



National Unit Specification: general information

UNIT Single Phase and Three Phase Principles (SCQF level 6)

CODE F5JV 12

SUMMARY

This Unit has been designed to introduce candidates to single phase and three phase alternating current (ac) circuits. Candidates will be provided opportunities to develop their knowledge and understanding of single phase ac quantities and the principles of power factor improvement using capacitance in parallel with an inductive load.

Candidates will develop the skills to construct phasor diagrams and power triangles and demonstrate their ability to undertake practical work and measurements proving the principles of power factor improvement for a single phase alternating current (ac) circuit. This Unit will provide opportunities for candidates to develop their knowledge and understanding of three phase generation and to calculate electrical quantities in three phase balanced loads.

This Unit may be suitable for candidates who may be employed or seeking employment as electrical, mechanical or marine craft persons or technicians or to further their engineering studies.

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

OUTCOMES

- 1 Solve problems involving single phase ac circuits.
- 2 Investigate the effects of connecting a capacitor in parallel across a R-L series circuit.
- 3 Explain the principles of three phase generation and determine line and phase relationships.
- 4 Solve problems involving three phase balanced loads.

Administrative Information

Superclass: XK

Publication date: March 2009

Source: Scottish Qualifications Authority

Version: 01

© Scottish Qualifications Authority 2009

This publication may be reproduced in whole or in part for educational purposes provided that no profit is derived from reproduction and that, if reproduced in part, the source is acknowledged.

Additional copies of this Unit Specification can be purchased from the Scottish Qualifications Authority. Please contact the Customer Contact Centre, telephone 0845 279 1000.

National Unit Specification: general information (cont)

UNIT Single Phase and Three Phase Principles (SCQF level 6)

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 Mathematics — Credit Level
- ◆ Standard Grade Physics or Technological Studies — Credit Level
- ◆ NQ Unit *Electrical Principles* (SCQF level 6)

CREDIT VALUE

1 credit 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:

- ◆ Numeracy (SCQF level 5)

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

National Unit Specification: statement of standards

UNIT Single Phase and Three Phase Principles (SCQF level 6)

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

Solve problems involving single phase ac circuits.

Performance Criteria

- (a) Calculate correctly inductive reactance, capacitive reactance and impedance in a series ac circuit containing resistance (R), inductance (L) and capacitance (C).
- (b) Determine correctly the supply current and voltage drops in a series ac circuit containing R, L and C.
- (c) Determine correctly the Active Power (P), Reactive Power (Q) and Apparent Power (S) in a series ac circuit containing R, L and C.

OUTCOME 2

Investigate the effects of connecting a capacitor in parallel across an R-L series circuit.

Performance Criteria

- (a) Measure and calculate correctly the supply current for a given ac series R-L circuit.
- (b) Draw correctly the phasor diagram for the given ac series R-L circuit and determine the circuit power factor.
- (c) Measure correctly the supply and branch currents for a given ac network comprising of C connected in parallel with an R-L in series circuit.
- (d) Draw correctly the phasor diagram for the given ac network comprising of C connected in parallel with an R-L in series circuit and determine the network power factor.
- (e) Explain correctly the effects of connecting a capacitor in parallel with an R-L series circuit.

National Unit Specification: statement of standards (cont)

UNIT Single Phase and Three Phase Principles (SCQF level 6)

OUTCOME 3

Explain the principles of three phase generation and determine line and phase relationships.

Performance Criteria

- (a) Explain correctly the generation of a three phase voltage supply.
- (b) Draw correctly the voltage phasor diagrams for star and delta connected windings and determine their line and phase relationships.
- (c) State correctly the advantages of three-phase supplies over single phase supplies.

OUTCOME 4

Solve problems involving three phase balanced loads.

Performance Criteria

- (a) Determine correctly line and phase voltages and currents for balanced three phase star and delta connected R-L loads.
- (b) Calculate correctly Active Power (P), Reactive Power (Q) and Apparent Power (S), for balanced three phase star and delta connected R-L loads.

EVIDENCE REQUIREMENTS FOR THIS UNIT

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

Outcome 1:

Written and/or recorded oral evidence is required which demonstrates that the candidate has achieved Outcome 1 to the standards specified in the Outcomes and Performance Criteria.

The assessment for Outcome 1 should last no longer than 45 minutes and should be conducted under controlled, supervised, closed-book conditions.

Outcome 2:

Written and/or recorded oral evidence and performance evidence, supplemented with an assessor observation checklist, is required which demonstrates that the candidate has achieved Outcome 2 to the standards specified in the Outcomes and Performance Criteria.

The assessment for Outcome 2 should be obtained under controlled, supervised, closed-book conditions

National Unit Specification: statement of standards (cont)

UNIT Single Phase and Three Phase Principles (SCQF level 6)

Outcomes 3 and 4:

Written and/or recorded oral evidence is required which demonstrates that the candidate has achieved Outcomes 3 and 4 to the standards specified in the Outcomes and Performance Criteria. Outcomes 3 and 4 may be assessed on an individual basis or as a single assessment. The assessment for Outcomes 3 and 4 should last no longer than 1 hour 15 minutes and be conducted under controlled, supervised, closed-book conditions.

Candidates may use a scientific calculator during assessments.

With regard to Outcome 1:

- ◆ candidates to solve correctly a problem using each of the expressions $X_L = 2\pi fL$, $X_C = 1 / 2\pi fC$ and $Z = \sqrt{[R^2 + (X_L - X_C)^2]}$
- ◆ candidates to solve correctly supply current I_S and Voltage Drops V_R , V_L and V_C by phasor diagram or calculation
- ◆ Active Power (P), Reactive Power (Q) and Apparent Power (S) quantities may be determined from the power triangle or by calculation

With regard to Outcome 2:

- ◆ candidates to explain two effects of connecting a capacitor across a series ac R-L circuit

With regard to Outcome 3:

- ◆ candidates should state three advantages of three phase supplies over single phase supplies

National Unit Specification: support notes

UNIT Single Phase and Three Phase Principles (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 at SCQF level 6 and but can also be offered as a free-standing Unit.

The Unit is one of a series of Units in the area of Electrical Principles. Other Units in this series include:

- ◆ *Electrical Principles* at SCQF level 5
- ◆ *Electrical Principles* at SCQF level 6
- ◆ *Electrostatics and Electromagnetics* at SCQF level 6
- ◆ *Electronic Network Analysis* at SCQF level 6
- ◆ *Circuit Element Principles* at SCQF level 6

This Unit provides the opportunity for candidates to develop their knowledge of single phase ac circuits including power factor improvement and the principles of three phase generation and three phase balanced loads to prepare for further engineering studies or employment.

This Unit is particularly suitable for candidates who have completed the Units *Electrical Principles* (SCQF level 5), *Electrical Principles* (SCQF level 6) or *Circuit Element Principles* (SCQF level 6). Successful completion of this Unit enhances the employability skills for candidates to gain employment in the electrical engineering industry.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

This Unit should be delivered in a practical electrical environment by a combination of lectures, demonstrations and practical exercises. Outcomes should be delivered in the following order: Outcome 1, Outcome 2, Outcome 3 and Outcome 4.

In delivering this Unit centres should encourage candidates to develop a sound knowledge and understanding of the basic concepts of single phase and three phase ac circuits as these principles and formulae are relevant to many areas of electrical and electronic engineering. Such understanding can be enhanced if lecturers relate these principles to practical examples for example power factor improvement in domestic and industrial applications.

It is recommended that candidates conduct internet searches into schemes for power factor improvement that illustrate the features and benefits of power factor correction.

The practical exercise of Outcome 2 requires the candidate to be given a circuit with known resistance, inductance and capacitance values supplied from a single phase ac supply with suitable measuring instruments. A simple fluorescent light could be used to demonstrate the principles of power factor improvement provided this exercise is conducted under close personal supervision by an electrically competent person in a workshop/laboratory setting.

National Unit Specification: support notes (cont)

UNIT: Single Phase and Three Phase Principles (SCQF level 6)

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

Candidates demonstrate their ability to perform and represent a series of complex calculations and measurements as they undertake this Unit. They learn to construct phasor diagrams and power triangles and complete measurements proving the principles of power factor improvement for a single phase alternating current circuit. As understanding of three phase generation is developed they apply principles to calculate electrical quantities in three phase balanced loads. Numeracy skills will be naturally enhanced, with a focus on the practical interpretation of application of number and graphics. Formative activities should be designed around electrical engineering contexts.

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)*.

Outcome 1 can be assessed by a written paper consisting of structured question/s, short answer, multiple choice questions. On-line assessment may be used.

Outcome 2 should take the form of a practical/laboratory exercise. Centres should develop appropriate guidance sheets to assist candidates through the laboratory/workshop exercise.

Outcomes 3 and 4 can be assessed by a written paper consisting of structured question/s, short answer, multiple choice questions. On-line assessment may be used.

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).