National Unit Specification: general information

UNIT Electrical Principles (SCQF level 6)

CODE F5HL 12

SUMMARY

This Unit has been designed to introduce candidates to Electrical Principles and provide opportunities to develop their knowledge and understanding of basic electrical concepts, magnetic and electromagnetic theory. Candidates will develop the skill to solve electrical quantities in direct current (dc) resistive networks and determine electromagnetic quantities. Candidates will be provided with the opportunity to describe the generation of an alternating voltage and determine the fundamental properties of a sinusoidal waveform. The relationships between alternating voltages, reactance and alternating currents (ac) are developed and are represented by phasor diagrams. This Unit is suitable for candidates wishing to progress a career in electrical and/or electronic engineering. It is also suitable for candidates studying other branches of engineering, science or technology, requiring knowledge of electrical principles or who may be employed or seeking employment as electrical, mechanical or marine craft persons or technicians.

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

OUTCOMES

1 Describe basic electrical concepts and solve problems in dc resistive networks.
2 Describe magnetic concepts and determine magnetic quantities.
3 Describe and determine fundamental properties of a sinusoidal waveform.
4 Determine alternating quantities and represent alternating quantities by phasor diagrams.

Administrative Information

Superclass: XJ

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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:

- Standard Grade Physics or Technological Studies — Credit Level
- Standard Grade Science or Mathematics — Credit Level
- NQ Unit *Electrical Principles* (SCQF level 5)

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.

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

- Problem Solving (SCQF level 6)
- Numeracy (SCQF level 6)

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

National Unit Specification: statement of standards

UNIT Electrical Principles (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

Describe basic electrical concepts and solve problems in dc resistive networks.

Performance Criteria

(a) Describe correctly the electron theory of current flow in terms of electrical conductors.
(b) Describe correctly circuit parameters in a dc resistive network.
(c) State correctly Kirchhoff's Current and Voltage laws as applied to dc resistive networks.
(d) Calculate correctly circuit parameters in a combined series-parallel resistive dc network.

OUTCOME 2

Describe magnetic concepts and determine magnetic quantities.

Performance Criteria

(a) Apply correctly Faraday's and Lenz's Laws to an electromagnetic induction problem.
(b) Describe correctly the concepts of self and mutual inductance.
(c) Calculate correctly the magnitude and direction of force on a current carrying conductor situated perpendicularly in a uniform magnetic field.
(d) Calculate correctly the instantaneous generated electro-motive force (e.m.f) when a coil of conductor is rotated in a steady magnetic field.

OUTCOME 3

Describe and determine fundamental properties of a sinusoidal waveform.

Performance Criteria

(a) Describe correctly the generation of an alternating e.m.f. created by a single rotating coil in a uniform magnetic field.
(b) Plot correctly a sinusoidal voltage waveform.
(c) Determine correctly the quantities of a sinusoidal waveform.
(d) Carry out measurements to verify accurately the root mean squared (r.m.s.) value and frequency of a displayed sinusoidal waveform.
(e) Represent correctly sinusoidal quantities by phasor diagram.

National Unit Specification: statement of standards (cont)

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OUTCOME 4

Determine alternating quantities and represent alternating quantities by phasor diagrams.

Performance Criteria

(a) Describe correctly inductive reactance and capacitive reactance.
(b) Solve correctly problems involving inductive and capacitive reactance.
(c) Calculate correctly the current in circuits containing resistance only, inductance only and capacitance only, when connected to a sinusoidal voltage.
(d) Draw correctly phasor diagrams for ac circuits containing resistance only, inductance only and capacitance only when connected to a sinusoidal voltage.

EVIDENCE REQUIREMENTS FOR THIS UNIT

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

Written and/or recorded oral evidence and performance evidence is required which demonstrates that the candidate has achieved all Outcomes to the standards specified in the Outcomes and Performance Criteria.

Outcomes may be assessed on an individual basis or as combinations of Outcomes (eg Outcomes 1 and 2 together and Outcomes 3 and 4 together). Regardless of which approach is taken total assessment time for Outcomes 1, 2, 3 and 4 should not exceed 2 hours.

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 the assessment(s).

Performance evidence supplemented with an assessor observation checklist, and written and/or recorded oral evidence is required which demonstrates that the candidate has achieved Outcome 3 to the standards specified in the Outcome and Performance Criteria.

With regard to Outcome 1:

- candidates to describe correctly the electron theory of current flow and the movement of electrons in electrical conductors with reference to conventional flow and electron flow
- candidates to describe correctly the meaning of the terms Resistance, Current, Voltage, Power and Energy including their relevant **unit** of measurement
- candidates to solve correctly **four** problems in a combined series-parallel dc resistive network, using a total of six resistors, from the following $V = IR$, $P = VI$, $P = I^2R$, $P = V^2 / R$ and $P = W/t$
- candidates to describe correctly Kirchhoff's Current law as applied to a single node in a dc resistive network
- candidates to describe correctly Kirchhoff's Voltage Law as applied to a series-parallel dc resistive network

National Unit Specification: statement of standards (cont)

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With regard to Outcome 2:

- candidates to correctly apply Faraday's and Lenz's Laws to an electromagnetic induction problem
- candidates to correctly describe the concepts of self and mutual inductance
- candidates to correctly calculate the magnitude and direction of force on a current carrying conductor situated perpendicularly in a uniform magnetic field
- candidates to correctly calculate the instantaneous generated electro-motive force (e.m.f) when a coil of conductor is rotated in a steady magnetic field

With regard to Outcome 3:

- candidates to plot correctly, on given scaled axes, a sinusoidal voltage waveform 0 to 360° using the waveform displayed on an oscilloscope or from values given in a table
- candidates to determine three quantities from: peak value, peak-to-peak value, average value, r.m.s. value, frequency and periodic time
- candidates to measure and verify accurately, using instruments, the E_{rms} and frequency of the waveform displayed on the oscilloscope
- candidates to draw to scale a phasor representation showing the relationship between alternating voltages $e = E_m \sin\omega t$ and $e = E_m \sin(\omega t + \phi)$ within 5% tolerance

With regard to Outcome 4:

- candidates to solve correctly two problems for each of the expressions $X_L = 2\pi fL$ and $XC = 1 / 2\pi fC$
- candidates to solve correctly the current for each of the following circuits: resistance only, inductance only and capacitance only, respectively
- candidates to draw phasor diagrams to scale showing the relationships between current and voltage for each of the following circuits: resistance only, inductance only and capacitance only respectively within a 5% tolerance

The Assessment Support Pack for this Unit provides sample assessment material. Centres wishing to develop their own assessments should refer to the Assessment Support Pack to ensure a comparable standard.

National Unit Specification: support notes

UNIT Electrical Principles (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 a mandatory Unit within the National Qualification Group Award in Electrical Engineering at SCQF level 6 but may also be offered as a free-standing Unit.

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
- *Electrostatics and Electromagnetics* at SCQF level 6
- *Electronic Network Analysis* at SCQF level 6
- *Single Phase and Three Phase Principles* at SCQF level 6
- *Circuit Element Principles* at SCQF level 6

This Unit provides the opportunity for candidates to develop their knowledge of basic electrical, magnetic, electromagnetic concepts and the properties of sinusoidal waveforms. Candidates will acquire the skill to solve electrical quantities in direct current (dc) resistive networks and determine electromagnetic and alternating quantities.

The fundamental properties of a sinusoidal waveform and the relationships between alternating voltages, alternating currents (ac) and reactance is developed.

This Unit is particularly suitable for candidates who wish to progress a career in Electrical and/or Electronic Engineering. It is also suitable for candidates studying other branches of engineering, science or technology, requiring knowledge of electrical principles.

Successful completion of this Unit enhances the employability skills for candidates to gain employment in the Electrical and/or Electronic Engineering and other related industries.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

This Unit should be delivered in a practical electrical environment by a combination of lectures, demonstrations and practical exercises. It is recommended that the Outcomes are delivered in the sequence outlined in the statement of standards.

For Outcome 1 it would be beneficial to candidates to undertake laboratory exercises to measure accurately expected values of supply current, branch currents and voltage to compare with calculated values to reinforce learning of the principles and laws of dc resistive networks.

Physical examination of circuit components such as resistors, inductors and capacitors and practice in the use of measuring instruments is recommended.

For Outcome 3 guidance and practice in the use of an oscilloscope will be beneficial to the candidates in achieving the Performance Criteria for this Outcome.

The use of available interactive software packages will develop candidate skills and further their knowledge of basic electrical concepts and principles.

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

Problem Solving skills, that is, critical thinking, planning, organising, reviewing and evaluating, will be developed and enhanced as candidates undertake calculations solving problems in dc resistive networks and determining electromagnetic quantities as well as practical work to verify sinusoidal waveforms.

The numerical work of Outcomes 1, 2, 4 also the creation of graphical information in Outcome 3 may provide candidates with opportunities to develop aspects of the Core Skill of *Numeracy*; Using Number and Using Graphical Information at 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)*.

Outcome 1, 2, and 4 may be assessed by short answer, structured question, restricted response and/or on-line assessment to give the candidate an opportunity to display knowledge of basic electrical, electromagnetic, alternating quantities and the opportunity to solve associated problems.

Outcome 3 may take the form of a practical exercise and a short answer question paper to demonstrate the measurement of electrical quantities and to give the candidate the opportunity to display knowledge of the fundamental properties of sinusoidal waveforms.

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)**.