



National Unit Specification: general information

UNIT Transformers (SCQF level 6)

CODE F5K0 12

SUMMARY

The purpose of this Unit is to provide candidates with opportunities to develop their knowledge and understanding of the construction and principle of operation of single and three-phase power transformers, current transformers, voltage transformers and auto transformers. Candidates will learn how to solve transformer problems using simple mathematical representations, the main methods of cooling transformers and the main transformer protection requirements.

This Unit is intended for candidates who are seeking a career as an electrical or multi-disciplinary engineering maintenance technician in the power utility industry, large industrial complex or with a transformer manufacturer.

This Unit may form part of a National Qualification Group Award or may be offered on a free-standing basis.

OUTCOMES

- 1 Explain the construction and operation of single phase power transformers.
- 2 Solve problems using transformer mathematical models.
- 3 Explain the construction, operation and application of specialised transformers.
- 4 Identify types of cooling arrangement for power transformers.
- 5 Explain the main protection requirements for power transformers.

Administrative Information

Superclass: XK

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National Unit Specification: general information (cont)

UNIT Transformers (SCQF level 6)

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have attained one of the following, or equivalent:

Standard Grade:

- ◆ Standard Grade Physics — Credit Level
- ◆ Standard Grade Mathematics — Credit Level

or one of the following NQ Units:

- ◆ NQ Unit *Electrical Fundamentals* (SCQF level 6)
- ◆ NQ Unit *Electrostatics and Electromagnetics* (SCQF level 6)

CREDIT VALUE

1 credit at SCQF level 6 (6 SCQF credit points at SCQF level 6*).

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.*

CORE SKILLS

There is no automatic certification of Core Skills in this Unit.

This Unit provides opportunities for candidates to develop aspects of the following Core Skills:

- ◆ Numeracy (SCQF level 6)
- ◆ Communication (SCQF level 6)

These opportunities are highlighted in the Support Notes of this Unit Specification.

National Unit Specification: statement of standards

UNIT Transformers (SCQF level 6)

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit Specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

OUTCOME 1

Explain the construction and operation of single phase power transformers.

Performance Criteria

- (a) Explain clearly constructional aspects of a single phase power transformer.
- (b) Explain correctly winding arrangements for a single phase power transformer.
- (c) Explain correctly the operation of a single phase power transformer.
- (d) State correctly the losses associated with a single phase power transformer.

OUTCOME 2

Solve problems using transformer mathematical models.

Performance Criteria

- (a) State correctly the characteristics of an ideal transformer.
- (b) Solve correctly calculations for an ideal transformer on load.
- (c) Draw correctly the equivalent circuit of a transformer containing winding resistance and reactive components.
- (d) Solve correctly problems for a transformer on load using its equivalent circuit containing winding resistance and reactance only.

OUTCOME 3

Explain the construction, operation and application of specialised transformers.

Performance Criteria

- (a) Explain clearly the construction of specialised transformers.
- (b) Explain clearly the operation of specialised transformers.
- (c) State correctly the applications of specialised transformers.

OUTCOME 4

Identify types of cooling arrangement for power transformers.

Performance Criteria

- (a) State correctly types of cooling medium used in power transformers.
- (b) State clearly circulating methods used in power transformers.
- (c) Identify correctly power transformer cooling classifications.

National Unit Specification: statement of standards (cont)

UNIT Transformers (SCQF level 6)

OUTCOME 5

Explain the main protection requirements for power transformers.

Performance Criteria

- (a) State correctly types of power transformer failure.
- (b) Identify correctly the protection devices provided for a given power transformer.
- (c) Explain clearly the operation of one type of basic protection scheme for a given power transformer.

EVIDENCE REQUIREMENTS FOR THIS UNIT

Evidence is required to demonstrate that candidates have achieved all Outcomes and Performance Criteria.

Outcomes 1, 2, 3 and 4:

Written and/or recorded oral evidence is required which demonstrates that the candidate has achieved Outcomes 1, 2, 3 and 4 to the standards specified in the Outcomes and Performance Criteria. This evidence should be obtained under controlled, supervised conditions with candidates not being allowed to bring any notes, textbooks, tutor examples into the assessment event.

Outcomes 1, 2, 3 and 4 may be assessed on an individual basis or as a single assessment covering all four Outcomes. The assessment for Outcomes 1, 2, 3 and 4 should be no longer than 2 hours and conducted under closed-book conditions.

Outcome 5:

Written and/or recorded oral evidence is required which demonstrates that the candidate has achieved Outcome 5 to the standards specified in the Outcomes and Performance Criteria. This evidence should be obtained under controlled, supervised conditions. Outcome 5 should be assessed by candidates undertaking an assignment in which they investigate the protection arrangements associated with a particular transformer. Candidates will be expected to produce a report on their investigation (500–750 words excluding diagrams) to be submitted on completion of Outcome 5. Centres should make every reasonable effort to ensure the report is the candidate's own work. Where copying or plagiarism is suspected, candidates should be interviewed to check their knowledge and understanding of the subject matter. A checklist should be used to record oral evidence of the candidates knowledge and understanding.

With regard to Outcome 1:

- ◆ two types of winding arrangement to be explained
- ◆ iron and copper losses only to be explained

National Unit Specification: statement of standards (cont)

UNIT Transformers (SCQF level 6)

With regard to Outcome 2:

- ◆ solve calculations using Voltage, Current and Turns ratios and the ideal power equation
- ◆ solve two calculations using primary and secondary winding resistance

With regard to Outcome 3:

- ◆ for Outcome 3 (a), (b) and (c) — any two of the specialised transformers voltage, current, auto and three-phase to be selected

With regard to Outcome 4:

- ◆ three cooling mediums to be stated
- ◆ two cooling methods to be stated
- ◆ four letter coding classifications to be identified

With regard to Outcome 5:

- ◆ two failures from core insulation, inter-turn winding, inter-winding, insulator bushing, tap changer, cooling medium, tap electrical connections, tank and cooling plant to be stated
- ◆ one protection scheme for the given power transformer to be explained eg differential protection, restricted earth fault protection, directional overcurrent protection

National Unit Specification: support notes

UNIT Transformers (SCQF level 6)

This part of the Unit Specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT

This is an optional Unit within the National Qualification Group Award in Electrical Engineering at SCQF level 6 but may also be offered as a free-standing Unit.

Successful completion of this Unit enhances the employability skills for candidates to gain employment in the power utility sector or an industrial employer with electrical power systems or a transformer manufacturer or progress to more advanced studies in electrical engineering.

This Unit provides the opportunity for candidates to develop their knowledge and understanding of single phase and specialised transformers, their cooling arrangements and protection requirements.

This Unit is particularly suitable for candidates who have completed the Units *Electrical Fundamentals* (SCQF level 6) and/or *Electrostatics and Electromagnetics* (SCQF level 6)

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

It is recommended that the Outcomes are delivered in the following order: Outcome 1, Outcome 2, Outcome 3, Outcome 4 and Outcome 5.

An organised visit to a transformer site or a transformer manufacturer accompanied by a suitably electrically competent person would be beneficial to the candidates in achieving the Outcomes of this Unit. Visual examination of transformer components and the use of a dismantable transformer are recommended. It is also recommended that candidates conduct internet searches to investigate the construction, operation, cooling and protection of transformers.

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

Candidates interpret and apply complex numerical and graphic information as they undertake this Unit, solving problems using transformer mathematical models. Numeracy skills should be naturally enhanced with the focus throughout on accuracy and the practical interpretation of transformer mathematical representations. Formative activities should include materials designed to support candidates to master concepts confidently in practical electrical engineering contexts.

Investigative research should involve analysing and evaluating complex paper based and electronic sources of technical information. Reports produced should be accurate, formally structured and clearly expressed. Examples of technical reports could be provided to indicate acceptable formats, structure and terminology. An organised visit to a transformer site or a transformer manufacturer would provide underpinning knowledge as well as opportunities to develop oral communication skills in a work related context.

National Unit Specification: support notes (cont)

UNIT Transformers (SCQF level 6)

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Opportunities for the use of e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by information and communications technology (ICT), such as e-testing or the use of e-portfolios or e-checklists. Centres which wish to use e-assessment must ensure that the national standard is applied to all candidate evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. Further advice is available in *SQA Guidelines on Online Assessment for Further Education (AA1641, March 2003)*, *SQA Guidelines on e-assessment for Schools (BD2625, June 2005)*.

Outcomes 1, 2, 3 and 4 may be assessed as at single assessment event covering all four Outcomes. Total assessment time for Outcome 1, 2, 3 and 4 should not be greater than two hours to provide candidates the opportunity to display their knowledge and understanding of the content. The assessment paper should comprise of a combination of short answer, restricted response and structured questions.

The assessment event must be conducted under controlled, supervised closed-book conditions with candidates not being allowed to bring any notes, textbooks, tutor examples into the assessment event.

Outcome 5 should be assessed by candidates undertaking an assignment in which they investigate the protection arrangements associated with a particular transformer. Candidates will be expected to produce a report on their investigation (500–750 words excluding diagrams) to be submitted on completion of Outcome 5.

CANDIDATES WITH DISABILITIES AND/OR ADDITIONAL SUPPORT NEEDS

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering alternative Outcomes for Units. Further advice can be found in the SQA document *Guidance on Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs* (www.sqa.org.uk).