National Unit Specification: general information

UNIT Operational Amplifiers (SCQF level 6)

CODE F5J6 12

SUMMARY

This Unit introduces candidates to operational amplifiers. Knowledge and understanding will be developed through parameter description, explanation of various operational circuits and by the design, construction and testing of operational amplifier circuits. This Unit is suitable for candidates wishing to progress a career in electrical and/or electronic engineering. It is also relevant to candidates studying other branches of engineering, science or technology, requiring knowledge of the application of operational amplifiers. Candidates will be able to apply the skills in relation to understanding the relevance of device parameters and how Operational Amplifier circuits can be used to perform various functions. This Unit may form part of a National Qualification Group Award or may be offered on a free standing basis.

OUTCOMES

1 Demonstrate knowledge and understanding of operational amplifier connections and parameters.
2 Perform calculations on operational amplifier circuits.
3 Construct and test operational amplifier circuits.

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 in a Science or Technology subject — Credit Level

Administrative Information

Superclass: XL

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Version: 01

National Unit Specification: general information (cont)

UNIT Operational Amplifiers (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:

- Communication (SCQF level 5)
- Numeracy (SCQF level 5)
- Problem Solving (SCQF level 5)

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

National Unit Specification: statement of standards

UNIT Operational Amplifiers (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

Demonstrate knowledge and understanding of operational amplifier connections and parameters.

Performance Criteria

(a) Identify operational amplifier connections.
(b) Define operational parameters.
(c) State parameter values for an ideal operational amplifier.
(d) State parameter values for a typical operational amplifier.

OUTCOME 2

Perform calculations on operational amplifier circuits.

Performance Criteria

(a) State gain and phase relationship for a voltage follower.
(b) Determine resistances of feedback resistors to achieve a specified voltage gain using voltage gain formulae for an inverting amplifier.
(c) Determine resistances of feedback resistors to achieve a specified voltage gain using voltage gain formulae for a non-inverting amplifier.
(d) Determine the output voltage of a summing amplifier.

OUTCOME 3

Design, construct and test operational amplifier circuits.

Performance Criteria

(a) Construct and test a voltage follower.
(b) Design, construct and test an inverting amplifier with specified gain.
(c) Design, construct and test a non-inverting amplifier with specified gain.
(d) Construct and test a summing amplifier.

National Unit Specification: statement of standards (cont)

UNIT Operational Amplifiers (SCQF level 6)

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 is required which demonstrates that the candidate has achieved all Outcomes to the standards specified in the Outcome and Performance Criteria.

This evidence should be produced under supervised, controlled conditions at appropriate points throughout the Unit either on an Outcome by Outcome basis or as integrated assessments. All calculations and measurements should be given using the relevant SI units of measurement.

The required written and/or recorded oral evidence is as follows:

Outcome 1

- identify the inverting and non-inverting inputs, positive and negative dc supply and output connections
- define open-loop gain, closed-loop gain, input impedance, output impedance, bandwidth and slew rate
- state ideal values for open-loop gain, input impedance, output impedance, bandwidth and slew rate
- state typical values of a practical operation amplifier for open-loop gain, input impedance, output impedance, bandwidth and slew rate

Outcome 2

- state gain and phase relationship for a voltage follower
- carry out calculations to determine suitable values of resistors for an inverting amplifier with specified gain
- carry out calculations to determine suitable values of resistors for a non-inverting amplifier with specified gain
- determine the output voltage for a summing amplifier with two inputs, and all circuit resistors of equal value

Outcome 3

- construct and test a voltage follower. Comparison of theoretical and measured voltage gain to be stated and a sketch of input and output phase relationship to be shown.
- design, construct and test an inverting amplifier with specified gain. Calculations to determine gain setting resistors to meet specified gain should be shown. Circuit diagram to be shown with correct connections and resistor values. Comparison of theoretical gain with measured gain (Passband). Sketch of input and output phase relationship.
- design, construct and test a non-inverting amplifier with specified gain. Calculations to determine gain setting resistors to meet specified gain should be shown. Circuit diagram to be shown with correct connections and resistor values. Comparison of theoretical gain with measured gain (Passband). Sketch of input and output phase relationship.

National Unit Specification: statement of standards (cont)

UNIT Operational Amplifiers (SCQF level 6)

- construct and test a summing amplifier with one dc and one ac input and specified values of resistors. Circuit diagram to be shown with correct connections and resistor values. Comparison of theoretical output with measured output. Output polarity to be included.

National Unit Specification: support notes

UNIT Operational Amplifiers (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 a restricted core Unit within the National Certificate in Electronic Engineering at SCQF level 6, however it may be delivered as a free-standing Unit.

This Unit introduces candidates to operational amplifiers. Knowledge and understanding will be developed through parameter description, explanation of various operational circuits and by the design, construction and testing of operational amplifier circuits. This Unit is suitable for candidates wishing to progress a career in electrical and/or electronic engineering. It is also relevant to candidates studying other branches of engineering, science or technology, requiring knowledge of the application of operational amplifiers. Candidates will be able to apply the skills in relation to understanding the relevance of device parameters and how operational amplifier circuits can be used to perform various functions.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

The Unit should be delivered in a practical electronics environment with access to a range of test equipment. Practical work could be used to reinforce circuit operation. Testing a range of pre-built circuits with switchable elements could be used enabling quick comparisons to be made for circuit variation in terms of effect on output signal.

Computer simulation software may be used to support teaching and reinforce learning. In particular, simulation software could be used effectively to demonstrate the effect on output signal for changes in circuit component values. Access to online resources via the internet could also be used to reinforce learning.

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

The Reading component of the Core Skill *Communication* at SCQF level 5 may be developed in all three Outcomes while candidates are reading materials on aspects of operational amplifiers from paper based and electronic sources.

The Writing component of the Core Skill *Communication* at SCQF level 5 may be developed in all three Outcomes while candidates are preparing written responses to formative and summative assessments.

The Using Graphical Information component of the Core Skill *Numeracy* at SCQF level 5 may be developed in Outcome 3 while candidates represent operational amplifiers in suitable diagram format.

The Critical Thinking component of the Core Skills *Problem Solving* at SCQF level 5 may be developed in Outcome 3 while candidates design suitable operational amplifier circuits.

National Unit Specification: support notes (cont)

UNIT Operational Amplifiers (SCQF level 6)

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).*

A structured report could be used for Outcome 3. The design specifications, calculations, circuit diagrams, measurements, results, sketches and conclusions could be contained within the report. It may also be appropriate to include the evidence for Outcomes 1 and 2 within this report in order to ensure that the theory is not in isolation from the practice. The candidate would then complete each section with required circuit information, test equipment used and all measurements and calculations. The required descriptions of relevant circuits and associated theory would also be entered by the candidates at appropriate points throughout the Unit. Since the practical work and completion of the structured report is part of the assessment process, it is essential that each candidate works independently and that the evidence is produced under supervised controlled conditions.

DISABLED CANDIDATES AND/OR THOSE WITH ADDITIONAL SUPPORT NEEDS

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website **www.sqa.org.uk/assessmentarrangements**