Next Generation Higher National Unit Specification

Engineering Systems: Practical Skills (SCQF level 7)

Unit code: J6DA 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 provides learners with knowledge and experience of some of the practical skills relevant to systems engineering. They develop practical skills in building and testing mechanical artefacts, and electrical and electronic circuits.

The target group for this unit is learners who want to develop their core engineering design and analysis skills to support a career in systems engineering.

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

- broad knowledge and understanding of engineering processes and theorems at SCQF level 6, for example in subjects related to electrical engineering, electronics or mechanical principles, or Higher Engineering Science
- a limited knowledge of software and modelling at SCQF level 6, for example Higher Engineering Science or in relevant units or qualifications
- relevant, equivalent workplace experience or SCQF level 6 qualifications, for example Higher Physics or a National Certificate (NC) in Engineering Systems

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

Unit outcomes

Learners who complete this unit can:

1 work safely and efficiently in a workshop environment
2 use engineering software to solve a pre-defined problem
3 assemble and test an electrical or electronic circuit
4 assemble and test a mechanical artefact

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

- Apply current relevant health and safety legislation in the workshop environment.
- Apply current operating procedures when using machine tools and equipment.
- Use equipment and machines within limitations and capability.
- Demonstrate knowledge of key health and safety legislation.
- Demonstrate knowledge of environmental legislation (for example local waste disposal).

Outcome 2

- Select electrical or electronics software for a given problem.
- Use electrical or electronics software to design a circuit to meet a given specification.
- Use electrical or electronics software to simulate the performance of a given circuit.
- Describe the purpose and operation of two pieces of electrical or electronics software.
- Select mechanical software for a given problem.
- Use mechanical software to design an artefact to meet a given specification.
- Use mechanical software to simulate the performance of a given artefact.
- Describe the purpose and operation of two pieces of mechanical software.
- Explain the significance of emerging engineering software for solving problems.

Outcome 3

- Use common methods to assemble a circuit (for example soldering, crimping).
- Select components from a given selection.
- Use electrostatic discharge prevention procedures.
- Use one schematic diagram in circuit assembly.
- Explain the significance of electrostatic discharge.
- Explain the purpose and operation of various components, including resistors, diodes, capacitors, and transistors.
- Explain conventions in schematic diagrams.
- Select and use equipment to test the circuit assembled for outcome 4.
- Interpret test data using graphical and other methods.
- Describe the purpose and operation of three types of electrical or electronic test equipment.

Outcome 4

- Use two common methods to assemble an artefact.
- Use two common methods to fabricate components.
- Use two machine tools to fabricate components.
- Use technical drawings in component fabrication.
- Explain conventions in technical drawings.
- Explain the purpose of two components.
- Explain the purpose and operation of two machine tools.
- Select and use equipment to test the artefact assembled for outcome 4.
- Interpret test data.
- Describe the purpose and operation of three types of mechanical test equipment.

Knowledge and skills

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

Knowledge	Skills
Learners should understand how to: ♦ apply current relevant health and safety legislation correctly ♦ use correct operating procedures ♦ explain the significance of emerging engineering software (for example digital twins, Internet of Things) in solving problems ♦ test an electrical or electronic circuit in line with pre-defined procedures ♦ test a mechanical artefact in line with pre-defined procedures	Learners can: ♦ apply current relevant health and safety legislation correctly ♦ use equipment within relevant limitations and capability ♦ apply electrical or electronic software (for example Simulink, Multisim) when solving a problem ♦ apply mechanical or manufacturing software (for example AutoCAD, PLCs) when solving a problem ♦ assemble an electrical or electronic circuit in line with pre-defined procedures ♦ test an electrical or electronic circuit in line with pre-defined procedures ♦ assemble a mechanical artefact in line with pre-defined procedures ♦ make use of advanced manufacturing techniques (for example CNC, 3D printing)

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 also develop the skill of integrity, as they consider the impact of their actions on others and the wider environment. Learners could provide evidence of this by demonstrating their knowledge of waste disposal legislation in their reports.

Social intelligence

Learners develop their feeling and collaborating skills as they work with other learners to develop solutions to problems and consider the impact of their actions on others. They could provide evidence of this by working with others in supervised practical activities.

Innovation

Learners develop the skills of curiosity and creativity as they use trial and error to develop solutions to problems. They could provide evidence of these by modifying and retesting artefacts.

Literacies

Learners develop core skills in the following literacies:

Numeracy

Learners develop their numeracy skills by using mathematical software.

Communication

Learners develop their communication skills by presenting test results and working with other learners to develop solutions to problems.

Digital

Learners develop digital literacy by using a broad range of engineering software and testing equipment.

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 to specific engineering pathway needs. In particular, you can deliver this unit alongside, and use it to support, the Engineering Systems Principles unit at SCQF level 7.

The notional design length is 120 hours, however, the amount of time you allocate to each outcome is at your discretion (particularly given the unit's holistic approach). We suggest the following distribution of time, including assessment:

Outcome 1 — Work safely and efficiently in a workshop environment (15 hours)

Outcome 2 — Use engineering software to solve a pre-defined problem (35 hours)

Outcome 3 — Assemble and test an electrical or electronic circuit (35 hours)

Outcome 4 — Assemble and test a mechanical artefact (35 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 systems engineering. It takes an integrated approach, combining principles theory with mathematical underpinning knowledge, practical experimentation and using digital technology. You could combine this unit with some of the learning in the mandatory units. We also encourage contextualisation — using real industry examples and case studies.

Work safely and efficiently in a workshop environment (outcome 1)

This introduces learners to working safely and efficiently in a workshop (electrical, mechanical, computer or any other form), and the importance of this. They learn about key legislation, their rights and responsibilities, and how to achieve safe and efficient work using correct operating procedures. They also cover the concept of limitation and capability as it applies to equipment, machines and humans, and develop related skills. As with all outcomes, you should encourage the use of digital technologies to help learners develop meta-skills, and compound and reinforce their knowledge and skills.

Use engineering software to solve a pre-defined problem (outcome 2)

Learners use engineering software to solve a pre-defined problem or problems, developing their knowledge and skills relating to engineering and simulation software in the process. They must use both mechanical (for example CAD) and electrical (for example Simulink) software, and have an awareness of emerging engineering software (for example digital twins) and its significance in an engineering context. You should give learners the opportunity to work with as many forms of engineering software as possible, as this helps them to develop their digital literacy.

Assemble and test an electrical or electronic circuit (outcome 3)

Learners apply their theoretical knowledge to assembling and testing an electrical or electronic circuit, in line with pre-defined procedures. The exact form of the circuit is at your discretion. However, it should be of a level of complexity and intricacy appropriate to the level of the unit, as well as the systems engineering ethos of the unit and the group award qualification as a whole. You should encourage the use of digital technologies to help learners develop meta-skills and compound their knowledge and skills. Deliver and assess this outcome as one or more group projects to develop collaboration skills.

Assemble and test a mechanical artefact (outcome 4)

Learners apply their theoretical knowledge to assembling and testing a mechanical artefact, in line with pre-defined procedures. The exact form of the circuit is at your discretion. However, it should be of a level of complexity and intricacy appropriate to the level of the unit, as well as the systems engineering ethos of the unit and the group award qualification as a whole. You should encourage the use of digital technologies to help learners develop meta-skills and compound their knowledge and skills. Deliver and assess this outcome as one or more group projects to develop collaboration skills.

Approaches to delivery

We advise that learners complete outcomes 1 and 2 first. These introduce learners to key concepts that they would benefit from understanding before they move on to the topics in outcomes 3 and 4. However, this is not mandatory.

Choose a holistic approach of active learning to encourage learners to consider the deeper context of the theories. Although the majority of the unit is not suitable for delivery in a virtual learning environment (VLE) because of its practical nature, we encourage you to use the VLE to support theoretical knowledge and further develop their digital literacy.

You could enhance this unit with guest lectures from industry specialists and industrial visits.

Approaches to assessment

In line with the approach to delivery, you should take a holistic approach to assessment. You can assess learners through a variety of means: creating physical artefacts or computer simulations supported by review of case study reports, mini projects, and group work. For case studies and mini projects, you can assess knowledge and skills through coursework exercises.

Learners could demonstrate evidence of all knowledge and skills in the context of a limited number of overarching complex systems engineering scenarios. It may be possible to assess all four outcomes by the design, assembly and testing of one or two electro-mechanical artefacts of sufficient complexity.

Learners must produce product evidence, for example reports. They should collate all evidence in their individual portfolio, which they produce under controlled or supervised, open-book conditions.

Outcome 1 — you could observe learners carrying out practical activities under open-book conditions, while working on their other outcomes. You could then provide evidence in the form of a completed observation checklist or witness testimony.

Outcomes 2, 3 and 4 — you can assess these holistically under open-book conditions. Learners could make use of engineering software to design or simulate mechanical artefacts and electrical or electronic circuits that they then build and test. Evidence would be a portfolio, including photographs of artefacts, test results and CAD designs, for at least one mechanical artefact and one electrical or electronic circuit.

Learners should keep a linear reflective account to measure their development of 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. Because of the open-book nature of the assessment, you must take care to ensure authenticity. You could do this by using variable values in coursework, making use of oral questioning and using originality-checking software.

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 Systems: 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 and skills specific to systems engineering, and experience of systems engineering in a practical environment. It forms part of the Higher National Certificate (HNC) in Engineering, which is aimed at learners wishing to become systems engineering technicians.

In this unit, you learn about topics such as how electrical circuits and mechanical objects are made. You then put this knowledge into practice by making one or more items.

Unit outcomes

On completion of this unit, you can:

1 work safely and efficiently in a workshop environment
2 use engineering software to solve a pre-defined problem
3 assemble and test an electrical or electronic circuit
4 assemble and test a mechanical artefact

Outcome 1 — you learn about the importance of working safely in a workshop environment, how this is regulated, and the potential impact of your actions on others, both now and in the future. You also learn how to use equipment, not just safely, but to the best of its capabilities. This gives you the knowledge you need to complete the other outcomes.

Outcome 2 — you use software to design and simulate electrical or electronic and mechanical items. You learn the advantages and disadvantages of using software. You also learn about emerging technology and how software is predicted to expand in the future.

Outcome 3 — you assemble and test an electrical or electronics circuit. You use a variety of methods to do this, and compare your final output to a given specification. You also learn how to compare test results to known standards, and what you can learn from these results.

Outcome 4 — you fabricate, assemble and test a mechanical object. You use a variety of methods to do this, and compare your final output to a given specification. You also learn how to compare test results to known standards, and what you can learn from these results.

You are assessed in a variety of ways, including things such as photographs of your final products, test data, programs, and drawings. 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 your focusing skills as you study the course material. You also develop the skill of integrity as you consider the impact of your actions on others and the wider environment.

Social intelligence

You develop your feeling and collaborating skills as you work with others to develop solutions to problems and consider the impact of your actions on others. You are also assessed on your ability to collaborate throughout a group project.

Innovation

You develop the skills of curiosity and creativity as you use trial and error to develop solutions to problems.

Administrative information

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Superclass: XA

History of changes

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

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