SCOTTISH
QUALIFICATIONS
AUTHORITY

National Unit Specification: general information

UNIT Electrical Fundamentals (Int 2)

NUMBER D132 11

COURSE Electronic and Electrical Fundamentals (Int 2)

SUMMARY

This unit has been designed to introduce candidates to the basic electrical engineering principles and laws. It covers the relationships between current, voltage, resistance, power and energy in a d.c. network. It also considers the factors relating to the generation of electricity as an a.c. (sinusoidal) waveform.

This unit offers a foundation for establishing electrical engineering principles and laws.

OUTCOMES

1 Determine the current, voltage and resistance relationships in a resistive d.c. network.
2 Solve problems on power and energy in d.c. resistive systems.
3 Determine the relationship between the factors relating to the force acting on a current-carrying conductor situated in a magnetic field.
4 Determine the factors which relate to the generation of a sinusoidal voltage waveform.

RECOMMENDED ENTRY

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

- Mathematics and either Technological Studies or Physics at grade 3 Standard Grade
- equivalent National units.

Administrative Information

Superclass: XJ

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Source: Scottish Qualifications Authority

Version: 03

National Unit Specification: general information (cont)

UNIT Electrical Fundamentals (Int 2)

CREDIT VALUE

1 credit at Intermediate 2.

CORE SKILLS

This unit gives automatic certification of the following:

Complete core skills for the unit	None	
Core skills components for the unit	Using Number	Int 2

Additional information about core skills is published in *Automatic Certification of Core Skills in National Qualifications* (SQA, 1999).

National Unit Specification: statement of standards

UNIT Electrical Fundamentals (Int 2)

OUTCOME 1

Determine the current, voltage and resistance relationships in a resistive d.c. network.

Performance criteria

(a) The determination of the relationship between supply current and branch currents in a combined series-parallel resistive d.c. network is correct.
(b) The determination of the relationship between applied voltage and the series potential differences in a combined series-parallel resistive d.c. network is correct.
(c) The calculation of the resultant resistance of a combined series-parallel resistive network is accurate.
(d) The determination of the relationship between current, voltage and resistance of a resistive d.c. network is correct.

Evidence requirements

The candidate could be given an assignment which would measure ability to determine resistance relationships and calculate currents and voltages in a resistive d.c. network. For example, the assignment could be constructed around specific tasks in which the candidates are provided with four resistors of known values, connected in a combined series-parallel configuration, suitable measuring instruments and a known d.c. supply.

The tasks would include:

- measurement of branch currents, supply current and series potential differences
- determination of the relationship between supply current and branch current
- determination of the relationship between applied voltage and series volt drops
- calculation of resultant network resistance from known resistance values
- calculation of supply current
- verification of relationship between I, V and R by comparison of the measured and calculated results.

This exercise should be carried out in conjunction with a suitably constructed observation checklist covering all practical elements of the assessment. Satisfactory achievement of the outcome will be based on results which show the relationships between quantities to be correct to within experimental tolerance.

National Unit Specification: statement of standards (cont)

UNIT Electrical Fundamentals (Int 2)

OUTCOME 2

Solve problems on power and energy in d.c. resistive systems.

Performance criteria

(a) The concepts of, and the relationships between, power and energy, are correctly stated and used.
(b) The application of the power expressions $P = VI$, $P = I^2R$, $P = V^2/R$ and $P = W/t$ is correct.
(c) The calculation of energy values from values of voltage, current, resistance and time is correct.

Evidence requirements

The candidate could be presented with short answer questions to assess the recall of knowledge and the understanding of power and energy as related to electrical systems.

The assessment could consist of 13 short answer questions to be allocated as follows:

1	Units of power: watt, kilowatt, etc.	1 question
2	Units of energy: joule, kilowatt hour etc.	1 question
3	Concept of power as the rate at which energy is dissipated.	1 question
4	Calculation of power values using appropriate expressions.	4 questions
5	Calculation of current, resistance and voltage from the power of expressions of (4).	3 questions
6	The calculation of energy values given voltage, current, resistance and time.	3 questions

Satisfactory achievement of the outcome will be based on the candidate producing nine correct responses which must include correct responses for points 1-3 (above), and two out of four for point 4, two out of three for point 5, two out of three for point 6. An incorrect response should be considered as one which shows a lack of understanding and is not caused by trivial arithmetic error.

OUTCOME 3

Determine the relationship between the factors relating to the force acting on a current-carrying conductor situated in a magnetic field.

Performance criteria

(a) The production and recognition of permanent and electromagnetic fields is correctly demonstrated.
(b) The description of the principle of force acting on a straight current-carrying conductor situated perpendicular to a uniform magnetic field is correct.
(c) The calculation of the force on a straight current-carrying conductor in a magnetic field is correct.

Evidence requirements

The candidate could be presented with questions to assess the recall of knowledge and the understanding of the concepts of magnetic fields and their interaction to cause a force to act on a current-carrying conductor situated in such a field.

The assessment could consist of 12 short answer questions to be allocated as follows:

1	Elements required to set up permanent and electromagnetic fields.	2 questions
2	Recognition of permanent magnetic field patterns.	2 questions
3	Recognition of electromagnetic field patterns including that of a straight current-carrying conductor.	2 questions
4	Interaction between magnetic fields to produce a force on a straight current-carrying conductor.	2 questions
5	The factors which determine magnitude and direction of the force on a straight current-carrying conductor situated perpendicular to a uniform magnetic field.	2 questions
6	The calculation of force from the expression $F = BIl$.	2 questions

Satisfactory achievement of the outcome will be based on the candidate producing nine correct responses which must include five out of six for points 1-3 above, and three out of four for points 4-5 (above) and one out of two for point 6 (above). An incorrect response should be considered as one which shows a lack of understanding and is not caused by trivial arithmetic error.

National Unit Specification: statement of standards (cont)

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OUTCOME 4

Determine the factors which relate to the generation of a sinusoidal voltage waveform.

Performance criteria

(a) The description of the factors which determine the e.m.f. generated by movement of a straight conductor in a magnetic field is correct.
(b) The determination of the direction of generated e.m.f. in a straight conductor is correct.
(c) The application of the expression $e = Blu \sin \alpha$ to calculate the e.m.f. generated in a rotating loop of conductor is correct.
(d) The graphical production of a sinusoidal voltage waveform using the expression $e = E_{max} \sin \alpha$ is correct.
(e) The application of the expression $E_{rms} = \frac{1}{\sqrt{2}} E_{max}$ to calculate the r.m.s. value of a sinusoidal e.m.f. is correct.

Evidence requirements

The candidate could be set a structured question to test the recall of knowledge and understanding of the concepts of the generation of a sinusoidal voltage waveform.

The candidate could be given two diagrams indicating conductors each of active length l metre, moving with a constant velocity u m/s^{-1} at the perpendicular through a uniform magnetic field of flux density *B* Tesla.

Diagram (a) would show a single straight conductor in the field and Diagram (b) would show a single loop conductor mounted on a central spindle.

The candidate would be required to:

- determine the factors governing the magnitude of generated e.m.f. in a straight conductor and the relationship between them
- determine the factors governing the direction of generated e.m.f. in a straight conductor
- calculate the instantaneous e.m.f. generated in a loop conductor rotating at constant speed in a uniform magnetic field using the expression $e = Blu \sin \alpha$
- plot, on given scaled axes, a sinusoidal voltage waveform using points determined from the expression $e = E_{max} \sin \alpha$
- calculate the r.m.s. value of generated voltage from a given maximum value using the relationship $E_{rms} = \frac{1}{\sqrt{2}} E_{max}$.

Satisfactory achievement of the outcome will be based on all parts of the question being answered correctly. An incorrect response should be considered as one which shows a lack of understanding and is not caused by trivial arithmetic error.

National Unit Specification: support notes

UNIT Electrical Fundamentals (Int 2)

This part of the unit specification is offered for guidance. The support notes are not mandatory.

It is recommended that you refer to the SQA Arrangements document for the Intermediate 2 Electronic and Electrical Fundamentals course before delivering this unit.

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

This unit will establish a foundation of electrical engineering principles and laws. It is written for electrical craft and technician candidates but can also be used by craft and technician candidates from other technology related backgrounds.

GUIDANCE ON CONTENT AND CONTEXT FOR THIS UNIT

Appropriate units, symbols and unit-symbols should be used throughout.

Outcome 1
Essential parts of a basic circuit, i.e. source, load, conductors.
Concept of current flow round a circuit. Potential difference.
Relationship between circuit current, voltage and resistance, i.e. $I = V/R$.
Series resistive circuits, i.e. resultant resistance, voltage distribution and current.
Parallel resistive networks, i.e. resultant resistance, current distribution and voltage.
Combined series-parallel resistive networks, i.e. resultant resistance, branch currents, series potential differences, etc.

Outcome 2
Concepts of power and energy.
Units of power: watt and kilowatt, etc.
Units of energy: joule and kilowatt hour, etc.
Calculation of power in electrical systems from the expressions $P = VI$, $P = I^2R$, $P = V^2/R$ and $P = W/t$.
Calculation of voltage, current and resistance from the power expressions.
Calculation of energy using expressions $W = Pt$, $W = VIt$, $W = I^2Rt$ and $W = V^2t/R$.

Outcome 3
Elements required to set up magnetic fields.
Permanent and electromagnetic field patterns.
Factors relating to the interaction of two magnetic fields.
Concept of force acting on a current-carrying conductor situated in a magnetic field as the result of interaction between two fields.
Factors determining the magnitude and direction of the force.
Calculation of force on a straight conductor using the expression $F = BIl$.

National Unit Specification: support notes (cont)

UNIT Electrical Fundamentals (Int 2)

Outcome 4

Concept of e.m.f. and its generation by the movement of a straight conductor at the perpendicular through a magnetic field.
Factors determining the magnitude of the generated e.m.f. and the direction in which it acts.
Calculation of generated e.m.f. using the expression $e = Blu$ volts.
Generation of e.m.f. by the rotation of a single loop of conductor in a magnetic field.
Generated e.m.f. at any instant as a function of sin α where α is the angle through which the loop has rotated at the given instant.
Use of the instantaneous e.m.f. expression $e = E_{max} \sin \alpha$ volts.
Statement of r.m.s. value of sinusoidal voltage as $E_{rms} = \frac{1}{\sqrt{2}} E_{max.}$

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

Laboratory investigation should be used where appropriate to determine the relationship between current, voltage and resistance, and the current and voltage distribution in resistive networks.

Exposition and discussion on power and energy with calculations to reinforce appreciation of relationships.

Concepts of force and generated e.m.f. should be verified by demonstration and/or laboratory investigation for Outcomes 3 and 4.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Examples of instruments of assessment that could be used for each outcome are given below.

Outcome 1

The candidate could be given an assignment which measures ability to determine resistance relationships and calculate currents and voltages in a resistive d.c. network. This exercise could be carried out in conjunction with a suitably constructed observation checklist covering all practical elements of the assessment. Satisfactory achievement of the outcome would be based on results which show the relationships between quantities to be correct to within experimental tolerance.

Outcome 2

A number of short answer questions to assess the recall of knowledge and the understanding of power and energy as related to electrical systems.

Outcome 3

A number of short answer questions to assess the recall of knowledge and the understanding of the concepts of magnetic fields and their interaction to cause a force to act on a current-carrying conductor situated in such a field.

National Unit Specification: support notes (cont)

UNIT Electrical Fundamentals (Int 2)

Outcome 4
A structured question to test the recall of knowledge and understanding of the concepts of the generation of a sinusoidal voltage waveform.

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 alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment and Certification Arrangements for Candidates with Special Needs/Candidates whose First Language is not English* (SQA, 1998).