills required for a successful career as an engineering technician.

Entry to this unit is at your centre's discretion. However, we recommend that learners have one or more of the following:

- a broad knowledge and understanding of manufacturing and mechanical concepts and theorems, for example an SCQF level 6 qualification in subjects related to manufacturing and mechanical principles
- an appreciation of engineering principles, for example an SCQF level 6 qualification in subjects related to mechanical or manufacturing engineering
- relevant, equivalent workplace experience or SCQF level 6 qualifications, for example Higher Physics or a National Certificate in an engineering discipline

This unit provides learners with suitable knowledge and skills to progress to employment in a wide range of engineering industry technical apprenticeships, or further study.

Unit outcomes

Learners who complete this unit can:

1 demonstrate an understanding of the relationship between the structure and properties of materials in relation to the manufacture of engineering products
2 demonstrate an understanding of manufacturing techniques in relation to the manufacture of a range of engineering products
3 describe relevant quality systems in relation to the manufacture of a range of products
4 determine production costs associated with the manufacture of a range of products

Evidence requirements

Assess this unit holistically, using a portfolio of written and/or oral recorded evidence generated by learners. They can gather evidence while studying other principles or discipline-specific units, however, they must generate evidence under unsupervised, open-book conditions.

To successfully achieve this unit, learners must provide evidence demonstrating that they have developed the knowledge and skills of each outcome.

The standard of evidence should be consistent with the SCQF level of this unit.

You can find further information in the ‘Additional guidance’ section.

Outcome 1

- Define the properties associated with materials used in engineering applications.
- Compare and contrast different types of materials used in engineering applications. Include the following properties where relevant: malleability; ductility; toughness; hardness; tensile, compressive and shear stress; resistivity; conductivity; fatigue; creep; toxicity; stability; and wear resistance.
- Give examples of how materials are selected and put to application based on the required properties.
- Identify and explain the various material testing procedures with reference to quality standards for the given application.
- With reference to material properties and various testing procedures, investigate the effects of heat treatment (where possible, include other treatments by comparison such as annealing or work hardening).
- Identify the requirements of safe disposal of engineering materials and the consideration required to meet environmental responsibilities.

Outcome 2

- Identify the main stages in transforming raw material into a manufactured component — primary and secondary processes.
- Understand the traditional, modern and specialist manufacturing techniques across a range of engineering industries.

- Determine the sequence of operations for the manufacture of a range of components using traditional, modern and specialist manufacturing techniques.
- Select and justify the appropriate manufacturing process or processes for the manufacture of a range of engineering products.
- Use financial appraisal techniques to determine the most suitable manufacturing process from a cost perspective.

Outcome 3

- Explain the principles of quality management in relation to the manufacturing engineering sector.
- Understand the core components of quality management — quality planning, quality control, quality assurance and quality improvement.
- Explain the requirement of a quality management system within a manufacturing engineering organisation in relation to meeting operational aims and objectives.
- Apply a range of quality improvement tools and techniques to given manufacturing scenarios.
- Develop an understanding of engineering measurement equipment used in relation to the inspection of a range of products including resolution, accuracy and calibration of the equipment.
- Perform inspection using a range of measurement equipment.

Outcome 4

- Determine direct and indirect costs, and fixed and variable costs including overheads.
- Determine costs involving overhead absorption, overhead allocation and depreciation.
- Calculate overall manufacturing costs for a range of products.
- Apply the principles of break-even analysis in relation to the mass production of a new product.

Knowledge and skills

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

Knowledge	Skills
Outcome 1 Learners should understand how to: ♦ define the mechanical properties of materials ♦ compare and contrast types of materials ♦ describe structure of materials ♦ identify the selection and application of materials based on their properties ♦ describe heat treatment processes ♦ identify and explain material testing processes ♦ describe the environmental impact of materials	**Outcome 1** Learners can: ♦ identify properties of materials ♦ perform heat treatment ♦ perform material testing
Outcome 2 Learners should understand how to: ♦ describe manufacturing processes ♦ determine the sequence of operations for the manufacture of a range of components ♦ select and justify appropriate manufacturing processes	**Outcome 2** Learners can: ♦ use financial appraisal techniques to determine the most suitable manufacturing process
Outcome 3 Learners should understand how to: ♦ explain the principles of quality management ♦ understand the core components of quality management systems ♦ develop an understanding of engineering measurement	**Outcome 3** Learners can: ♦ perform inspection techniques using a range of measurement equipment ♦ apply a range of quality improvement tools and techniques

Knowledge	Skills
Outcome 4 Learners should understand how to: ♦ identify manufacturing costs ♦ determine cost allocation and apportionment ♦ calculate overall manufacturing costs	**Outcome 4** Learners can: ♦ apply the principles of break-even analysis

Meta-skills

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

Self-management

Learners develop their focusing skills as they study the course material. They develop integrity through a number of ethical decisions they make, and they also develop initiative when making decisions and thinking independently.

Social intelligence

Learners develop communication skills as they share information with you and their fellow learners. They develop collaborating through teamwork and building relationships.

Innovation

Learners develop sense-making skills as they investigate materials and compare processes. They develop their creativity during design, material and process selection elements. They also develop critical thinking skills, as the decisions they make require a degree of logical thinking.

Literacies

Learners develop core skills in the following literacies:

Numeracy

Learners develop their numeracy skills through costing and material testing.

Communication

Learners develop their communication skills when studying the course material, engaging with you and their fellow learners, and presenting their final project.

Digital

Learners use information and communication technology (ICT) in many elements of the course, for example in financial analysis.

Delivery of unit

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

While the exact time allocated to this unit is at your centre's discretion, the notional design length is 120 hours.

The amount of time you allocate to each outcome is at your discretion, however we suggest the following time distribution for each outcome, including assessment:

Outcome 1 — demonstrate an understanding of the relationship between the structure and properties of materials in relation to the manufacture of engineering products
(24 hours)

Outcome 2 — demonstrate an understanding of manufacturing techniques in relation to the manufacture of a range of engineering products
(40 hours)

Outcome 3 — describe relevant quality systems in relation to the manufacture of a range of products
(26 hours)

Outcome 4 — determine production costs associated with the manufacture of a range of products
(30 hours)

Additional guidance

The guidance in this section is not mandatory.

Content and context for this unit

Learners develop knowledge, understanding and skills related to manufacturing engineering principles, with a focus on engineering materials, manufacturing processes, quality systems and manufacturing costs.

Demonstrate an understanding of the relationship between the structure and properties of materials in relation to the manufacture of engineering products (outcome 1)

Introduces learners to the properties of engineering materials and how these properties can be utilised in engineering applications. They should understand further treatments and how to alter the properties, and the testing procedures used.

Demonstrate an understanding of manufacturing techniques in relation to the manufacture of a range of engineering products (outcome 2)

Introduces learners to a range of manufacturing processes. They should understand how to select the correct processes and define the sequence of operations for the manufacture of a range of products. They should also use financial appraisal techniques to help determine suitability of processes.

Describe relevant quality systems in relation to the manufacture of a range of products (outcome 3)

Introduces learners to quality systems. They should learn quality management principles and how these are used within a manufacturing environment. This outcome also covers engineering measurement principles, as well as inspection and testing techniques.

Determine production costs associated with the manufacture of a range of products (outcome 4)

Introduces learners to production costs associated with manufacturing a range of products. They should understand how to identify cost types associated with production and calculate overall costs of products. They should also use break-even analysis for the introduction of new products.

Approaches to delivery

You should take a sequential approach to delivery, where learners study and complete outcomes 1 to 4 in order. However, you can deliver outcomes in an integrated manner if you prefer.

Do this in a learning space or virtual learning environment. You should teach primarily using problem-based-learning (PBL) techniques, such as case studies and mini projects, supported by other methods. The holistic teaching format of PBL encourages learners to consider the deeper context of the theory.

Approaches to assessment

We recommend that you assess this unit holistically. Learners should generate evidence principally using case studies.

Opportunities for e-assessment

Assessment that is supported by information and communication technology (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

Manufacturing Engineering: Materials and Processes (SCQF level 7)

This information 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 and skills specific to manufacturing engineering. It forms part of the Higher National Certificate (HNC) in Engineering, and is aimed at those who want to progress to a manufacturing engineering technician role.

Before starting the unit, you should have some knowledge and understanding of engineering drawings, materials used in engineering, and manufacturing processes and equipment. This could be an SCQF level 6 qualification in mechanical or manufacturing engineering, or relevant, equivalent workplace experience.

You learn about the fundamentals of manufacturing engineering, as well as material properties and their importance when selecting materials to solve engineering problems.

There is a holistic approach to assessment. You are assessed using a variety of ways, including project-based learning, case studies and lab exercises. You should collate all evidence in your individual portfolio.

There are opportunities to carry out assessment in conjunction with other units in the HNC qualification, including the Manufacturing Engineering: Simulation and Modelling unit at SCQF level 7 and the Engineering Principles unit at SCQF level 7, in the form of real-world engineering problems.

Unit outcomes

On completion of this unit, you can:

1 demonstrate an understanding of the relationship between the structure and properties of materials in relation to the manufacture of engineering products
2 demonstrate an understanding of manufacturing techniques in relation to the manufacture of a range of engineering products
3 describe relevant quality systems in relation to the manufacture of a range of products
4 determine production costs associated with the manufacture of a range of products

This unit provides a career development opportunity if you are already in industry, and the opportunity for you to build the engineering knowledge, skills and experience required to progress to further study at HND level or university.

Outcome 1 introduces you to the properties of engineering materials and their importance when selecting materials for engineering applications. You understand how these properties can change through various processes and undertake testing processes to determine material properties.

Outcome 2 introduces you to a range of manufacturing processes. You learn how to select the correct processes and define the sequence of operations for the manufacture of a range of products. You also use financial appraisal techniques to help determine the suitability of processes.

Outcome 3 introduces you to quality systems. This covers quality management principles and how these are used within a manufacturing environment. This outcome also introduces you to engineering measurement principles, as well as inspection and testing techniques.

Outcome 4 introduces you to production costs associated with the manufacture of a range of products. You learn how to identify cost types associated with production, and calculate overall costs of products. You use break-even analysis for the introduction of new products.

Meta-skills

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

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

Self-management

As you work through the course material and case studies, you develop the skills of adapting and using initiative through critical reflection and independent thinking.

Social intelligence

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

Innovation

You develop critical thinking, curiosity and sense-making skills as you analyse problems related to manufacturing engineering principles.

Administrative information

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Superclass: WA

History of changes

Version	Description of change	Date

Note: please check SQA's website to ensure you are using the most up-to-date version of this document.