



## National Unit Specification: general information

**UNIT** Electrostatics and Electromagnetics (SCQF level 6)

**CODE** F5D3 12

### SUMMARY

This Unit is intended for candidates with little or no prior knowledge of electric or electromagnetic field theory but who wish to develop knowledge and skills in this important area of electrical engineering. The Unit is particularly suitable for those candidates training to be electrical or electronic technicians.

The aim of this Unit is to provide candidates with the opportunity to develop knowledge and understanding of the concepts and principles involved with electrostatic and electromagnetic fields. Candidate will also learn how to solve problems involving parallel plate capacitors, capacitors in series and parallel, series magnetic circuits, self and mutual inductance and coupling of coils.

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

### OUTCOMES

- 1 Solve problems involving electrostatic fields and parallel plate capacitors.
- 2 Solve problems involving capacitor networks.
- 3 Solve problems involving series magnetic circuits.
- 4 Solve problems involving self and mutual inductance.

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#### Administrative Information

**Superclass:** XK

**Publication date:** December 2008

**Source:** Scottish Qualifications Authority

**Version:** 01

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## National Unit Specification: general information (cont)

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### 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:

- ◆ NQ Unit *Electrical Principles* at SCQF level 6
- ◆ Standard Grade Physic at credit level
- ◆ Standard Grade Technological Studies at credit level
- ◆ Standard Grade Mathematics at credit level

### 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 Skill:

- ◆ Numeracy (SCQF level 6)

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

## **National Unit Specification: statement of standards**

### **UNIT        Electrostatics and Electromagnetics (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**

Solve problems involving electrostatic fields and parallel plate capacitors.

##### **Performance Criteria**

- (a) Sketch correctly the electric field associated with a parallel plate capacitor, include fringing flux.
- (b) Describe correctly the quantities commonly used in electrostatic field theory.
- (c) State correctly the units associated with quantities commonly used in electrostatic field theory.
- (d) State correctly the relationships used when solving problems involving parallel plate capacitors.
- (e) Calculate accurately the capacitance of a parallel plate capacitor without and with a dielectric.
- (f) Calculate accurately the energy stored in a parallel plate capacitor.
- (g) State correctly the different types of capacitor available for use.

#### **OUTCOME 2**

Solve problems involving capacitor networks.

##### **Performance Criteria**

- (a) Calculate accurately the total capacitance of a series-parallel network of capacitors.
- (b) Determine accurately the voltage distribution in a series-parallel capacitance network supplied from a dc voltage source.
- (c) Determine the charge distribution in a series-parallel capacitance network supplied from a dc voltage source.

## National Unit Specification: statement of standards (cont)

### UNIT Electrostatics and Electromagnetics (SCQF level 6)

#### OUTCOME 3

Solve problems involving series magnetic circuits.

#### Performance Criteria

- (a) Sketch correctly magnetic fields associated with magnets and current carrying conductors.
- (b) Describe correctly quantities used in electromagnetic field theory.
- (c) State correctly the units associated with quantities used in electromagnetic field theory.
- (d) State correctly the relationships used when solving magnetic circuit problems.
- (e) Solve accurately a series magnetic circuit problem.
- (f) Calculate accurately the energy stored by an inductor.

#### OUTCOME 4

Solve problems involving self and mutual inductance.

#### Performance Criteria

- (a) State correctly what is meant by the term self-inductance
- (b) Solve accurately a problem involving  $e = -L \frac{di}{dt}$
- (c) State correctly what is meant by the term mutual inductance
- (d) Solve accurately a problem involving  $e = -M \frac{di}{dt}$
- (e) State correctly what is meant by perfect coupling
- (f) Solve accurately a problem involving  $M = k\sqrt{L_1 L_2}$

### EVIDENCE REQUIREMENTS FOR THIS UNIT

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

Written and/or recorded oral evidence should be produced to demonstrate that the candidate has achieved all the Outcomes and Performance Criteria.

Outcomes may be assessed on an individual basis, as combinations of Outcomes (eg Outcomes 1 and 2 together and Outcomes 3 and 4 together) or as a single assessment covering all four Outcomes. Regardless of which approach is taken total assessment time should not exceed 2 hours and 30 minutes. Assessment(s) should be conducted under controlled, supervised, closed-book conditions in which candidates should not be allowed to bring any notes, handouts, textbooks or any other relevant materials into the assessment. Candidates may use a scientific calculator during assessment(s).

## National Unit Specification: statement of standards (cont)

### UNIT Electrostatics and Electromagnetics (SCQF level 6)

With regard to Outcome 1:

- ◆ the meaning of three quantities should be correctly described from the following: charge, voltage, electromotive force, electric field strength, electric flux density and capacitance
- ◆ two electrostatic units should be correctly stated
- ◆ two relationships should be correctly stated from the following (or transposed versions of these equations):

$$Q = It$$

$$E = \frac{V}{d}$$

$$D = \frac{\Phi}{A}$$

$$C = \frac{Q}{V}$$

- ◆ three capacitor types should be correctly stated from the following list: paper, electrolytic, mica, polyester, ceramic, tantalum and variable

With regard to Outcome 2:

- ◆ the same series-parallel capacitor network can be used to assess all three Performance Criteria. Regardless of whether the same network is used or not, the capacitor network(s) used for assessment purposes must contain five capacitors

With regard to Outcome 3:

- ◆ the meaning of three quantities should be stated correctly from the following: magnetic flux, magnetic field strength, magnetic flux density, magnetomotive force, reluctance
- ◆ two magnetic field units should be correctly stated
- ◆ two relationships should be stated from the following (or transposed versions of these equations):

$$F = NI$$

$$H = \frac{F}{l} = \frac{NI}{l}$$

$$B = \frac{\Phi}{A} = \mu H$$

$$S = \frac{\Phi}{\mu_0 \mu_r A} = \frac{l}{\mu_0 \mu_r N^2 A}$$

- ◆ the series magnetic circuit must contain two metallic parts of different dimensions and one air gap

## National Unit Specification: support notes

### UNIT                      Electrostatics and Electromagnetics (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 Unit has been developed as optional Unit in the National Certificate Group Award in Electrical Engineering. The Unit is one of a series of units in the area of Electrical Principles. Other units in this series include:

*Electrical Principles* at SCQF level 5  
*Electrical Principles* at SCQF level 6  
*Single Phase and Three Phase* at SCQF level 6  
*Circuit Element Principles* at SCQF level 6  
*Network Analysis* at SCQF level 6

The aim of the Unit is to allow candidates to develop their knowledge and understanding of the concepts and principles associated with electrostatic and electromagnetic fields. Candidate will also learn how to solve problems involving parallel plate capacitors, capacitors in series and parallel, series magnetic circuits, self and mutual inductance and coupling of coils.

In delivering the Unit centres should encourage candidates to develop a sound knowledge and understanding of the basic concepts, principles and formulae associated with electric and magnetic fields since these are relevant to many areas of electrical and electronic engineering. Such understanding can be enhanced if lecturers relate these concepts and ideas to practical examples involving electric and magnetic fields taken from domestic and industrial applications.

To reinforce learning lecturers may wish to compare electrostatic and electromagnetic quantities although such comparisons should not be assessed in the Unit. Similarly lecturers may wish to compare quantities in magnetic circuit calculations with those in electric circuit calculations although once again this should not be assessed.

There may be opportunities to integrate the delivery of this Unit with some of the other Electrical Principles units in the NCGA Electrical Engineering. For example, it may be possible to link some of the subject matter in this Unit to that taught in the *Circuit Element Principles* (SCQF level 6) Unit.

#### **GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT**

This Unit may be delivered by a combination of lectures, worked examples, tutorial exercises and laboratory exercises. The Unit could be delivered in a classroom and/or electrical laboratory. Practical experimental work can play a particularly important role in reinforcing candidate learning. Candidates should be allowed to examine the construction of different types of capacitors and inductors. Good diagrams, wall charts and other forms of visual aids will help candidates to learn about electric and magnetic fields and the construction of capacitors and inductors. The Internet also provides a rich source of information on electric and electromagnetic fields, capacitors and inductors.

## National Unit Specification: support notes (cont)

### UNIT Electrostatics and Electromagnetics (SCQF level 6)

#### OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

Numeracy skills will be naturally enhanced in this Unit, with the focus on electric and electromagnetic field theory and the practical interpretation and application of number and graphics. Candidates have to work confidently with complex numerical and graphical concepts, carrying out a number of sustained calculations to determine solutions to a range of problems. Formative activities should be designed to develop accuracy and confidence in electrical engineering contexts.

#### 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)*.

Formative assessment exercises involving candidates in solving problems associated with parallel plate capacitors, series parallel capacitor networks, series magnetic circuits, self and mutual inductance and magnetic coupling will play a particularly important role in building candidate knowledge, understanding and confidence of Unit content.

The suggested approach to summative assessment in this Unit is as follows:

Outcomes 1 and 2 — an assessment paper comprising a balance of short answer, restricted response, and structured questions lasting 1 hour and 15 minutes. The assessment should be conducted at a single assessment event.

Outcomes 3 and 4 — an assessment paper comprising a balance of short answer, restricted response, and structured questions lasting 1 hour and 15 minutes. The assessment should be conducted at a single assessment event.

#### 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](http://www.sqa.org.uk)).