Next Generation Higher National Unit Specification

Electrical Engineering: Practical Skills (SCQF level 7)

Unit code: J6D6 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.

This edition: October 2024 (version 2.0)

Unit purpose

This unit introduces learners to practical skills and develops the knowledge required for aspects of electrical engineering, including:

- safe working practices
- using electronic measuring instruments on extra low voltage circuits
- the electrical installation circuit design process
- installation of a range of low voltage electrical circuits
- inspection and testing of low voltage electrical circuits

The target group for this unit is learners who want to develop knowledge and skills to support a career in electrical engineering.

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

- SCQF level 6 in subjects relating to electrical engineering, electronics or mechanical engineering, for example a National Certificate (NC) in Electrical Engineering
- Higher Physics or Higher Engineering Science
- relevant, equivalent workplace experience, for example a Modern or Foundation Apprenticeship

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 work safely and efficiently in electrical work environments
2 understand safe isolation procedures
3 use test instruments to measure electronic circuits
4 install and test low voltage electrical circuits

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 related industry environments.
- Apply risk assessment and method statements when undertaking all workshop tasks.
- Select the correct equipment, machines or instruments for a task.
- Demonstrate knowledge of safe working practices.
- Demonstrate efficient, environmental and economic working practices.

Outcome 2

- Explain the fundamental principles of protection for electrical safety.
- Identify component parts of the supply intake position, earthing arrangement (TN-C-S, TN-S, TT), surge protection and distribution.
- Interpret electrical distribution schematic diagrams.
- Identify a selection of isolation components to current regulations.
- Explain why, in certain work environments, permit to work and sanction for test documents are required.
- Explain the use of test instruments and precautions for proving ‘dead’.

- Demonstrate safe isolation procedure on low voltage installations, including individual circuits, single- and triple-pole overcurrent devices and the whole installation.

Outcome 3

- Select the correct instrument for given situations.
- Explain the main parameters in the specification of a range of instruments.
- Draw circuit diagrams to show the connections of an ammeter, voltmeter and wattmeter for measurement of current, voltage and power values respectively, including series, parallel and network circuits.
- Carry out connection of instruments for measurement of current, voltage and power values in DC circuits and compare results with calculations, including series, parallel and network circuits.
- Use an oscilloscope to measure electrical waveform parameters of DC and AC waveforms, and to signal overlap comparison and loading effects, including half-wave and full-wave rectification.
- Show awareness of instrument functions, including manual and auto set up.
- Demonstrate measurement of power factor in a given resistive, inductive, capacitive (RLC) circuit and economic power factor correction.
- Understand the importance of interpreting measured values correctly to compare to data and calculated values.

Outcome 4

- Understand terms of loading and maximum demand.
- Understand the importance of earthing an electrical system and automatic disconnection of supply (ADS).
- Identify wiring components used in domestic, commercial and industrial electrical installations.
- Identification of AC motor starting methods, protection, switchgear and accessories.
- Demonstrate circuit design to current Institution of Engineering and Technology (IET) wiring regulations.
- Interpret a domestic circuit diagram and wire an installation of accessories to a layout diagram and test.
- Interpret a commercial circuit diagram and wire an installation of accessories to a layout diagram and test.
- Install a motor circuit with a suitable starter circuit, emergency-stop and remote stop start station, for example a direct online (DOL) wiring system, and test.
- Interpret circuit parameters measured by the test instruments.
- Use a relevant test certificate to cover all tests required for the installations.

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: ♦ apply current relevant health and safety legislations ♦ apply safe working practice procedures	**Outcome 1** Learners can: ♦ carry out risk assessment and method statements ♦ apply safe working practices ♦ use appropriate personal protective equipment, test instruments and tools correctly
Outcome 2 Learners should understand how to: ♦ explain the need for a permit to work process, and maintenance systems and records ♦ explain the safe isolation procedure process	**Outcome 2** Learners can: ♦ identify electrical isolation points ♦ carry out safe isolation procedure on low voltage systems (controlled environment)
Outcome 3 Learners should understand how to: ♦ explain the need for measuring and test instruments ♦ select suitable equipment to measure parameters of electrical circuits	**Outcome 3** Learners can: ♦ use test instruments to measure current, voltage and resistance values in DC and AC circuits ♦ use an oscilloscope to measure electrical waveform in DC and AC circuits
Outcome 4 Learners should understand how to: ♦ explain causes and dangers associated with overcurrent ♦ interpret given circuit diagrams and transfer into a wiring diagram ♦ apply current industry regulations in the selection of an appropriate cable for a given application	**Outcome 4** Learners can: ♦ identify electrical components and circuits ♦ install domestic, commercial and industrial electrical circuits to current wiring regulations

Meta-skills

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

Self-management

Learners develop their focusing skills by methodical working practices as they study learning materials and use attention to detail in circuit design. They develop the skill of integrity and increase their awareness of the impact of their actions on others and the environment.

Learners also develop adaptability and initiative. They can provide evidence of their self-management meta-skills by critical reflection on the quality of their motor installation.

Social intelligence

Learners develop their skills in communication and collaboration by working with others and enhancing their ability to receive and communicate information as a team. They can provide evidence of this in a workshop activity that demonstrates team working.

Learners also develop their social conscience as they consider the design and economic impact of the use of materials in workshop tasks.

Innovation

Learners develop their curiosity, creativity, sense-making and critical thinking as they problem solve, summarise, select, compare, and contrast applications of electrical engineering practical skills. They can provide evidence of these skills when modifying circuits and installations.

Literacies

Learners develop core skills in the following literacies:

Numeracy

Learners develop their numeracy skills by understanding facts, figures, statistics and data analysis to industry standards.

Communication

Learners develop their communication and collaboration skills by presenting portfolio work and team working on workshop tasks.

Digital

Learners develop digital literacy through using IT equipment, engineering software and electrical test instruments.

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.

You can deliver this unit alongside, and it also supports, the following units:

- Electrical Engineering Principles (SQCF level 7)
- Electrical Power and Drive Systems (SCQF level 7)

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 — Work safely and efficiently in electrical work environments (15 hours)
Outcome 2 — Understand safe isolation procedures (25 hours)
Outcome 3 — Use test instruments to measure electronic circuits (40 hours)
Outcome 4 — Install and test low voltage electrical circuits (40 hours)

Additional guidance

The guidance in this section is not mandatory.

This unit could provide evidence for some of the Engineering Maintenance National Occupational Standards (NOS) requirements, and you can refer to these standards when delivering the unit.

Content and context for this unit

Work safely and efficiently in electrical work environments (outcome 1)

Learners develop knowledge and understanding of relevant health and safety legislation and carry out risk assessments and method statements to achieve safe working practices in the workshop environment (for example, PPE, Electricity at Work Regulations, HSE GS38 standards). They also cover efficient, economic and environmental working practices. Workshop tasks and industry case studies give learners opportunities to develop their social intelligence and self-management meta-skills, for example working with others in a workshop environment and being conscious of time and sustainability of materials. You should encourage them to use digital portfolios to record evidence and assess them with a mixture of individual and group activities or projects.

Understand safe isolation procedures (outcome 2)

Learners use their knowledge to apply relevant procedures for the completion of permit to work documentation in an industrial scenario. They demonstrate simulation of low voltage safe isolation and reinstatement of supply in a controlled environment. They also learn about the concept of safe isolation on an industrial type test rig to allow real visualisation of actual installation equipment. This controlled environment should simulate a low voltage single-supply and three-phase supply at an extra low voltage level (for safety reasons). You should encourage learners to develop collaboration skills in group activities, for example given roles in a permit to work scenario. You can complete delivery and assessment of this outcome in group activities or projects, but we recommend that you assess the practical safe isolation activity individually.

Use test instruments to measure electronic circuits (outcome 3)

You should introduce learners to electrical and electronic measuring instruments and their importance and use in electrical engineering. Assembling electronic circuits in a practical environment and using engineering software (for example multi-sim) to create and test circuits electronically, gives learners an awareness of digital simulation. Delivery and assessment of this outcome can be a mixture of group and individual activities or projects. You should encourage learners to collate evidence electronically using digital images of practical activities. They develop meta-skills in digital literacy and understand limitations with software and practical activities.

Install and test low voltage electrical circuits (outcome 4)

You should introduce learners to the design of low voltage electrical installations and practical installations of circuits in a domestic, commercial and industrial setting. For example, a domestic circuit could consist of flat twin install in a two-way and intermediate lighting circuit, and a commercial circuit could consist of a plastic conduit system and install of PVC singles in a radial power circuit or similar circuit. The industrial motor circuit could use:

- metallic trunking and a conduit system, with a DOL stop start
- e-stop wired in PVC singles and remote stop start

The circuit could be in steel wired armoured cable, retained on a cable tray or basket, or similar to this specification of complexity. You should encourage learners to collate digital images and portfolios to record evidence. You can assess them with a mixture of individual and group activities or projects.

Approaches to delivery

We suggest you deliver outcome 1 first, to introduce safe working practices. You can deliver outcomes 2, 3 and 4 in any order.

Learners must understand the terminology used in the electrical industry and the reasons behind design concepts delivered for installation. When delivering the unit, you must ensure that learners have a high level of familiarity with the context and specific conditions of outcome requirements. You should provide learners with opportunities to develop their understanding of the electrical industry.

Outcomes are mostly workshop-environment based, although there is theoretical knowledge across all outcomes that you can deliver in a classroom or virtual learning environment (VLE). A blended approach of delivery allows learners to understand theories and concepts in a classroom or VLE before attempting practical tasks in a workshop.

Approaches to assessment

You should integrate the open-book assessment for all outcomes in this unit into one overall project portfolio. Learners should collate all evidence required in their individual portfolios.

Portfolios could consist of a suitable balance of:

- short answer response questions
- structured questions
- reflective accounts
- diagrams
- data recording
- case study reports
- computer simulations
- group work

For the practical elements of outcomes 2, 3 and 4, learners must have access to the current IET wiring regulations and electrical design software (for example multi-sim). Outcome 2 requires a controlled environment where they can demonstrate a simulation of low voltage safe isolation procedure.

Because of the open-book nature of the assessment, you must take care to ensure authenticity.You can 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

Electrical 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 the knowledge and skills required to carry out tasks in installation, testing and measurement of extra low and low voltage DC and AC electrical systems. Electrical principles are integrated by combining theories and practical tasks and using mathematical calculation. The unit also covers the use of electrical testing equipment and using real-world industry standards and compliance to current Institution of Engineering and Technology (IET) wiring regulations.

You develop the practical skills required to construct and test basic electrical installations, simulating the processes used in the workplace.

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

- SCQF level 6 in subjects relating to electrical engineering, electronics or mechanical engineering, for example an NC in Electrical Engineering
- Higher Physics or Higher Engineering Science
- relevant, equivalent workplace experience, for example a Modern or Foundation Apprenticeship

You are assessed on a continual basis. You provide evidence of work in an individual portfolio which could consist of reflective accounts, diagrams, data recording, and digital images of practical works.

On completion of this unit, you can:

- work safely and efficiently in electrical work environments
- understand safe isolation procedures
- use test instruments to measure electronic circuits
- install and test low voltage electrical circuits

It also provides you with suitable knowledge and skills to progress to employment in a wide range of engineering industry technical apprenticeships, or further study.

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 by methodical working practices as you study learning materials and use attention to detail in circuit design. You develop the skill of integrity and increase your awareness of the impact of your actions on others and the environment. You develop adaptive skills and use initiative. You could provide evidence of this by critical reflection on the quality of your motor installation.

Social intelligence

You develop your skills in communicating and collaborating by working with others. This also develops your ability to receive and communicate information as a team. You could provide evidence of team working by demonstrating it in a workshop activity.

You also develop your social conscience as you consider the design and economic impact of the use of materials in workshop tasks.

Innovation

You develop your curiosity, creativity, sense-making and critical thinking as you problem solve, summarise, select, compare, and contrast applications of electrical engineering practical skills. You could provide evidence of these skills by modifying circuits and installations.

Administrative information

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Superclass: XJ

History of changes

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

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