Higher National Unit Specification

General information for centres

Unit title: Single Phase A.C. Circuits

Unit code: DG54 34

Unit purpose: This Unit is designed to enable candidates to develop knowledge and understanding and apply basic electrical concepts and theorems to the solution of simple electrical problems. The Unit also provides candidates with the opportunity to examine first order transient responses as found in R – L and R – C series circuits. The Unit also allows candidates the opportunity to develop the necessary knowledge and skills to solve single-phase a.c. circuit problems using complex notation.

On completion of the Unit candidates should be able to:

1. Solve problems involving basic electrical concepts and theorems
2. Solve single-phase a.c. circuit problems using complex notation

Credit value: 1 HN Credit at SCQF level 7: (8 SCQF credit points at SCQF level 7*)

**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.*

Recommended prior knowledge and skills: It would be an advantage for candidates to have a basic knowledge and understanding of electrical, electrostatic and magnetic concepts and theorems, although this is not absolutely essential because some of these concepts and theorems are revised in the first Outcome. Possession of basic knowledge and understanding of these concepts and theorems may be evidenced by possession of a Higher in Electrical Engineering or the following National Qualification Units: D136 12 AC Circuit Theory and Applications; E9RR 12 Circuit Elements; E9RS 12 DC and AC Circuit Responses; E9RV 12 Electromagnetics; E9RW 12 Electrostatics; E9RX 12 Network Analysis; E9S0 12 Single Phase AC.

It may also be an advantage for candidates to take the Mathematics for Engineering 1: Electronics and Electrical Unit before this Unit as the Mathematics for Engineering 1: Electronics and Electrical Unit contains an Outcome on complex numbers which would underpin much of the work in the second Outcome of this Unit.

Core skills: There may be opportunities to gather evidence towards Core Skills in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

General information for centres (cont)

Context for delivery: This Unit was developed for the HNC and HND Electronics awards. If the Unit is used in another group award(s) it is recommended that it should be taught and assessed within the context of the particular group award(s) to which it contributes.

Assessment: The assessment for both Outcomes in this Unit should be combined together into one assessment paper. This paper should be taken by candidates at one single assessment event that should last one hour and thirty minutes. The assessment paper should be composed of a suitable balance of short answer, restricted response and structured questions. Assessment should be conducted under controlled, supervised conditions. It should be noted that candidates must achieve all the minimum evidence specified for each Outcome in order to pass the Unit.

Furthermore, where a centre considers it appropriate, the assessment for this Unit could be combined with the assessment for the Electrical Networks and Resonance Unit into one assessment paper. This paper should be taken by candidates at one single assessment event that should last two hours and thirty minutes. The assessment paper should be composed of a suitable balance of short answer, restricted response and structured questions. Assessment should be conducted under controlled, supervised conditions. It should be noted that candidates must achieve all the minimum evidence specified for each Outcome in this Unit and in the Electrical Networks and Resonance Unit in order to pass both Units.

Higher National Unit specification: statement of standards

Unit title: Single Phase A.C. Circuits

Unit code: DG54 34

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

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in 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 basic electrical concepts and theorems

Knowledge and/or skills

- Electrostatic and magnetic fields
- Electrical quantities (charge, current, e.m.f., voltage, resistance, inductance and capacitance)
- Waveforms
- Ohm's Law (applied to d.c. circuits only)
- Kirchhoff's Law (applied to d.c. circuits only)
- Circuit reduction techniques (as applied to combinations of series and parallel resistors only)
- Circuit reduction techniques (as applied to combinations of series and parallel capacitors only)
- Voltage and current division
- Energy and power (in d.c. circuits only)
- Circuit responses to the sudden application or removal of a d.c. voltage to an R – L series circuit
- Circuit responses to the sudden application or removal of a d.c. voltage to an R – C series circuit

Evidence requirements

Evidence for the knowledge and/or skills in this Outcome will 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 questions correctly based on a sample of the items shown above. In any assessment of this Outcome **eight out of eleven** knowledge and/or skills items should be sampled.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of eight out of eleven knowledge and/or skills items is required each time the Outcome is assessed. Candidates must provide a satisfactory response to all eight items.

Higher National Unit specification: statement of standards (cont)

Unit title: Single Phase A.C. Circuits

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 that the candidate is able to:

- draw electric and magnetic fields
- explain electrical quantities
- draw waveforms which commonly occur in electronic or electrical engineering
- perform calculations using Ohm's law
- solve a circuit problem using Kirchhoff's Law
- reduce a network containing a series and parallel combination of resistors to one total resistance
- reduce a network containing a series and parallel combination of capacitors to one capacitance
- solve a problem involving voltage or current division
- solve problems involving energy and power in electronic and/or electrical circuits
- sketch voltage/time and current/time responses to the sudden application and removal of a d.c. voltage to an R - L series circuit
- sketch voltage/time and current/time responses to the sudden application and removal of a d.c. voltage to an R - C series circuit

Evidence should be generated through assessment undertaken in controlled, supervised 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 will be permitted to use scientific calculators during the assessment.

Assessment guidelines

Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response and structured questions.

The assessment of this Outcome should be combined with that for Outcomes 2 to form a single assessment paper, details of which are given under Outcome 2.

Outcome 2

Solve single-phase ac circuit problems using complex notation

Knowledge and/or skills

- Calculation of impedance, current and voltages in a R - L - C series circuit using complex notation
- Phasor (Argand) diagram representation of current and voltage quantities associated with an R - L - C series circuit
- Calculation of apparent, active and reactive powers and power factor associated with an R - L - C series circuit

Higher National Unit specification: statement of standards (cont)

Unit title: Single Phase A.C. Circuits

- Determination of total circuit impedance and supply current in a series-parallel circuit using complex notation and circuit reduction techniques
- Calculation of branch currents in a parallel circuit using current division
- Calculation of apparent, active and reactive powers and power factor associated with a series parallel circuit

Evidence requirements

Evidence for the knowledge and/or skills in this Outcome will 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 questions correctly based on a sample of the items shown above. In any assessment of this Outcome **three out of six** knowledge and/or skills items should be sampled.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of three out of the six knowledge and/or skills items is required each time the Outcome is assessed. Candidates must provide a satisfactory response to all three items.

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

- calculate impedance, current and voltages in an R - L - C series circuit
- represent current and voltages associated with an R - L - C series circuit on an Argand diagram
- calculate at least two of the following quantities associated with an R - L - C series circuit: apparent, active and reactive powers and power factor
- determine the total impedance and supply current of a series-parallel a.c. circuit using circuit reduction techniques
- calculate at least one branch current in a parallel a.c. circuit using current division
- calculate at least two of the following quantities associated with a series-parallel a.c. circuit: apparent, active and reactive powers and power factor

Evidence should be generated through assessment undertaken in controlled, supervised 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 will be permitted to use scientific calculators during the assessment.

Higher National Unit specification: statement of standards (cont)

Unit title: Single Phase A.C. Circuits

Assessment guidelines

The assessment of this Outcome should be combined with that for Outcome 1 to form one assessment paper for the Unit. This single assessment paper should be taken at a single assessment event lasting one hour and thirty minutes and carried out under supervised, controlled conditions. Such a paper should be composed of an appropriate balance of short answer, restricted response and structured questions.

In addition, where a centre considers it appropriate, the assessment for this Unit could be combined with the assessment for the Electrical Networks and Resonance Unit to form one single assessment paper for both Units. This assessment paper should be taken at a single assessment event lasting two hours and thirty minutes and carried out under supervised, controlled conditions. Such a paper should be composed of an appropriate balance of short answer, restricted response and structured questions.

Administrative Information

Unit code: DG54 34

Unit title: Single Phase A.C. Circuits

Superclass category: XJ

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Source: SQA

Higher National Unit specification: support notes

Unit title: Single Phase A.C. Circuits

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 written in order to allow candidates to develop knowledge, understanding and skills in the following areas: -

(1) the use of basic electrical concepts and theorems to solve problems in electrical and electronic engineering

(2) the use of complex notation to solve single-phase series, parallel and series-parallel electrical circuit problems

This Unit has been developed as part of a group of electronic and electrical principles Units. There are two other Units in the group entitled Electrical Networks and Resonance and Transmission Lines and Complex Waves. This Unit and the Electrical Networks and Resonance Units are both at SCQF level 7 and are mandatory Units within the Principles/Technology section of the new HND Electronics award. The Electrical Networks and Resonance Unit is an optional Unit within the new HNC Electronics award. Transmission Lines and Complex Waves; the Unit at SCQF level 8 within the optional section of the HND Electronics award only.

The three Units mentioned in the previous paragraph have been developed as an integrated suite of Units to meet all the electrical and electronic principles requirements of the new HNC and HND Electronics and Electrical awards. However, this does not preclude the use of one or more of these Units in other awards where award designers feel this to be appropriate. As well as providing a substantial course in electrical and electronic principles these Units also provide important underpinning knowledge, understanding and skills for other parts of the HNC and HND Electronics awards (e.g. analogue electronics Units).

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 to 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 electronic and electrical 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.

Higher National Unit specification: support notes (cont)

Unit title: Single Phase A.C. Circuits

The list of topics is given below. Lecturers are advised to study this list of topics 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 basic electrical and magnetic concepts and theorems (19 hours)

- Simple electrostatic and magnetic fields (field between two plates with a potential difference between them, fields between magnetic poles with and without a current carrying conductor between them, fields associated with two current carrying conductors)
- Charge, current, e.m.f., voltage
- Resistance, inductance, capacitance
- Equations for energy associated with electrostatic and magnetic fields
- Description and classification of different types of resistors, inductors and capacitors
- Tolerances
- Waveforms (e.g. d.c., a.c. square, triangular, step and ramp)
- Ohm's law (applied to d.c. circuits only)
- Kirchhoff's law (applied to d.c. circuits only)
- Resistors in series and parallel
- Application of circuit reduction techniques to combinations of series and parallel resistors
- Voltage and current division rules
- Energy and power in d.c. circuits
- Capacitors in parallel and series
- Circuit reduction techniques applied to combinations of series and parallel capacitors
- Inductors in series
- Concept of transient response as opposed to an instantaneous response
- Explanation of transient behaviour of R - L and R - C series circuits when a d.c. voltage is suddenly applied and removed from such circuit
- Time constants for R - L and R - C series circuits.
- Sketches of voltage/time and current/time responses when a d.c. voltage is suddenly applied to or removed from an R - L series circuit.
- Sketches of voltage/time and current/time responses when a d.c. voltage is suddenly applied to or removed from an R - C series circuit.

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

- Investigation of different waveforms commonly found in electrical and electronic engineering
- Confirmation of Ohm’s Law by experiment

- Experimental confirmation of the total resistance of circuits involving combinations of series–parallel resistors.
- Experimental confirmation of voltage and current division laws.
- Measurement of currents and voltages against time for an R - L or R - C series circuit when a dc voltage is suddenly applied or removed (i.e. charge and discharge conditions).

Outcome 2
Solve circuit problems using complex notation (19.5 hours)

- Peak, r.m.s. and average values of an a.c. waveform
- Revision of a.c. waveform and phasor diagrams associated with pure resistance, pure inductance and pure capacitance
- Impedance of R - L, R - C and R – L - C series circuits
- Determination of current and voltage quantities in R - L, R - C and R - L - C series circuits using phasor diagrams and calculation of horizontal and vertical components approach
- Introduction of j operator as a means of distinguishing between horizontal and vertical components of voltage and current
- Characteristics of the j operator
- Complex expressions of current, voltage, R, jwL, 1/jwC and impedance
- Addition and subtraction of complex numbers
- Multiplication and division of complex numbers using polar form and complex conjugate
- Argand diagram and its relation to phasor and impedance diagrams
- Impedances in series and parallel (comparison with dc case)
- Application of circuit reduction techniques to networks containing combinations of series and parallel impedances involving complex notation
- Calculation of supply current
- Voltage and current division (comparison with dc case)
- Calculation of apparent, active, reactive powers and power factor in ac circuits using complex numbers
- Exercises involving ac circuit problems using complex numbers

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

- Measurement of current, potential differences and active power in the following a.c. circuits:
    - R – L - C in series
    - R - L in series // C

Higher National Unit specification: support notes (cont)

Unit title: Single Phase A.C. Circuits

It is recommended that as many as possible of the above experiments are conducted as practical laboratories so that students gain experience in reading and wiring up circuit diagrams, using test equipment, analysing the results of experiments etc.

It will be noted from the topic list for the first Outcome that lecturers are provided with opportunities to revise basic electrical, magnetic and electrostatic concepts. This section has been included to ensure that all candidates have a basic knowledge and understanding of fundamental electrical and electronic principles before proceeding with more advanced electrical principles studies.

Guidance on the delivery and assessment of this Unit

It should be noted that this Unit can be delivered on a free standing basis or combined with the Electrical Networks and Resonance Unit for teaching and learning and assessment purposes to form an integrated electronic and electrical principles programme. This provides course planners with the flexibility to keep the two Units separate or combine them for teaching and learning and assessment purposes. Such flexibility may be important to a centre where, for example, both Units are included in a number of HN Engineering courses, and these courses have to be combined to ensure viable candidate numbers in a class. For details of how the assessment for the two Units can be integrated see the Assessment guidelines in Outcome 2 of the Single Phase A.C. Circuits Unit and Outcome 2 of the Electrical Networks and Resonance Unit.

This Unit has been designed to incorporate sufficient time to allow lecturers to teach the core electrical and electronic principles 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.

As this Unit provides core electrical and electronic principles which underpin much of the studies done in other areas of HNC and HND Electronics awards it is recommended that the Unit be delivered towards the start of these awards.

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

Details on approaches to assessment are given under Evidence Requirements and Assessment guidelines under each Outcome in the Higher National Unit specification: statement of

standards section. It is recommended that these sections be read carefully before proceeding with assessment of candidates.

Open learning

This Unit could be delivered by distance learning, which may incorporate some degree of on-line support. However, with regard 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 the assessment, which is required to be at a single event, was conducted under controlled, supervised conditions.

For information on normal open learning arrangements, please refer to the SQA guide *Assessment and Quality Assurance of Open and Distance Learning* (SQA 2000).

Special needs

This Unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering special alternative Outcomes for Units. For information on these, please refer to the SQA document *Guidance on Special Assessment Arrangements* (SQA, 2001).

General information for candidates

Unit title: Single Phase A.C. Circuits

This Unit has been designed to allow you to develop knowledge, understanding and skills in basic electrical and magnetic concepts and theorems that underpin so much of more advanced studies in Electronic and Electrical Engineering. If you have studied these subjects before the early parts of this Unit will provide you with an opportunity to revise the electrical concepts and theorems you have learnt in previous courses.

This Unit will also provide you with an opportunity to study the ways in which resistance - inductance and resistance - capacitance series electrical circuits respond to the sudden application or removal of a d.c. voltage such as when a switch is closed or opened in such circuits. This in turn will introduce you to the ideas of transient responses that are so important in so many branches of Engineering.

This Unit will also allow you the opportunity to develop the necessary knowledge and skills to solve single - phase a.c. circuit problems using complex notation. Complex notation is a powerful tool for solving a range of a.c. circuit problems and a good grasp of this tool will allow you to solve complex problems involving combinations of series and parallel impedances.

It is good to gain sound theoretical knowledge and understanding but it is also important that you are able to set your theoretical knowledge within a practical Electronics and Electrical context. Thus, it is likely during this Unit that you will be provided with the opportunity to relate theory to practice by doing practical experiments and computer simulations on electronic and electrical circuits.

By the end of the Unit you will be expected to solve simple electrical and electronic problems using basic electrical concepts and theorems. You will also be expected to sketch the graphs associated with resistance - inductance and resistance - capacitance series circuits when a d.c. voltage is suddenly applied or removed from these circuits. You will also be expected to use complex notation to solve a range of single - phase a.c. circuit problems.

The formal assessment for this Unit will consist of a single assessment paper lasting one hour and thirty minutes. The assessment will be conducted under closed book conditions in which you will not be allowed to take notes, textbooks etc. into the assessment. However, you will be allowed to use a scientific calculator. You will sit this assessment paper at the end of the Unit

It is also possible that the centre where you take this Unit will combine it with the Electrical Networks and Resonance Unit for teaching and learning and assessment purposes. Under these circumstances the assessment for both Units will take the form of a single assessment paper, taken at one assessment event conducted under controlled, supervised conditions. The length of the assessment paper will be two hours and thirty minutes and no notes, textbooks etc. will be allowed into the assessment. Ask your lecturer if the two Units will be combined for teaching and learning and assessment purposes.