Higher National Unit specification

General information for centres

Unit title: Automotive Engineering: Electrical and Electronic Principles and Ancillary Systems

Unit code: F53X 34

Unit purpose: This Unit develops knowledge and understanding of the electrical and electronic principles of systems used in modern vehicles and the operation of ancillary systems used within them. The Unit develops a level of understanding that would allow a diagnostic technician in the automobile industry to diagnose faults in electrical/electronic systems that utilise electrical and electronic components.

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

1 Explain the electromagnetic principles and behaviour of vehicle electrical component operation.
2 Explain the operation of digital electronic circuits.
3 Explain the operation of electronic components.
4 Explain the principle of operation of an electronically controlled central locking system and its components.
5 Explain the principle of operation of an electronic window control system and its components.
6 Apply test procedures to electronic systems to determine their serviceability.

Credit points and level: 2 HN credits at SCQF level 7: (16 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: While entry to this Unit will be at the discretion of the centre, it is recommended that candidates have prior knowledge of Vehicle Electrical Systems, for example at SVQ level 3 or equivalent.

Core Skills: There are opportunities to develop the Core Skills of *Communication, Problem Solving* and *Numeracy* at SCQF level 5 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: This Unit may be assessed by a mixture of extended responses and practical exercises, with the use of observation checklists.

Higher National Unit specification: statement of standards

Unit title: Automotive Engineering: Electrical and Electronic Principles and Ancillary Systems

Unit code: F53X 34

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

Explain the electromagnetic principles and behaviour of vehicle electrical component operation

Knowledge and/or Skills

- Electromagnetic principles
  - — Electromagnetism, current movement, magnetic flux
  - — Maxwell Screw Rule, Flemings Dynamo and Motor Rule (left and right hand rules)
- Electromagnetic components (motors; generators/alternators; coils and solenoids)
- Electromagnetic component operation

Evidence Requirements

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- explain the electromagnetic principles above in the operation of electromagnetic components. This must include an annotated diagram of each component above, and eight calculations, two for each component: motors; generators/alternators; coils and solenoids, to substantiate each electromagnetic principle.
- explain the construction of electromagnetic components: motors; generators/alternators; coils and solenoids.
- explain the operation of electromagnetic components in vehicles: motors; generators/alternators; coils and solenoids.

Assessment Guidelines

Calculations could include the electromagnetic factors of flux density in a coil; the force on a conductor in a motor; the induced e.m.f. in a conductor of a generator; the current flowing through a coil given the mean length, cross sectional area and the number of turns. Diagrams may be sourced, for example, from textbooks etc. There is no requirement to draw a detailed diagram from scratch, although candidates may opt to do so. Principles may be assessed by short answer questions and calculations. Construction and operation can be assessed by short answer questions and a suitable checklist.

Higher National Unit specification: statement of standards (cont)

Unit title: Automotive Engineering: Electrical and Electronic Principles and Ancillary Systems

Outcome 2

Explain the operation of digital electronic circuits

Knowledge and/or Skills

- Single circuits
- Combinational circuits
- Truth tables
- Boolean expressions

Evidence Requirements

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- explain the operation of a single circuit with a diagram
- explain the operation of a combinational circuit with a diagram

Evidence for the final two Knowledge and Skills items will be sampled and assessed under unseen, supervised conditions. Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can either:

- construct truth tables for **each** type of circuit
  or
- construct Boolean Expressions for **each** type of circuit

Assessment Guidelines

This Outcome may be assessed by short answer questions, calculations and diagrams. Diagrams may be sourced, for example, from textbooks etc. There is no requirement to draw a detailed diagram from scratch, although candidates may opt to do so.

Higher National Unit specification: statement of standards (cont)

Unit title: Automotive Engineering: Electrical and Electronic Principles and Ancillary Systems

Outcome 3

Explain the operation of electronic components

Knowledge and/or Skills

- Electronic components
  - Diodes
  - Transistors
  - Senders
  - Sensors
- Electronic circuit diagrams
- Current flow, voltage, voltage drop and resistance

Evidence Requirements

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- explain the construction and operation of at least four of each of the following electronic components: diodes, transistors, senders and sensors
- draw and construct an electronic circuit using a minimum of three of the electronic components above
- calculate current flow, voltage, voltage drop and resistance in the above circuit

Assessment Guidelines

This Outcome may be assessed by short answers, and could include the use of diagrams and calculations.

It is strongly recommended that NP, PN, Avalance and Zener diodes are covered.

Outcome 4

Explain the principle of operation of an electronically controlled central locking system and its components.

Knowledge and/or Skills

- Electronically controlled central locking system
  - input device (remote)
  - input device (manual, to include switch, lock and key)
  - Electronic Control Unit (ECU)
  - control relay
  - actuator/door solenoid

Evidence Requirements

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- explain the principle of operation of an electronically controlled central locking system. The explanation must cover the five components given in the Knowledge and Skills.
- explain the principle of operation of a central locking Electronic Control Unit (ECU). This must cover input, process and output.

Assessment Guidelines

Candidates may utilise diagrams, eg from manuals, software packages etc. in order to explain the operation of a central locking system. It is anticipated that this Outcome be assessed by an extended response of approximately 500 words, or equivalent.

Higher National Unit specification: statement of standards (cont)

Unit title: Automotive Engineering: Electrical and Electronic Principles and Ancillary Systems

Outcome 5

Explain the principle of operation of an electronic window control system and its components.

Knowledge and/or Skills

- Electronic window control system
  - input device (remote)
  - input device (switches)
  - Electronic Control Unit (ECU)
  - relays
  - window motors/regulators

Evidence Requirements

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- explain the principle of operation of an electronic window control system. The explanation must cover the five components given in the Knowledge and Skills.
- explain the principle of operation of an Electronic window Control Unit (ECU). This must cover input, process and output.

Assessment Guidelines

Candidates may utilise diagrams, eg from manuals, software packages etc in order to explain the operation of an electronic window control system. It is anticipated that this Outcome be assessed by an extended response exercise of approximately 500 words, or equivalent.

Higher National Unit specification: statement of standards (cont)

Unit title: Automotive Engineering: Electrical and Electronic Principles and Ancillary Systems

Outcome 6

Apply test procedures to electronic systems to determine their serviceability.

Knowledge and/or Skills

- Diagnostic test equipment
- Test sequence and recording of result
- Electronic systems and their serviceability
- Health and safety procedures

Evidence Requirements

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- demonstrate the correct use of diagnostic test equipment. Candidates must apply test procedures to both systems identified in Outcomes 4 and 5 (electronic central locking and window control systems). Each system must have a recognised fault. The candidate must record results to determine systems serviceability.
- apply appropriate health and safety procedures.

This Outcome must be assessed by a practical exercise using appropriate diagnostic equipment to assess the serviceability of the two systems. This Outcome must be assessed under workshop conditions.

Assessment Guidelines

A checklist could be used to record results.

Administrative Information

Unit code: F53X 34

Unit title: Automotive Engineering: Electrical and Electronic Principles and Ancillary Systems

Superclass category: XR

Original date of publication: August 2008

Version: 01

History of changes:

Version	Description of change	Date

Source: SQA

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Higher National Unit specification: support notes

Unit title: Automotive Engineering: Electrical and Electronic Principles and Ancillary Systems

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 80 hours.

Guidance on the content and context for this Unit

Candidates should achieve the level of understanding of someone who may become a diagnostic technician in the automotive industry, being required to diagnose electrical/electronic system faults on vehicles. This Unit covers ancillary systems found in modern vehicles such as electronically controlled central locking and power windows.

Where candidates are asked to apply appropriate health and safety procedures, these will relate to the practical element of the particular Outcome.

Where candidates are asked to use diagrams these may be sourced, for example, from textbooks etc. There is no requirement to draw detailed diagrams from scratch, although candidates may opt to do so.

In Outcome 4, candidates' explanations of the operation of the ECU within the particular system should give a broad overview of the ECU's general operation within the system, without going into major depth of the ECU's internal components. More complex explanation of the general operation of the ECU components could be covered at SCQF level 8.

Outcome 6 should be delivered in an automotive workshop that has sufficient vehicles or systems that enable candidates to carry out the required practical diagnostic tests. It is very important that the relevant data/procedures are available to enable candidates to acquire the salient test procedures. It is strongly recommended that this Unit is integrated in its delivery and assessment with other pertinent Units from the Automotive Engineering HNC.

Guidance on the delivery and assessment of this Unit

For Outcome 2, in which candidates must use a Truth table or a Boolean expression for each circuit. Examples of possible assessments could be:

- construct a simple diagram of a switchable circuit to move an electrical motor in both directions. (can be a rotational or linear motor) eg Electric window motor or door lock solenoid.
- construct a combination diagram for a multi-switchable circuit eg Interior lamp lighting from switch or door jamb.

For Outcome 3, an example of possible assessment could be:

- design a circuit to work an actuator. Draw a circuit diagram for the circuit. Build the circuit on a small board using the components. Use calculations to prove Ohms Law and Kirchhoff's Law.

For Outcome 4 in which candidates explain the principle of operation of a central locking Electronic Control Unit (ECU), this need not be a detailed explanation of how the ECU works, but should merely cover the input, process and output.

For Outcome 5 in which candidates explain the principle of operation of an Electronic window Control Unit (ECU) this need not be a detailed explanation of how the ECU works, but should merely cover the input, process and output.

For Outcome 6, the assessment checklist or job card could cover for example, diagnostic computer, using fault codes, manual operation of components by the computer.

Opportunities for developing Core Skills

The delivery and assessment of this Unit may contribute towards the Core Skill of *Communication* at SCQF level 5. The general skills of the Written Communication component are 'read, understand and evaluate written communication' for its reading element and 'produce well-structured written communication' for its written element. Specific reading skills required by candidates at SCQF level 5 include identifying and summarising significant information, ideas and supporting details in a written communication, and evaluation of the effectiveness of the communication in meeting its purpose; and specific writing skills include 'presenting all essential ideas, information and supporting detail in a logical and effective order, and use of a structure which takes account of purpose and audience, emphasising the main points.

Candidates may need to utilise these skills in such tasks as the principle of operation of an electronically controlled central locking system and its components in Outcome 4. Candidates may be asked to produce an extended response of around 500 words on this topic, which would allow for development of Communication, as would any similar writing on other relevant topics throughout delivery of the Unit.

Depending on assessment instruments used, candidates may develop the Oral Communication component to SCQF level 5, if for example, delivering an oral presentation or leading discussion on any related topics.

The delivery and assessment of this Unit may offer opportunities to develop the Core Skill of *Problem Solving* at SCQF level 5. Its three components Critical Thinking, Planning and Organising and Reviewing and Evaluating require candidates to be able to:

- analyse a situation or issue
- plan, organise and complete a task
- review and evaluate a problem solving activity

These skills may be used across all three Outcomes in which candidates need to use equipment to gain information and arrive at a conclusion (diagnosis). Candidates could be asked to plan their activity and to review the success of their problem solving strategy upon completion of the task.

These skills may be used during the Unit, especially given the practical nature of Outcome 6 which may require the planning of test procedures to two systems. Candidates will need to use specialised equipment to gather and record information, with which they will determine systems serviceability. Candidates could be asked to plan their activity and to review the success of their problem solving strategy upon completion of the task.

The delivery and assessment of this Unit may contribute towards development of the Core Skill of *Numeracy* at SCQF level 5. The component Using Number may be developed during the calculations carried out by candidates in Outcome 1 (eg the electromagnetic factors of flux density in a coil; the force on a conductor in a motor; etc). The general skill for this component is 'apply a wide range of numerical skills in everyday and generalised contexts.' In so doing, candidates may need to perform the component's specific skills as follow:

- work confidently with a numerical concept
- decide on the numerical operations to be carried out
- carry out complex calculations or a number of sustained calculations

The general skill required by the component 'Using Graphical Information' is the ability to 'interpret and communicate graphical information in everyday and generalised contexts'. Specific skills include the interpretation of information from tables, graphs, etc and communication of information by appropriately incorporating such tables and graphs. Again, candidates may meet these criteria particularly in the first Outcome when dealing with data/calculations. The construction and operation aspect of the Outcome may be assessed by short answer questions with the use of diagrams, and principles may be assessed by short answer and calculations. Candidates may make use of tables, graphs, etc.

Open learning

This Unit could be delivered by distance learning. However, it would require planning by the centre to ensure the sufficiency and authenticity of candidate evidence. Completion of this Unit would also require access to specialised equipment. The practical aspects and equipment required (it should be delivered in a workshop environment) may engender some difficulties in delivering via Open Learning.

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)**.

General information for candidates

This Unit will develop your knowledge and understanding of the electrical and electronic principles of systems used in modern vehicles and the operation of ancillary systems used within them. The Unit develops a level of understanding that would allow a diagnostic technician in the automotive industry to diagnose faults in electrical/electronic systems that utilise electrical and electronic components. This is a double credit Unit at SCQF level 7.

On completion of this Unit you should be able to:

1 Explain the electromagnetic principles and behaviour of vehicle electrical component operation.
2 Explain the operation of digital electronic circuits.
3 Explain the operation of electronic components.
4 Explain the principle of operation of an electronically controlled central locking system and its components.
5 Explain the principle of operation of an electronic window control system and its components.
6 Apply test procedures to electronic systems to determine their serviceability.

This Unit is comprised of a mixture of theoretical and practical work. You will learn about the electrical principles and electronic components used in most modern motor vehicle applications. This will give you underpinning knowledge which can be applied across the automotive subject area. This Unit will further your knowledge and understanding of the basic electrical/electronic principles which you can apply to most vehicle systems.

In this Unit you will be assessed by a mixture of extended responses and your completion of practical exercises, under the observation of your tutor.

Throughout the Unit, you will need to follow appropriate health and safety procedures in any practical work undertaken.

In undertaking this Unit there may be opportunities for you to develop Core Skills in the areas of *Communication*, *Problem Solving* and *Numeracy*.