Next Generation Higher National Unit Specification

Engineering Practical Skills (SCQF level 6)

Unit code: J7GS 46

SCQF level: 6 (16 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 gives learners the opportunity to develop knowledge and skills in the following engineering areas:

- mechanical fitting, turning, milling, sheet metalwork or welding
- electrical installation or electronics

Learners gain an appreciation of what is involved in using these skills in industry.

The unit is suitable for learners who want to develop practical skills in a range of engineering disciplines.

Unit outcomes

Learners who complete this unit can:

1 demonstrate a range of engineering manufacturing skills
2 demonstrate a range of electrical or electronic engineering skills

Evidence requirements

Where you assess evidence requirements on a sample basis, 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.

Demonstrate a range of engineering manufacturing skills (outcome 1)

Learners must demonstrate knowledge and skills (see the 'Knowledge and skills' section) in any two of the following practical engineering skills areas:

- mechanical fitting
- turning
- milling
- sheet metalwork
- welding

Learners generate evidence by manufacturing a product for each of the two practical engineering skills areas they have chosen. Alternatively, learners can manufacture one product using the knowledge and skills they have developed in both practical engineering skills areas, as long as they satisfy the evidence requirements.

For mechanical fitting, turning and milling, learners' products should be fit for purpose and have tolerances that are within +/− 0.25 mm. For sheet metalwork and welding, learners' products should be fit for purpose and have tolerances that are within +/− 1 mm. Learners carrying out sheet metalwork should work on sheet less than 3 mm.

Learners' responses must show they can:

- correctly interpret information from an engineering drawing or drawings
- select appropriate tools and equipment
- select appropriate materials
- mark out materials appropriately
- apply the range of engineering skills necessary to make the product to the required tolerances
- check the product to ensure it is fit for purpose and within the required tolerances
- conduct all engineering operations in line with health and safety procedures and practices
- maintain a record of practical activities in a log book

Learners must produce evidence under supervised conditions.

Log books should contain a minimum of three entries for each of the two products learners manufacture, or six entries if learners manufacture one product. Each entry should be a minimum of 150 words.

Demonstrate a range of electrical or electronic engineering skills (outcome 2)

Learners generate evidence by producing an electrical installation circuit or an electronic circuit that meets the evidence requirements.

Learners must produce evidence under supervised conditions.

Learners' responses must show they can:

- correctly interpret information on circuit and wiring diagrams
- select the correct tools and equipment
- select the correct materials
- apply appropriate electrical installation skills and practical assembly skills to ensure the circuit functions correctly and is within specification (all electrical installation work must comply with the latest version of the BS 7671 wiring regulations)
- appropriately inspect and test the assembled circuit to ensure it is functional and within specification
- conduct all electrical installation or electronic work in line with health and safety procedures and practices
- maintain a record of project activities in a log book

Log books must contain a minimum of six entries for the electrical or electronic construction project. Each entry should be a minimum of 150 words.

Knowledge and skills

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

Knowledge	Skills
Outcome 1 Learners should understand: ♦ mechanical fitting ♦ turning ♦ milling ♦ sheet metalwork ♦ welding	**Outcome 1** Learners can: ♦ correctly interpret information from an engineering drawing or drawings ♦ select appropriate tools and equipment ♦ select appropriate materials ♦ mark out materials appropriately ♦ apply the range of engineering skills necessary to make the product to the required tolerances ♦ check the product to ensure it is fit for purpose and within the required tolerances ♦ conduct all engineering operations in line with health and safety procedures and practices ♦ maintain a record of practical activities in a log book
Outcome 2 Learners should understand: ♦ electrical engineering skills and/or electronic engineering skills	**Outcome 2** Learners can: ♦ correctly interpret information on circuit and wiring diagrams ♦ select the correct tools and equipment ♦ select the correct materials ♦ apply appropriate electrical installation skills and practical assembly skills to ensure the circuit functions correctly and is within specification (all electrical installation work must comply with the latest version of the BS 7671 wiring regulations) ♦ carry out appropriate inspection and testing of the assembled circuit to ensure it is functional and within specification

Knowledge	Skills
	Outcome 2 (continued) Learners can: ♦ conduct all electrical installation or electronic work in line with health and safety procedures and practices ♦ maintain a record of project activities in a log book

Meta-skills

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

Self-management

Learners develop the meta-skills of focusing, adapting and initiative as they study the course material. They can provide evidence of these in their reflective reports.

Social intelligence

Learners develop the meta-skill of communicating as they produce technical reports. They also develop the meta-skill of collaborating as they work with other learners on lab exercises.

Innovation

Learners develop the meta-skills of curiosity, sense-making and critical thinking as they take part in learning activities and projects, either individually or in groups.

Literacies

Learners develop core skills in the following literacies:

Numeracy

Learners develop their numeracy skills when they perform calculations to analyse DC and AC circuits.

Communication

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

Digital

Learners develop digital literacy by accessing the course material through a virtual learning environment (VLE).

Delivery of unit

This unit is part of HNC 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 the unit is at your centre's discretion, the notional design length is 80 hours.

The amount of time you allocate to each outcome is also at your discretion. We suggest the following distribution of time, including assessment:

Outcome 1 — Demonstrate a range of engineering manufacturing skills
(40 hours)

Outcome 2 — Demonstrate a range of electrical or electronic engineering skills
(40 hours)

Additional guidance

The guidance in this section is not mandatory.

Content and context for this unit

This unit allows learners to develop knowledge and practical skills in any two of the following engineering areas:

- mechanical fitting
- turning
- milling
- sheet metalwork
- welding

Learners also develop knowledge and skills in electrical installation or electronics.

The unit is not intended to produce skilled craftspeople. Rather, it allows learners to develop an appreciation of what is involved in applying a range of multi-disciplinary skills in practical engineering situations.

We recommend that you cover the following areas.

Demonstrate a range of engineering manufacturing skills (outcome 1)

Common part

- Induction in engineering workshop health and safety procedures and practices.
- Interpretation of information on engineering drawings by introducing appropriate conventions, standards, drawings, etc.
- Brief explanation of the properties of materials that learners could use to make their products.

Mechanical fitting

- Identification of the following tools:
  - benches and vices
  - files
  - hammers
  - hacksaws
  - punches
  - spanners
  - screwdrivers
  - taps and dies
  - drills
  - compasses
  - dividers

- Explanation of marking and measuring out procedures.
- Learners practise marking and measuring out procedures.
- Learners practise use of hand tools.
- Explanation of the use of a pillar drill, including:
  - types of drills
  - drill geometry
  - workholding techniques
  - using a drilling machine
  - common reasons for drill failure
- Learners practise using a pillar drill.
- Explanation of how to use the following measuring instruments:
  - vernier callipers
  - vernier height gauge
  - micrometer
  - protractor
  - gauges
- Learners practise verification of measurements using:
  - vernier callipers
  - vernier height gauge
  - micrometer
  - protractor
  - gauges (for example, depth, go-no-go)

OR

Turning

- Using an appropriate diagram, identification of the various parts of a lathe.
- Brief explanation of lathe tool geometry, for example:
  - clearance
  - rake
- Explanation of different types of lathe tools available, including the materials used in their construction.
- Explanation of speeds and feeds.
- Explanation of setting-up procedures.
- Explanation of different types of chucks (3 and 4 jaws).
- Learners practise using a 3-jaw chuck.
- Learners practise turning between centres.
- Turning operations:
  - facing off
  - facing to length
  - turning diameter to shoulder

- turning between centres
- centre drilling
- drilling hole
- reaming hole
- knurling
- parting off

OR

Milling

- Using appropriate diagrams, identification of various parts of horizontal, vertical and universal milling machines.
- Brief explanation of different types of cutters, for example:
  - face mill
  - slot drill
  - end mill
  - side and face cutters
  - slitting saws
  - angle cutters
- Procedure for mounting cutters on horizontal or vertical or universal mill.
- Explanation of cutting speeds and feeds.
- Explanation of workholding techniques, for example:
  - setting the vice parallel
  - clamping regular objects in the vice
  - setting of datum face
  - setting work to marking out
- Learners practise setting up and using milling machines.
- Milling operation:
  - milling a block
  - facing to length on horizontal and vertical mills
  - milling to a shoulder
  - milling a slot

OR

Sheet metalwork

- Identification of the following tools:
  - benches and vices
  - files
  - hammers and mallets
  - hacksaws

  - punches
  - spanners
  - screwdrivers
  - drills
  - compasses
  - dividers
  - hole cutters
  - stakes
  - folders
  - rollers
- Explanation of marking and measuring out procedures.
- Learners practise marking and measuring out procedures.
- Learners use tools to cut and shape or form materials.
- Explanation of non-thermal joining methods, for example:
  - riveting
  - bolting
  - screwing
  - adhesive
- Learners practise use of non-thermal joining methods.
- Dimensional checks on components (using, for example, rulers, callipers, dividers).

OR

Welding

- Brief explanation of the following welding processes:
  - manual metal arc (MMA)
  - metal active gas (MAG)
  - tungsten inert gas (TIG)
- Brief explanation of the practical applications of the above three welding processes.
- Demonstration of the set up and use of each welding process.
- Learners practise using selected welding process.
- Explanation of material preparation and joint set-up (for example, for butt, lap, fillet or open corner).
- Explanation of weld defects.
- Inspecting joints for weld defects.

Demonstrate a range of electrical or electronic engineering skills (outcome 2)

Electrical installation

- Induction in electrical installation health and safety procedures and practices.
- Interpretation of information on circuit and wiring diagrams by introducing appropriate conventions, standards, drawings, etc.

- Identification of cables, for example:
  - single
  - two and three core PVC cables
  - steel wire armour cable
  - mineral insulated cable
- Identification of accessories, principally relevant to electrical wiring exercises:
  - switch boxes
  - joint boxes
  - ceiling roses
  - lamp holders
  - socket outlets
  - switched fuse outlets
  - distribution board
  - consumer unit
  - clips
  - fuses
  - circuit breakers
  - residual current devices (RCDs)
- Identification of tools, for example:
  - pliers
  - wire strippers
  - side cutters
  - screwdrivers
  - hammers
  - knives
  - crimping tools
  - hacksaw
  - rule
  - hand drills
  - spirit level
  - plumb line
- Learners practise installation skills including correct and neat termination of wiring.
- Explanation of simple inspection techniques.
- Explanation of continuity and insulation resistance testing — introduction to test instruments and procedures used to conduct tests with these instruments.
- Learners practise inspection and testing procedures.
- Interpretation of BS 7671 requirements appropriate to installation exercises.

OR

Electronics

- Induction in electronic workshop health and safety procedures and practices.
- Interpretation of information on electronic circuit and wiring diagrams by introducing appropriate conventions, standards, drawings, etc.
- Explanation of printed circuit board (PCB) and copper strip board construction techniques.
- Demonstration of board population and wiring skills.
- Demonstration of soldering skills.
- Learners practise electronic construction skills.
- Demonstration of electronic test equipment, for example:
  - digital multimeter
  - logic probe
  - power sources
  - signal generator
  - oscilloscope (for oscilloscopes basic testing techniques only)
- Learners practise using test equipment.

Approaches to delivery

You should deliver the unit using:

- engineering workshops
- fabrication or welding workshops
- electrical installation workshop
- electronics workshop

You should demonstrate practical skills and then, under appropriate supervision, allow learners to practise these skills.

Charts and boards with tools or materials secured to them can be useful when teaching the names of different tools and materials.

If you deliver the welding option, we strongly recommend that you provide examples of acceptable and defective joints so that learners can recognise the differences between ‘good’ and ‘bad’ joints.

Before learners enter any workshop, you should give them an induction on relevant health and safety issues. You should emphasise health and safety, and make sure learners always practice it in workshops. Do not allow learners to enter any workshop without wearing the appropriate personal protective equipment (PPE).

Learners could do their own risk assessments of workshops before entering them. They could then compare their risk assessment with yours. This could help to reinforce health and safety issues.

As learners may lift heavy items during the unit, you should instruct them in proper manual handling and lifting techniques.

Approaches to assessment

Assessment for outcome 1 involves learners manufacturing two products, one each from the two engineering skills areas you have taught them. Alternatively, learners can manufacture one product that covers the knowledge and skills requirements for these two engineering skills areas.

Assessment for outcome 2 involves learners manufacturing, inspecting and testing an electrical installation or an electronic circuit.

Learners must maintain a log book while carrying out the assessment tasks.

Learners can produce the engineering product or products, and/or the electrical installation or electronic circuit as part of an integrated project.

All assessment should take place under supervised conditions.

Outcome 1

To record assessment evidence, you should develop checklists that cover the evidence requirements.

Learners can include the following information in their log book:

- how they intend to manufacture the product
- progress made in making the product
- interpretation of measurement results
- any health and safety issues
- what new knowledge they have gained from manufacturing the product
- any transferable skills they have acquired (for example working with others by sharing tools and equipment; numeracy skills from using measuring equipment)

This list is not exhaustive. You should actively encourage learners to present information in graphical format.

Learner evidence should include as a minimum:

Mechanical fitting

- Use a minimum of five different hand tools.
- Carry out measuring and marking out procedures.
- Use measuring and marking out equipment.
- Cut and shape materials.
- Carry out drilling operations.
- Use taps and dies.

- Perform appropriate fitting skills.
- Verify measurements using appropriate measuring equipment.

Turning

- Set up lathe.
- Select speeds and feeds.
- Use a 3-jaw chuck.
- Turn between centres.
- Turning operations (minimum of six operations):
  - facing off
  - facing to length
  - turning diameter to a shoulder
  - turning a diameter between centres
  - centre drilling
  - drilling hole
  - reaming hole
  - knurling
  - parting off
- Verify measurements using appropriate measuring equipment.

Milling

- Use a horizontal or vertical or universal milling machine.
- Mount and use appropriate cutters, choosing a minimum of two from:
  - face mill
  - slot drill
  - end mill
  - slab mill
  - side and face cutters
  - slitting saws
  - angle cutters
- Select appropriate speeds and feeds.
- Use appropriate safe workholding techniques.
- Milling operations (minimum of three operations):
  - milling a block
  - facing to length on horizontal or vertical mill
  - milling to a shoulder
  - milling a slot
- Verify measurements using appropriate measuring equipment.

Sheet metalwork

- Use a minimum of five different hand tools.
- Carry out measuring and marking out procedures.
- Use measuring and marking out equipment.
- Cut and shape or form materials.
- Use any two non-thermal joining techniques.
- Perform appropriate fitting skills.
- Verify measurements using appropriate measuring equipment.

Welding

- Use the MMA, MAG or TIG process.
- Set up equipment for welding.
- Prepare materials to be welded.
- Perform any two of the following welds to an acceptable standard:
  - butt
  - lap
  - fillet
  - open corner
- Visually identify weld defects.

Outcome 2

To record assessment evidence, you should develop checklists that cover the evidence requirements.

Learners can include the following information in their log book:

- how they intend to manufacture the electrical installation or electronic circuit
- progress made in manufacturing the electrical installation or electronic circuit
- interpretation of inspection and test results
- any health and safety issues
- what new knowledge they have gained from manufacturing the electrical installation or electronic circuit
- any transferable skills they have acquired (for example working with others by sharing tools and equipment; numeracy skills from using electrical and electronic test equipment)

This list is not exhaustive. You should actively encourage learners to present information in graphical format.

Electrical installation

The electrical installation may involve either a domestic or an industrial electrical wiring system. Examples of each are shown below.

Domestic

A domestic installation comprising a two-way controlled lighting circuit and a socket ring circuit containing a minimum of three sockets and one fused spur. The installation should be wired on a board with both the lighting and ring socket circuits being wired in multi-core PVC. Tests on the completed installation should include continuity, polarity and insulation resistance testing.

We recommend that you develop a checklist to support assessment judgements. The checklist could include the following points:

- Accessories are positioned accurately.
- Accessories are installed securely.
- Wiring systems are installed correctly.
- Electrical terminations are electrically and mechanically sound.
- Wiring systems are satisfactorily inspected.
- Wiring systems are correctly tested and results are appropriately recorded.

Industrial

An industrial installation that requires the learner to wire up a 3-phase motor connected to a direct-on-line starter with remote stop/start station. The learner should manufacture a length of metal trunking as a joining piece between a distribution board and the motor starter and cable tray, to include a 90-degree flat bend between the starter and the motor. Wiring should be done using PVC single core cable, and either steel wire armour cable or mineral insulated cable, as appropriate.

The terminations at the motor starter and motor terminals should be crimped terminations. Tests on the completed installation should include continuity, polarity and insulation resistance testing.

We recommend that you develop a checklist to support assessment judgements. The checklist could include the following points:

- Accessories are positioned accurately.
- Accessories are installed securely.
- Wiring systems are manufactured correctly.
- Wiring systems are installed correctly.
- Electrical terminations are electrically and mechanically sound.
- Wiring systems are satisfactorily inspected.
- Wiring systems are correctly tested and results are appropriately recorded.

Electronic circuit

Learners could construct the following circuits:

- a two-stage transistor amplifier
- a summer amplifier, using an operational amplifier

- a timer circuit
- a combinational logic circuit involving a minimum of four integrated circuits

We recommend that you develop a checklist to support assessment judgements. The checklist could include the following points:

- Interpret information on circuit and wiring diagrams correctly when constructing the electronic circuit.
- Select a PCB or copper strip board to construct the electronic circuit.
- Select passive and active components correctly.
- Populate the board with components and devices correctly, and wire the circuit according to the circuit and wiring diagrams.
- Solder all components, devices and wires accurately, and neatly avoid any dry joints.
- Crimp any terminals to stranded conductors as required.
- Test the completed circuit to ensure correct functionality.
- Construct the electronic circuit in line with health and safety procedures and practices.

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 Practical Skills (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

In this unit you develop knowledge and skills in any two of the following engineering areas:

- mechanical fitting
- turning
- milling
- sheet metalwork
- welding

You also develop knowledge and skills in electrical installation or electronics.

It is important to emphasise that in doing the unit, you will not become a skilled craftsperson in any of the engineering areas identified above. However, you will gain an appreciation of what is involved in using these skills in industry.

Your lecturers demonstrate various practical skills to you and then you practise these skills yourself. Your lecturers will emphasise the importance of health and safety throughout the unit.

On completing the unit, you are able to:

1 demonstrate a range of engineering manufacturing skills
2 demonstrate a range of electrical or electronic engineering skills

You are assessed by:

- outcome 1 — producing an engineering product or products
- outcome 2 — completing an electrical installation or an electronic circuit

These should demonstrate that you have achieved the engineering skills to the appropriate standard.

You are also required to maintain a log book while you complete the assessments.

Meta-skills

Throughout the unit, you 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 meta-skills of focusing, adapting and initiative as you study the course material. You can provide evidence of these in your reflective reports.

Social intelligence

You develop the meta-skill of communicating as you produce technical reports. You also develop collaboration skills as you work with other learners on lab exercises.

Innovation

You develop the meta-skills of curiosity, sense-making and critical thinking as you take part in learning activities and projects, either individually or in groups.

Administrative information

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Superclass: XA

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.