Next Generation Higher National Unit Specification

Engineering Principles (SCQF level 6)

Unit code: J6CT 46

SCQF level: 6 (8 SCQF credit points)

Valid from: session 2024 to 2025

Prototype unit specification for use in pilot delivery only (version 3.0) August 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.

This edition: August 2024 (version 3.0)

Unit purpose

This unit forms part of the Higher National Certificate (HNC) in Engineering.

The target group for this unit is learners who want to develop their core engineering design and analysis skills to support a career in an engineering field such as:

- electrical engineering
- mechanical engineering
- systems engineering
- manufacturing engineering
- measurement and control 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. At SCQF level 6, this unit provides learners with suitable knowledge and skills for progression or articulation to further study.

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

- basic knowledge and understanding of electrical and mechanical principles at SCQF level 5, for example in units related to engineering or physics, such as Engineering Science or Engineering Systems Principles at SCQF level 7
- relevant, equivalent workplace experience

Unit outcomes

Learners who complete this unit can:

1 describe mechanical engineering quantities used in engineering systems
2 describe electrical engineering quantities used in engineering systems
3 compare mechanical and electrical quantities
4 investigate the properties of materials used in engineering systems

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

Where sampling is indicated, you must teach all content in the 'Knowledge and skills' section and it must be available for assessment. Learners should not know which items they will be assessed on in advance. You must use a different sample for each assessment occasion.

Outcome 1

Sample any three of the four required items:

- Describe work, power (mechanical, fluid and thermal) and energy (potential, kinetic, flow and thermal), including standard international (SI) units of measurement.
- Describe mass, length, force, stress and strain, including SI units of measurement.
- Describe linear velocity, linear acceleration, angular velocity, angular acceleration, friction and inertia, including SI units of measurement.
- Describe pressure, temperature, flow and thermal energy, including SI units of measurement.

Outcome 2

Sample any two of the three required items:

- Describe energy and power (real or active, reactive and apparent), including SI units of measurement.
- Describe voltage, electro-motive force (EMF) and current, including SI units of measurement.
- Describe resistance, capacitance, inductance and charge, including SI units of measurement.

Outcome 3

Sample any three of the four required items:

- Compare mechanical (mass and spring) and electrical (inductor and capacitor) energy storage elements.
- Compare mechanical (damper) and electrical (resistor) power dissipative elements.
- Compare mechanical and electrical external inputs applied to one electrical, one mechanical, and one electromechanical system.
- Compare mechanical and electrical power transfer mechanisms in one electrical, one mechanical, and one electromechanical system.

Outcome 4

Sample any three of the four required items:

- Investigate three mechanical properties of three different materials. Identify the materials and justify their key properties for use in the particular application.
- Investigate three electrical properties of three different materials. Identify the materials and justify their key properties for use in the particular application.
- Investigate three fluid properties of three different materials used in two different systems. Identify the materials and justify their key properties for use in the particular application.
- Investigate three thermal properties of three different materials. Identify the materials and justify their key properties for use in the particular application.

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: ♦ describe work, power and energy ♦ describe mass, length, force, stress and strain ♦ describe linear velocity, linear acceleration, angular velocity, angular acceleration, friction and inertia ♦ describe pressure, temperature, flow and thermal energy	**Outcome 3** Learners can: ♦ compare mechanical and electrical energy storage elements ♦ compare mechanical and electrical power dissipative elements ♦ compare mechanical and electrical external inputs ♦ compare mechanical and electrical power transfer mechanisms
Outcome 2 Learners should understand how to: ♦ describe energy and power ♦ describe voltage, EMF and current ♦ describe resistance, capacitance, inductance and charge	**Outcome 4** Learners can: ♦ investigate mechanical properties ♦ investigate electrical properties ♦ investigate fluid properties ♦ investigate thermal properties

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.

Social intelligence

Learners develop their communication skills as they share information between other learners and teachers or lecturers.

Innovation

Learners develop their sense-making skills as they investigate materials and compare quantities.

Literacies

Learners develop core skills in the following literacies:

Communication

Learners develop their communication skills by studying the course material and engaging with other learners, and teachers or lecturers.

Digital

Learners develop their digital skills and computer literacy by using information and communications technology (ICT).

Delivery of unit

This unit is a mandatory unit in the HNC in Engineering. The framework includes mandatory and optional units, and you can tailor the selected combination of units to specific qualifications.

We recommend you deliver this unit alongside or after workshop and laboratory activities introducing learners to electrical, mechanical and materials practical aspects, as defined in the related skills outcomes.

The notional design length is 40 hours, however, the amount of time you allocate to each outcome is at your centre's discretion. We suggest the following distribution of time, including assessment:

Outcome 1 — Describe mechanical engineering quantities used in engineering systems (8 hours)

Outcome 2 — Describe electrical engineering quantities used in engineering systems (8 hours)

Outcome 3 — Compare mechanical and electrical quantities (10 hours)

Outcome 4 — Investigate the properties of materials used in engineering systems (14 hours)

Additional guidance

The guidance in this section is not mandatory.

Content and context for this unit

This unit gives learners some of the knowledge and skills they need to support a career in engineering.

Describe mechanical engineering quantities used in engineering systems (outcome 1)

This introduces learners to mechanical engineering quantities. This knowledge provides a foundation that supports later study of mechanical principles. Learners should study the outcome 1 quantities in the context of one or more complex engineering systems, so they can describe the quantities with some knowledge of how they apply in reality.

Describe electrical engineering quantities used in engineering systems (outcome 2)

This introduces learners to electrical engineering quantities. This knowledge provides a foundation that supports later study of electrical principles. Learners should study the outcome 2 quantities in the context of one or more complex engineering systems, so they can describe the quantities with some understanding of how they apply in reality.

Compare mechanical and electrical quantities (outcome 3)

Learners critically compare mechanical and electrical quantities to understand their differences and similarities. For example, the concepts, ideas and behaviours that underpin a spring, mass and damper mechanical system are very similar to a series electrical circuit capacitance, inductance and resistance system.

Investigate the properties of materials used in engineering systems (outcome 4)

Learners investigate the properties of materials to learn how they perform in different environments and different engineering applications. The properties depend on the context you deliver this unit, and on the system and/or materials you use. For example, in an electrical power system, the resistivity of porcelain would be a suitable property to investigate, while for a cooling system, the viscosity of oil would be a relevant property to investigate.

You do not need any specific resources for this unit other than information and communications technology (ICT). However, if you use the recommended delivery approach of practical experimentation, you need suitable laboratory facilities and equipment.

Approaches to delivery

You should take a semi-sequential approach to delivery. Start with outcomes 1 and 2, as these introduce learners to some key principles that they would benefit from before they move on to study outcomes 3 and 4. Outcomes 3 and 4 contain discrete subject matter, and are not interdependent, so you can deliver them in any order.

You should deliver these in a learning space or virtual learning environment (VLE). We recommend you take a holistic approach to delivery, where learning occurs in the context of one (or a few) overarching, complex systems engineering scenarios. Use practical experimentation, (as delivered in related units' skills outcomes), to help learners understand the concept, and support this with self-directed research, to investigate and learn about the relevant quantities and concepts.

In outcomes 1 and 2, you should relate quantities to known standards where applicable (for example, definitions of metre and kelvin), and to their influence on engineering systems.

In outcome 3, you should explore specific similarities including (but not limited to):

- mass, spring and damper — series inductor, capacitor, resistor circuit
- force and pressure — EMF as external inputs
- fluid and heat flow — electrical current
- friction as a form of mechanical resistance generating heat — electrical resistance generating heat
- storage of potential energy, as in a dam, with the storage of electrostatic energy in a capacitor
- storage of kinetic energy, as in a flywheel, with magnetic energy in an inductor

The concept of energy transfer should be fully explored, for example electrical to mechanical energy, mechanical to electrical energy, electrical and mechanical energy to heat energy.

In outcome 4, learners should investigate typical materials used in engineering systems in terms of their key:

- mechanical properties, such as:
  - malleability
  - ductility
  - toughness
  - hardness
  - tensile
  - compressive and shear fatigue
  - creep
  - toxicity
  - stability
  - wear resistance

- electrical properties, such as:
  - resistivity
  - conductivity
  - permeability
  - permittivity
  - current handling capability
  - breakdown voltage
- flow properties, such as:
  - viscosity
  - flow resistance
- thermal properties, such as:
  - conduction and insulation properties
  - conductivity
  - specific heat capacity
  - radiation properties

We encourage using computer simulation to support practical experimentation, and industrial visits to see real applications.

Approaches to assessment

In line with the approach to delivery, you should take a holistic approach to assessment. You can assess learners in a variety of ways, but these should mainly be reports on practical experimentation.

Learners could demonstrate evidence of all knowledge and skills items in the context of one or more overarching complex systems engineering scenarios. They should collate all evidence in their individual portfolio, which they produce under unsupervised, open-book and untimed conditions.

Learners could keep a linear reflective account to measure their meta-skills, digital literacies, professional skills and wider employer-desired skills. They should record this in their portfolio.

You should provide learners with support, guidance and feedback on areas of development, and signpost developmental opportunities.

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

Engineering Principles (SCQF level 6)

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 the knowledge and skills that are fundamental to all engineering learners to study for the Higher National Certificate in Engineering. You study some of the key engineering principles found in a variety of engineering disciplines.

Unit outcomes

On completion of this unit, you can:

1 describe mechanical engineering quantities used in engineering systems
2 describe electrical engineering quantities used in engineering systems
3 compare mechanical and electrical quantities
4 investigate the properties of materials used in engineering systems

Outcome 1 — introduces you to mechanical engineering quantities — this knowledge provides a foundation that supports later study of mechanical principles.

Outcome 2 — introduces you to electrical engineering quantities — this knowledge provides a foundation that supports later study of electrical principles.

Outcome 3 — provides the opportunity to critically compare mechanical and electrical quantities to understand their differences and similarities — for example, the concepts, ideas and behaviours that underpin a spring, mass and damper mechanical system are similar to a series electrical circuit capacitance, inductance and resistance system.

Outcome 4 — allows you to investigate the properties of materials to gain knowledge of how they perform in different environments and different engineering applications.

You are assessed by a variety of ways, including reports you produce on practical experiments you have performed. You should collate all assessment evidence in your individual portfolio, along with reflective reports that you produce about your learning.

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 the skill of focusing, as you study the course material.

Social intelligence

You develop your communication skills, as you share information.

Innovation

You develop the skill of sense-making, as you investigate materials and compare quantities.

Administrative information

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Superclass: XA

History of changes

Version	Description of change	Date
2.0	♦ Additional wording in 'Evidence requirements' to clarify sampling. ♦ Changed 'section' to 'information' in 'Information for learners' section for consistency across units. ♦ Minor wording, formatting and punctuation changes throughout for clarity and to apply house style.	August 2023
3.0	Additional wording to clarify conditions of assessment.	August 2024

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