National Unit Specification: general information

UNIT Single and Three Phase Induction Motors (SCQF level 6)

CODE F5JT 12

SUMMARY

This Unit is designed for candidates with a basic knowledge and understanding of electrical motors but who wish to enhance their knowledge and understanding of single and three phase induction motors. This Unit is particularly suitable for those candidates training to be electrical technicians or electrical maintenance personnel.

The aim of this Unit is to provide candidates with the opportunity to develop their knowledge and understanding of universal motors, single and three phase induction motors. Candidates will also learn about three phase induction motor starting methods.

This Unit may form part of a National Qualification Group Award or may be offered on a free-standing basis.

OUTCOMES

1 Explain the construction, principle of operation, characteristics and applications of universal motors.
2 Explain the construction, principle of operation, characteristics and applications of single phase motors.
3 Investigate the construction, principle of operation, characteristics and applications of three phase induction motors.
4 Explain three phase induction motor starting methods.

Administrative Information

Superclass: XJ

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National Unit Specification: general information (cont)

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RECOMMENDED ENTRY

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

- Standard Grade Physics — Credit Level
- Standard Grade Technological Studies— Credit Level
- NQ Unit *Rotating Electrical Machines* (SCQF level 5)

CREDIT VALUE

1 credit(s) at SCQF level 6 (6 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 Access 1 to Doctorates.*

CORE SKILLS

There is no automatic certification of Core Skills in this Unit.

The Unit provides opportunities for candidates to develop aspects of the following Core Skills:

- Problem Solving (SCQF level 6)
- Communication (SCQF level 6)

These opportunities are highlighted in the Support Notes of this Unit Specification.

National Unit Specification: statement of standards (cont)

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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 SQA.

OUTCOME 1

Explain the construction, principle of operation, characteristics and applications of universal motors.

Performance Criteria

(a) Explain correctly the derivation of the name universal motor.
(b) Identify accurately the main constructional features of a universal motor.
(c) Explain correctly the principle of operation of a universal motor.
(d) Explain correctly the main characteristics of a universal motor.
(e) State correctly applications of universal motors.

OUTCOME 2

Explain the construction, principle of operation, characteristics and applications of single phase motors.

Performance Criteria

(a) Identify accurately the constructional features of a single phase induction motor.
(b) Explain correctly the principle of operation of a single phase induction motor.
(c) Explain correctly the main characteristics of single phase induction motors.
(d) State correctly applications of single phase induction motors.

OUTCOME 3

Investigate the construction, principle of operation, characteristics and applications of three phase induction motors.

Performance Criteria

(a) Explain correctly the constructional features of a three phase induction motor.
(b) Explain correctly the principle of operation of a three phase induction motor.
(c) Calculate correctly the slip of a three-phase induction motor.
(d) Sketch accurately the torque-slip curve for a three phase induction motor.
(e) Explain correctly, using the torque-slip curve, three phase induction motor start-up for a given load.
(f) State correctly applications of three phase induction motors.

National Unit Specification: statement of standards (cont)

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OUTCOME 4

Explain three phase induction motor starting methods.

Performance Criteria

(a) Explain correctly with the aid of an appropriate diagram, the principles of the Direct on Line starting (D.o.L.) method as applied to three phase induction motors.
(b) Explain correctly the reasons for reduced voltage starting of a three-phase induction motor.
(c) Explain correctly with the aid of an appropriate diagram, the principles of one reduced voltage method of starting a three phase induction motor.

EVIDENCE REQUIREMENTS FOR THIS UNIT

Evidence is required to demonstrate that candidates have achieved all Outcomes and Performance Criteria.

Written and/or recorded oral evidence should be produced to demonstrate that the candidate has achieved all the Outcomes and Performance Criteria.

Outcomes may be assessed on an individual basis, as combinations of Outcomes (eg Outcomes 1 and 2 together and Outcomes 3 and 4 together) or as a single assessment covering all four Outcomes. Regardless of which approach is taken total assessment time should not exceed two hours.

Assessment(s) should be conducted under controlled, supervised, closed-book conditions in which candidates should not be allowed to bring any notes, handouts, textbooks or any other relevant materials into the assessment.

Candidates are permitted to use a scientific calculator.

With regard to Outcome 1:
- candidates can either be asked to sketch and label a diagram of a universal motor or can be provided with a diagram of the motor and be asked to label the main parts
- a minimum of two characteristics of a universal motor should be correctly stated
- a minimum of two applications of a universal motor should be correctly stated

With regard to Outcomes 2:
- the choice of single phase induction motor to satisfy the Performance Criteria can be taken from the following list: split-phase, capacitor-start, capacitor start-capacitor-run or shaded pole
- candidates can either be asked to sketch and label a diagram of the single phase induction motor or can be provided with a diagram of the motor and be asked to label the main parts
- a minimum of two motors should be assessed and candidates may use torque-speed graphs to aid their explanations
- a minimum of two motors should be assessed and two applications for each motor should be stated correctly

National Unit Specification: statement of standards (cont)

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With regard to Outcome 3:

- the applied load should allow the motor to reach normal operating speed
- a minimum of three applications of three phase induction motors should be correctly stated

With regard to Outcome 4:

- any one of the following reduced voltage starting methods can be assessed: star-delta, auto-transformer, wound-rotor or soft-start

The Assessment Support Pack for this Unit provides sample assessment material. Centres wishing to develop their own assessments should refer to the Assessment Support Pack to ensure a comparable standard.

National Unit Specification: support notes

UNIT Single and Three Phase Induction Motors (SCQF level 6)

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 is an Optional Unit within the National Qualification Group Award in Electrical Engineering. If the Unit is included in another Group Award it is important that it is delivered in the context of the subject matter covered in that Group Award. This Unit may also be offered on a free-standing basis.

This Unit is one of three NQ electrical machines Units. The other two Units are entitled:

- *Rotating Electrical Machines* at SCQF level 5
- *Direct Current Machines* at SCQF level 6

The Unit *Rotating Electrical Machines* has been designed to provide a foundation level of knowledge and understanding on electrical machines. As such it provides a suitable entry Unit for the two SCQF level 6 electrical machines Units.

There is also an NQ Unit on static electric plant at SCQF level 6 entitled:

- *Transformers* at SCQF level 6

The aim of the *Single and Three Phase Induction Motors* Unit is to allow candidates to develop a knowledge and understanding of the constructional features, principles of operation, characteristics and applications of universal motors and single and three phase induction motors. Candidates will also learn about three phase induction motor starting methods.

This Unit could be delivered in combination with the *Electrical Plant Maintenance* SCQF level 6 Unit

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

The Outcomes in this Unit should be delivered in the sequence given in the Unit Specification. This Unit may be delivered largely in a classroom/workshop environment by a combination of lectures, tutorial work, investigations using paper based and electronic sources and practical exercises which may include candidates disassembling different types of motors to study their constructional features. Centres may also wish to allow candidates to perform experiments on motors to investigate some of their performance characteristics. It should be noted that the Internet contains a rich source of information on the construction, principles of operation and applications of universal, single phase and three phase induction motors. It also provides helpful information on three phase induction motor starting methods. Well annotated wall charts of motor constructional features can also act as an important source of learning.

National Unit Specification: support notes (cont)

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OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

Elements of the Core Skill of *Problem Solving*, that is, critical thinking, planning, organising, reviewing and evaluating, could be developed if formative work includes practical workshop experiments to investigate the performance characteristics of motors. Matching motor characteristics to their applications will involve candidates in analysing constructional features and principles of operation while taking account of factors affecting safety and efficient working practice. Practical work can also provide an environment in which to discuss, review and evaluate the process, allowing opportunities to develop the skills in oral communication needed for the workplace.

Candidates may have opportunities to develop the reading element of the Core Skill *Communication* while undertaking investigations. Access to and evaluation of a range of complex technical information on the Internet could support the currency of underpinning knowledge. Written responses should present complex information clearly and accurately, using appropriate terminology and an acceptable tone and style.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Opportunities for the use of e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by information and communications technology (ICT), such as e-testing or the use of e-portfolios or e-checklists. Centres which wish to use e-assessment must ensure that the national standard is applied to all candidate evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. Further advice is available in *SQA Guidelines on Online Assessment for Further Education (AA1641, March 2003), SQA Guidelines on e-assessment for Schools (BD2625, June 2005)*.

Formative assessment exercises involving candidates in writing up answers to questions about motors should be used to reinforce candidate learning.

Suitable methods of assessment for this Unit could include the following:

Outcomes 1 and 2 — an assessment paper comprising a balance of short answer, restricted response and structured questions lasting one hour.

The assessment should be conducted at a single assessment event and be conducted under controlled, supervised, closed-book conditions in which candidates should not be allowed to bring any notes, handouts, textbooks or any other relevant materials into the assessment.

Outcomes 3 and 4 — an assessment paper comprising a balance of short answer, restricted response and structured questions lasting one hour.

The assessment should be conducted at a single assessment event and be conducted under controlled, supervised, closed-book conditions in which candidates should not be allowed to bring any notes, handouts, textbooks or any other relevant materials into the assessment.

National Unit Specification: support notes (cont)

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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)**.