National Unit Specification: general information

UNIT Fundamental Electrical Principles (Intermediate 2)

NUMBER D9AF 11

COURSE Electrical Installation Fundamentals (Intermediate 2)

SUMMARY
This unit has been designed to provide candidates with the fundamental principles required to underpin their understanding of basic electrical installation systems and their design. It deals initially with the concept of current flow and the need for, and properties of, basic electrical circuits. It considers the relationships between current, voltage and resistance, the connection of load devices and the use of instruments.

OUTCOMES
1 Interpret the requirements of basic electrical circuits.
2 Use instruments to measure current, voltage, resistance and power in d.c. networks.
3 Determine the relationships between current, voltage and resistance in d.c. networks.

RECOMMENDED ENTRY
While entry to this unit 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 and 4 (General level) Standard Grade
  OR
- Equivalent National Units

Administrative Information

Superclass: XJ

Publication date: March 2003

Source: Scottish Qualifications Authority

Version: 01

National Unit Specification: general information (cont)

UNIT Fundamental Electrical Principles (Intermediate 2)

CREDIT VALUE
1 credit at Intermediate 2 (6 SCOTCAT points*) at SCQF level 5.

**SCOTCAT 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 SCOTCAT 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 or core skills components in this unit.

Additional information about core skills is published in the *Catalogue of Core Skills in National Qualifications* (SQA, 2001).

National Unit Specification: statement of standards

UNIT Fundamental Electrical Principles (Intermediate 2)

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 the Scottish Qualifications Authority.

OUTCOME 1
Interpret the requirements of basic electrical circuits.

Performance criteria

a) The concept of current as the rate of electron flow through a conducting material is correctly stated.
b) The characteristics and applications of electrical conducting and insulating materials are correctly determined.
c) The concept of a basic electrical circuit as a means of transmitting and controlling the transfer of energy from a source to a load device is correct.
d) The use of loads as energy-conversion devices is correctly determined.

Evidence requirements
The candidate should be presented with restricted response questions to assess the recall of knowledge and the understanding of circuits as arrangements of conductors and insulators which permit electrical energy to be transmitted safely from a source to a load device.

The assessment could consist of 10 restricted response questions to be allocated as follows:

1	Electron theory of current flow	2 questions
2	Conducting and insulating materials	2 questions
3	Applications of conducting and insulating materials	2 questions
4	Function and component parts of the electric circuit	2 questions
5	Function of a load device and energy conversion	2 questions

Satisfactory achievement of the outcome will be based on the candidate producing correct responses to SEVEN out of TEN questions as shown for the various assessment sections:

Section 1: ONE correct out of TWO responses
Section 2: TWO correct out of TWO responses
Section 3: TWO correct out of TWO responses
Section 4: ONE correct out of TWO responses
Section 5: ONE correct out of TWO responses.

National Unit Specification: statement of standards (cont)

UNIT Fundamental Electrical Principles (Intermediate 2)

OUTCOME 2
Use instruments to measure current, voltage, resistance and power in d.c. networks.

Performance criteria
a) The identification of instruments to measure electrical quantities is correctly determined.
b) The determination of the connections of the ammeter, voltmeter, ohmmeter and wattmeter is correct.
c) The use of measuring instruments to determine current, voltage, resistance and power is correct.

Evidence requirements
The candidate should be given an assignment designed to measure the ability to connect instruments in a circuit and to take accurate readings of current, voltage, resistance and power in a circuit supplying a practical resistive load device.

The assignment would require the candidate to:
- Choose the appropriate instrument for measurement of the appropriate load property
- Correctly connect the instrument
- Accurately take the appropriate measurement.

Write a report on the assignment including the need for instruments.

The exercise should be carried out in conjunction with a suitably constructed checklist covering all aspects of the practical elements of the assignment.

Satisfactory achievement of the outcome will be based on the candidate producing a satisfactory report on the assignment and a checklist record which shows that all elements of the PCs are achieved.

OUTCOME 3
Determine the relationships between current, voltage and resistance in d.c. networks.

Performance criteria
a) The determination of the relationship between current, voltage and resistance in a d.c. circuit is correct.
b) The determination of voltage drop across circuit conductors is correct.
c) The determination of power and current ratings of practical load devices is correct.
d) The determination of current, voltage and resistance relationships in a series-parallel resistive d.c. network is correct.

National Unit Specification: statement of standards (cont)

UNIT Fundamental Electrical Principles (Intermediate 2)

Evidence requirements

i) PC (d)
The candidate should be given an assignment designed to measure the ability to determine the relationships between current, voltage and resistance in a d.c. resistive network.
The assignment could require the candidate to make measurements of current, voltage and resistance within a network comprising FOUR resistors, of known value, connected as a series-parallel network across a known d.c. supply.
The candidate will be required to:

- Use the ohmmeter to measure the actual resistance values of the resistors to be connected
- Connect the resistors, and measuring instruments, in the given d.c. network configuration
- Apply the required input voltage and measure the volt drops within the network
- Measure the branch and supply currents of the network
- Calculate the network resistance from the known resistance values
- Calculate the supply and circuit currents using the known resistance and supply voltage values
- Calculate the network volt drops using the known resistance and supply voltage values
- Write a report confirming the relationships between the measured and calculated values of current and voltage.

The exercise should be carried out in conjunction with a suitably constructed checklist covering all aspects of the practical elements of the assignment.

ii) PCs (a, b, c)
The candidate should be presented with restricted response questions to assess the recall of knowledge and the understanding of the relationship between current, voltage and resistance in a d.c. circuit and the determination of current and power ratings of practical load devices.

The assessment could consist of 8 restricted response questions to be allocated as follows:

1	Ohm's Law relationship and cable volt-drop calculations	3 questions
2	Power relationships $P = I^2R$, V^2/R, VI watts and calculations	5 questions

Satisfactory achievement of the outcome will be based on the candidate producing:

1 A satisfactory report on the assignment and a checklist record which shows that all elements of PC (d) are achieved and
2 A satisfactory response to FIVE out of EIGHT questions as follows. An incorrect response should be considered as one which shows a lack of understanding rather than one caused by a trivial arithmetic error.

Section 1: TWO correct out of THREE responses
Section 2: THREE correct out of FIVE responses.

NOTE: The restricted response questions of Outcomes 1 and 3 (a, b, c) may be combined into one Assessment Instrument. Also, the laboratory assignments of Outcomes 2 and 3 (d) may be combined into one Assessment Instrument.

National Unit Specification: support notes

UNIT Fundamental Electrical Principles (Intermediate 2)

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

It is recommended that you refer to the SQA Arrangements Document for the Intermediate 2 Electrical Installation 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 provide candidates with the fundamental principles required to underpin their understanding of basic electrical installation systems and their design. It is aimed at young people and adult returners, who wish to enter the electrical contracting industry and/or to progress to further studies in Electrical Installation or Electrical Engineering.

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT

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

Outcome 1

Elementary approach to the electron theory of current flow.
Conventional direction of current flow.
The characteristics of conducting and insulating materials in relation to their ability to permit electron (current) flow.
The need for both conducting and insulating materials in electrical engineering.
Types and applications of various conducting and insulating materials and a comparison of their characteristics.
The concept of 'electricity' as a form of energy.
The unit of energy as the joule, kilowatt hour etc.
The concept of a basic electrical circuit as a means of transmitting electrical energy to a load device.
The need for the energy transfer process to be controlled.
The component parts of a basic circuit to include a source, load, conductors, insulation, switch.
The concept of a load as an energy conversion device.
Examples of practical load devices to provide energy conversion from electrical to heat, mechanical, light etc. energy.

Outcome 2

The need to make measurements of electrical quantities i.e. current, voltage, resistance and power, in a circuit.
The units of current, voltage, resistance and power as the ampere, volt, ohm and watt respectively.
The ammeter as an instrument for measuring current in a circuit.
The concept of the measured current flowing through the ammeter and the need for a series connection.
The voltmeter as an instrument for measuring the voltage across a component.
The concept of measured voltage being across the voltmeter and the need for a parallel connection.
The concept of resistance as an opposition to current flow.
The ohmmeter as an instrument for measuring resistance.
The concept of power as the rate of change of energy.
The concept of power as a function of current and voltage.
The wattmeter as an instrument for measuring load power.

The wattmeter as an instrument having two measuring elements i.e. a series element to measure current and a parallel element to measure voltage.

Use of instruments in practical circuits to measure electrical quantities, including the use of instrument scales.

Outcome 3

Relationship between current, voltage and resistance in a d.c. circuit i.e. $I = V/R$.
Practical investigations to verify the Ohm's Law relationship.
The concept of practical circuit conductors having resistance.
The concept of volt drop across practical conductors when carrying current.
The implication of conductor volt drop on the effectiveness of energy conversion by means of a load device.
Calculation of power and current ratings of practical load devices $P = VI$, $P = I^2R$, $P = V^2/R$.
Calculation of current, volt drops, resultant resistance in a series connected resistive circuit.
Current relationship in a series circuit i.e. I is common to all series components.
Voltage distribution relationship in a series circuit i.e. $V = V_1 + V_2 + V_3$ etc.
Resistance relationship in a series circuit i.e. $R = R_1 + R_2 + R_3$ etc.
Practical investigations to verify series circuit relationships.
Calculation of supply and branch current, branch volt drops, resultant resistance in a parallel connected resistive circuit.
Current distribution in a parallel network i.e. $I = I_1 + I_2 + I_3$ etc.
Voltage relationship in a parallel network i.e. V is common across all branches.
Resistance relationship in a parallel network i.e. $I/R = I/R_1 + I/R_2 + I/R_3$
Practical investigations to verify parallel network relationships.
Calculation of supply and branch currents, volt drops, resultant resistance in a series-parallel connected resistive circuit.
Current distribution in a series-parallel network.
Voltage distribution in a series-parallel network.
Resistance relationships in a series-parallel network.
Practical investigations to verify series-parallel network relationships.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

Laboratory investigations should be used wherever possible to determine and reinforce the relationships between current, voltage and resistance in d.c. networks.

Circuit relationships should be discussed and calculations used to reinforce an appreciation of these relationships.

The concepts of power and energy should be discussed and related to meaningful examples which convey the function of electrical engineering as a means of transmitting energy and converting it into various forms for the benefit of society.

Reference should be made throughout the delivery of this unit to the other units in the Electrical Installation Fundamentals course and these units should not be taught in isolation.

National Unit Specification: support notes (cont)

UNIT Fundamental Electrical Principles (Intermediate 2)

The use of ammeters, voltmeters ohmmeters and wattmeters should be demonstrated and practical exercises devised to provide candidates with experience in connecting these in circuits and taking accurate readings. The use of instrument ranges.

Knowledge and Understanding	*Contexts, applications, illustrations and activities*
1 Know the concept of current flow as the rate of electron flow through a conduction material	Discussion of electron theory of current flow
2 Know the concept of the conventional current flow direction	Explanation of the conventional flow direction being opposite to that of electron flow
3 Know the electrical characteristics of conducting and insulating materials	Practical investigation
4 Understand the need for both conducting and insulating materials in electrical engineering	
5 Know the types and applications of various conducting and insulating materials	Examples of various practical conductors and insulators
6 Know the concept of energy as the ability to perform work	Examples of various energy types i.e. chemical, mechanical, electrical, light, heat, etc.
7 Know that electricity is a form of energy	
8 Know common units of power and energy	Units of watt, kilowatt, joule and kWhr
9 Know the basic function of an electrical circuit as a means of delivering energy to a load device	
10 Know that energy transfer needs to be controlled	
11 Describe the component parts of an electric circuit	Examples of various simple circuits with control devices
12 Know the circuit load device as a means of converting electrical energy into another form	
13 State examples of load devices and their energy conversion processes	Examples of load devices i.e. motor, heater, lamp, etc and the energy output from each
14 Know the concept of power as the rate of energy change	Examples of the energy/power relationship
15 Calculate current ratings for given power values of practical load devices	
16 Connect measuring instruments in circuits	Laboratory experiments
17 Measure circuit current, voltage and power	Laboratory experiments
18 Know the relationships between current, voltage, resistance and power in a series-parallel arrangement of resistors connected to a d.c. supply	Laboratory experiments
19 Calculate the values of voltage, current, resistance and power in a series-parallel arrangement of resistors connected to a d.c. supply	Tutorial work and laboratory experiments
20 Calculate the voltage drop over circuit cables for given load power ratings	Tutorial work

National Unit Specification: support notes (cont)

UNIT Fundamental Electrical Principles (Intermediate 2)

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

A number of restricted response questions to assess the recall of knowledge and understanding of the basic function and component parts of a simple electric circuit. This would include questions on the characteristics of the circuit components and the concept of current flow.

Outcome 2

The candidate could be given an assignment designed to measure the ability to connect instruments in a circuit and to take accurate readings of current, voltage, resistance and power in a circuit supplying a practical load device.

The exercise could be carried out in conjunction with a suitably constructed checklist covering all aspects of the practical elements of the assignment.

Satisfactory achievement of the outcome would be based on the candidate producing a satisfactory report on the assignment and checklist record which shows that all elements of the PCs are achieved.

Outcome 3

Two types of assessment instrument could be used for this outcome:

i) The candidate could be given an assignment designed to measure the ability to determine the relationships between current, voltage and resistance in a d.c. resistive network.
The assignment could require the candidate to make measurements of current, voltage and resistance measurements within a network comprising FOUR resistors, of known value, connected as a series-parallel network across a known d.c. supply.
The exercise could be carried out in conjunction with a suitably constructed checklist covering all aspects of the practical elements of the assignment.

ii) A number of restricted response questions to assess the recall of knowledge and the understanding of the relationship between current, voltage and resistance in a d.c. circuit and the determination of current and power ratings of practical load devices.

Satisfactory achievement of the assignment would be based on the candidate producing: a satisfactory report on the assignment and a checklist record which shows that all elements of PC (d) are achieved.

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, publication code AA0645/3).