SQA Advanced Unit Specification

General information for centres

Unit title: Electrical Engineering Principles 1

Unit code: HV2F 46

Unit purpose: This Unit has been designed to enable candidates to develop knowledge, understanding and skills in electrical principles and theorems and to apply these to the solution of simple dc and ac electrical circuit problems. The Unit also introduces candidates to the basic concepts of inductance and capacitance and the use of Kirchhoff's, Faraday's and Lenz's Laws and the solution of simple dc magnetic and electrical circuit problems.

On completion of the Unit the candidate should be able to:

1 Solve problems involving dc circuits.
2 Solve problems involving magnetic and electromagnetic quantities.
3 Solve problems involving capacitors.
4 Solve ac circuit problems.

Credit points and level: 1 SQA Credit at SCQF level 6: (8 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 National 1 to Doctorates.*

Recommended prior knowledge and skills: Entry to the Unit is at the discretion of the centre however candidates should have a basic knowledge and understanding of Mathematics and Electrical Principles. Such basic knowledge and understanding may be evidenced by possession of the following NQ units: Core Mathematics 4, Mathematics: Engineering Numeracy and Electrical Fundamentals.

Core Skills: There are opportunities to develop the Core Skills of Using Number and Critical Thinking at SCQF level 6 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Context for delivery: If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

Assessment: The assessment for this Unit should comprise of two separate assessment papers. The first assessment paper should cover Outcomes 1 and 2 and the second assessment paper should cover Outcomes 3 and 4. Each assessment paper should be taken at a single assessment event lasting one hour and 15 minutes and should be carried out under supervised, controlled conditions. Assessment should be conducted under closed book conditions and as such candidates should not be allowed to bring any textbooks, handouts or notes to the assessment. Candidates should be permitted to use scientific calculators during the assessments.

Unit specification: statement of standards

Unit title: Electrical Engineering Principles 1

Unit code: HV2F 46

The sections of the Unit stating the Outcomes, knowledge and/or skills, and evidence requirements are mandatory.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the knowledge and/or skills section must be taught and available for assessment. Candidates should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Solve problems involving dc circuits

Knowledge and/or skills

- Charge, current, emf, potential difference
- Ohm's Law
- Series, parallel and series-parallel circuits
- Kirchhoff's Current Law
- Kirchhoff's Voltage Law
- Solve dc circuit problems using Kirchhoff's law
- Voltage and current division
- Energy and power in dc circuits

Outcome 2

Solve problems involving magnetic and electromagnetic quantities

Knowledge and/or skills

- Magnetic and electromagnetic fields
- Flux, Flux Density and Magnetic Field Strength
- Faraday's Law
- Lenz's law
- Calculations involving Faraday's and Lenz's laws
- Self inductance
- Mutual inductance
- Calculations involving self and mutual inductance

Evidence Requirements

Evidence for the knowledge and/or skills items in Outcomes 1 and 2 should be provided on a sample basis. The evidence may be presented in response to specific questions. Each candidate will need to demonstrate that she/he can answer correctly questions based on a sample of the items shown under the knowledge and skills items in the Outcomes. In any assessment of the Outcomes **six out of eight** knowledge and/or skills items should be sampled from Outcome 1 and **six out of eight** knowledge and/or skills items should be sampled from Outcome 2.

In order to ensure that candidates will not be able to for see what items they will be questioned on, a different sample of six out of eight knowledge and/or skills items from Outcome 1 and six out of eight knowledge and/or skills items from Outcomes 2 are required each time the Unit is assessed. Candidates must provide a satisfactory response to the sampled items.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing the candidate is able to for:

Outcome 1

- explain two of the following electrical concepts: charge, current, emf or potential difference
- State Ohm's Law
- calculate current and voltage quantities in a dc series - parallel resistance network containing one voltage source and a minimum of 6 resistors
- state Kirchhoff's Current Law
- state Kirchhoff's Voltage Law
- calculate current and voltage (or power) values in a two mesh dc resistance network containing two voltage sources using Kirchhoff's Laws
- undertake one calculation involving voltage division and one calculation involving current division
- calculate one energy and one power value in a dc circuit

Outcome 2

- draw typical magnetic fields associated with a magnet and a current carrying conductor
- explain two of the following terms: flux, flux density, magnetic field strength
- state Faraday's and Lenz's Laws
- solve two problems involving Faraday's and Lenz Laws
- state what is meant by the term self inductance
- state what is meant by the term mutual inductance
- undertake two calculations involving self inductance and one calculation involving mutual inductance

The assessment for Outcomes 1 and 2 must be combined together to form one assessment paper. This assessment paper should be taken at a single assessment event lasting one hour and 15 minutes and carried out under supervised, controlled conditions.

Assessment should be conducted under closed book conditions and as such candidates should not be allowed to bring any textbooks, handouts or notes to the assessment. Candidates should be permitted to use scientific calculators during the assessment.

Assessment guidelines

The assessment paper should be composed of an appropriate balance of short answer, restricted response and structured questions.

Outcome 3

Solve problems involving capacitors

Knowledge and/or skills

- Electrostatic field
- Flux, Flux Density and Electric Field Strength
- Capacitance of parallel plate capacitor
- Capacitances in parallel and series
- Calculation of quantities in series — parallel capacitor network

Outcome 4

Solves ac circuit problems

- Sinusoidal waveform
- Inductive and capacitive reactance and impedance
- Determine quantities in ac series circuits using graphical methods
- Determine quantities in ac series circuits using algebraic methods
- Active Power, Apparent Power, Reactive Power and power factor

Evidence Requirements

Evidence for the knowledge and/or skills items in Outcomes 3 and 4 should be provided on a sample basis. The evidence may be presented in response to specific questions. Each candidate will need to demonstrate that she/he can answer correctly questions based on a sample of the items shown under the knowledge and skills items in the Outcomes. In any assessment of the Outcomes **bullet point 5** and **any other two out of four** knowledge and/or skills items should be sampled from Outcome 3 and **bullet point 3** and **any other two out of four** knowledge and/or skills items should be sampled in Outcome 4.

In order to ensure that candidates will not be able to for see what items they will be questioned on, a different sample of two out of four knowledge and/or skills items (plus bullet point 5) from Outcome 3 and two out of four knowledge and/or skills items (plus bullet point 3) from Outcome 4 should be sampled each time the Unit is assessed. Candidates must provide a satisfactory response to the sampled items.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing the candidate is able to for:

Outcome 3

- draw an electrostatic field associated with a parallel plate capacitor
- explain two of the following terms: flux, flux density, electric field strength
- calculate the capacitance of a parallel plate capacitor using the
- equation $C = \varepsilon_0\varepsilon_r A/d$
- calculate the resultant capacitance of capacitors in parallel (minimum of three) and capacitors in series (minimum of three)
- calculate charge and voltage quantities in a dc series — parallel capacitor network containing one voltage source and a minimum of six capacitors

Outcome 4

- undertake calculations involving sinusoidal waveforms (eg peak value, peak to peak value, rms value, periodic time, frequency)
- undertake one calculation involving inductive reactance, one involving capacitive reactance and one involving impedance
- determine current and voltage quantities in an R-L series circuit using graphical methods
- determine current and voltage quantities in an R-L series circuit using algebraic methods
- calculate active power, apparent power, reactive power and power factor in a series R-L ac circuit

The assessment for Outcomes 3 and 4 should be combined together to form one assessment paper. This assessment paper should be taken at a single assessment event lasting one hour and 15 minutes and carried out under supervised, controlled conditions. Assessment should be conducted under closed book conditions and as such candidates should not be allowed to bring any textbooks, handouts or notes to the assessment. Candidates should be permitted to use scientific calculators during the assessment

Assessment guidelines

The assessment paper should be composed of an appropriate balance of short answer, restricted response and structured questions.

Administrative Information

Unit code: HV2F 46

Unit title: Electrical Engineering Principles 1

Superclass category: XJ

Original date of publication: November 2017

Version: 01

History of Changes:

Version	Description of change	Date

Source: SQA

SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of SQA Advanced Qualifications.

FURTHER INFORMATION: Call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our Centre Feedback Form.

Unit specification: support notes

Unit title: Electrical Engineering Principles 1

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

The Unit has been written in order to allow candidates to develop knowledge, understanding and skills in the following areas:

1 Solving problems involving dc circuits.
2 Solving problems involving magnetic and electromagnetic quantities.
3 Solving problems involving capacitors.
4 Solving ac circuit problems.

This Unit has been developed as one of two Electrical Principles Units within the SQA Advanced Certificate in the Engineering Practice and SQA Advanced Certificate/SQA Advanced Diploma in Mechatronics Frameworks. The other unit is Electrical Engineering Principles 2 which is a SCQF level 7 unit. Both Electrical Engineering Principles 1 and 2 may be stand alone units in other SQA Advanced Certificate/SQA Advanced Diploma awards.

In designing this Unit, the Unit writers have identified the range of topics they would expect to be covered by lecturers. The writers have also given recommendations as to how much time should be spent on each outcome. This has been done to help lecturers decide what depth of treatment should be given to the topics attached to each of the outcomes. Whilst it is not mandatory for a centre to use this list of topics it is strongly recommended that it does so to ensure continuity of teaching and learning across the Electrical Engineering Principles units and because the assessment exemplar pack for this Unit is based on the knowledge and/or skills and list of topics in each of the Outcomes.

The list of topics is given below. Lecturers are advised to study this list in conjunction with the assessment exemplar pack so that they can get a clear indication of the standard of achievement expected of candidates in this Unit.

Outcome 1

Solve problems involving dc circuits (15 hours)

- charge, current, emf., voltage
- simple dc circuit containing source, switch and load
- resistance, voltage, current
- resistances in series
- resistances in parallel
- applications of circuit reduction techniques to combinations of series, parallel and series and parallel resistors
- explanation of Kirchhoff's Current and Voltage Laws (applied to dc circuits only)
- calculations of voltage and currents in dc series circuits
- voltage and current division

- branch voltages and currents in a dc parallel circuit
- branch voltages and currents in a dc series- parallel
- energy and power in dc circuits
- calculations involving energy and power
- Kirchhoff's Laws applied to two mesh networks containing two voltage sources

Areas for practical work may include, but not limited to, the following:

- confirmation of Ohm's Law
- experimental confirmation of the total resistance of a circuit involving a combination of series — parallel resistances
- measurement of currents and voltage in a combination of series — parallel circuits
- experimental confirmation of Kirchhoff's Laws

Outcome 2

Solve problems involving magnetic and electromagnetic quantities (6 hours)

- sketches of magnetic fields associated with magnets
- sketches of magnetic fields associated with current carrying conductors
- explanation of flux, flux density and magnetic field strength
- explanation of Faraday's Law
- $e = -N\Delta\varphi/\Delta t$
- explanation of Lenz's Law
- comparison of Lenz's Law with Newton's Law – to every action there is an equal and opposite reaction
- calculations involving Faraday's and Lenz's Laws
- explanation of the term self inductance
- $e = -L\Delta i/\Delta t$
- calculations involving self inductance
- explanation of the term mutual inductance
- $e = -M\Delta i/\Delta t$
- calculations involving mutual inductance

Areas for practical work may include, but not limited to, the following

- confirmation of Faraday's law by experiment.

Assessment — 1 hour and 15 minute

Outcome 3

Solve problems involving capacitors (5.5 hours)

- sketch typical electrostatic fields (e.g. the field associated with a parallel plate capacitor)
- explanation of terms flux, flux density and electric field strength
- concept of capacitance associated with a parallel plate capacitor
- calculation of capacitance associated with a parallel plate capacitor using the formulae $C = \varepsilon_0\varepsilon_r A/d$
- description of construction and characteristics of different types of capacitor
- capacitances in parallel and series
- calculations involving capacitors in parallel, series and series — parallel

Outcome 4

Solves ac circuit problems (11 hours)

- sketch sinusoidal waveforms
- identification and determination of key sinusoidal waveform parameters (e.g. peak value, peak to peak value, rms, periodic time and frequency)
- inductive and capacitive reactance
- calculations of inductive and capacitive reactance using the formulae $X_L = 2\pi fL$ and $X_C = 1/2\pi fC$
- phasor diagrams associated with R only, L only and C only circuits
- calculations associated with R only, L only and C only circuits
- calculation of Z associated with R — L series circuits
- calculations and phasor diagrams associated with R — L series circuits*
- active Power, Apparent Power, Reactive Power and power factor in R — L series circuits only
- calculations of Active Power, Apparent Power, Reactive Power and power factor in ac series circuits

  * It should be noted that phasor quantities should be determined by both graphical and algebraic methods.

Areas for practical work may include, but not limited to, the following:

- experimental confirmation of currents and voltages in ac series circuits
- experimental confirmation of power quantities in ac series circuits

Assessment — 1 hour and 15 minutes

Guidance on the delivery and assessment of this Unit

For candidates who have studied electrical principles previously parts of this Unit may provide opportunities to revise the concepts, theories and practices learnt in their previous studies.

This Unit has been designed to incorporate sufficient time to allow lecturers to teach each outcome contained in the Unit. The Unit has also been written to allow sufficient time for candidates to practice what they have learnt through appropriate formative assessment exercises. Additionally, the Unit has been designed to incorporate time for some experimental work and computer simulations (these will not be formally assessed in the Unit) so that candidates have an opportunity to confirm electrical theories in practice. Whilst it is recognised that computer simulation can be a valuable tool in confirming electrical theories, it is nevertheless felt important that candidates do some practical laboratory work so that they can gain experience in reading and wiring up circuit diagrams, using test equipment, analysing the results of experiments etc. The assessment time of two hours and 30 minutes has been taken into account when the overall time allocation has been addressed.

Candidates will have opportunities to develop their knowledge and skills in Using Numbers and in Critical Thinking while undertaking formative assessment exercises involving a range of electrical problems and when analysing the results of electrical experiments.

As this Unit provides fundamental electrical principles which underpin much of the studies done in other technological areas it is recommended that the Unit be delivered towards the start of the Advanced Certificate Engineering Practice awards.

Where this Unit is incorporated into other awards it is recommended that it be delivered in the context of the specific occupational area(s) that the award is designed to cover.

Information on Evidence Requirements and Assessment guidelines is given after Outcomes 2 and 4 in the SQA Advanced Unit specification: statement of standards section. The first written assessment should take place after Outcomes 1 to 2 have been delivered and the second written assessment after Outcomes 3 to 4 has been completed.

Opportunities for developing Core Skills

There are opportunities to develop the Core Skills of Using Number and Critical Thinking at SCQF level 6 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Open learning

This Unit could be delivered by distance learning, which may incorporate some degree of on-line support. However, with regards to assessment, planning would be required by the centre concerned to ensure the sufficiency and authenticity of candidate evidence. Arrangements would be required to be put in place to ensure that assessment, whether done at a single or multiple events, was conducted under controlled, supervised conditions.

To keep administrative arrangements to a minimum, it is recommended that for distance learning candidates the two assessment papers are taken at two separate assessment events following the guidance given in the evidence requirements to Outcomes 2 and 4 in the SQA Advanced Unit specification: statement of standards section.

For further information and advice, please see *Assessment and Quality Assurance of Open and Distance Learning* (SQA, February 2001 — publication code A1030).

Equality and inclusion

This unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website www.sqa.org.uk/assessmentarrangements.

General information for candidates

Unit title: Electrical Engineering Principles 1

This Unit has been designed to allow you to develop knowledge, understanding and skill in electrical concepts, theorems and practices that will underpin much of your studies in Electrical Engineering and other areas of Engineering. During the delivery of the Unit you will study dc circuit theory, inductance and capacitance and simple ac theory.

This Unit will normally be delivered by a combination of lectures, tutorial exercises, practical work and/or computer work. The tutorial exercises will be designed to develop your knowledge, skills and confidence in solving electrical problems. Practical work is particularly important as it will allow you to confirm electrical theorem in practice as well as allowing you to learn important electrical skills such as interpreting circuit/wiring diagrams, wiring up circuits, using electrical test equipment and interpreting the results of experiments. Please ask your lecturer what practical work you will do in this Unit.

The formal assessment for this Unit will consist of two assessment papers each lasting one hour and 15 minutes. The first assessment paper will cover Outcomes 1and 2 and the second paper will cover Outcomes 3 and 4. Both assessments will be conducted under supervised, controlled, closed book conditions. However, you will be allowed to use a scientific calculator during the assessments.