

## SQA Advanced Unit specification

### General information

**Unit title:** Applied Mathematics for Civil Engineering (SCQF level 8)

**Unit code:** HR6L 48

**Superclass:** RB

**Publication date:** August 2017

**Source:** Scottish Qualifications Authority

**Version:** 01

### Unit purpose

This Unit is designed to enable learners to use calculus, differential equations and numerical analysis to support applications in civil engineering. Learners will develop skills in both differentiation and integration at an advanced level.

### Outcomes

On successful completion of the Unit the learner will be able to:

- 1 Solve problems involving calculus.
- 2 Solve problems using matrices.
- 3 Solve problems involving linear equations and differential equations using numerical analysis.

### Credit points and level

1 SQA Credit at SCQF level 8: (8 SCQF credit points at SCQF level 8)

### Recommended entry to the Unit

Learners should have a basic understanding of mathematical concepts and theorems as evidenced by completion of the Unit *Mathematics for Civil Engineering* or equivalent.

## **Core Skills**

Achievement of this Unit gives automatic certification of the following Core Skills component:

Complete Core Skill	None
Core Skill component	Using Number at SCQF level 6

There are also opportunities to develop aspects of Core Skills which are highlighted in the Support Notes of this Unit specification.

## **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.

The Assessment Support Pack (ASP) for this Unit provides assessment and marking guidelines that exemplify the national standard for achievement. It is a valid, reliable and practicable assessment. Centres wishing to develop their own assessments should refer to the ASP to ensure a comparable standard. A list of existing ASPs is available to download from SQA's website.

## **Equality and inclusion**

This Unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website [www.sqa.org.uk/assessmentarrangements](http://www.sqa.org.uk/assessmentarrangements).

## SQA Advanced Unit specification: Statement of standards

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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.

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. Learners 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

Solve problems involving calculus.

#### Knowledge and/or Skills

- ◆ Curves with polar equations
- ◆ Integration by substitution
- ◆ Integration by parts
- ◆ Integration techniques for partial fractions
- ◆ Partial differentiation

### Outcome 2

Solve problems using matrices.

#### Knowledge and/or Skills

- ◆ Determinants, Inverses, Rank
- ◆ Eigen values
- ◆ Eigenvectors
- ◆ Symmetric matrices

### Outcome 3

Solve problems involving linear equations and differential equations using numerical analysis.

#### Knowledge and/or Skills

- ◆ Taylor series and linear approximation
- ◆ Introduction to Fourier series
- ◆ Positive definitive matrices
- ◆ Change differential equations by finite difference

### Evidence Requirements for this Unit

Learners will need to provide evidence to demonstrate their Knowledge and/or Skills across all Outcomes by showing that they can:

- ◆ define and solve problems involving integration of functions and using partial differentiation techniques.
- ◆ solve problems involving linear algebra and vector analysis.
- ◆ use numerical analysis methods, solve problems involving linear equations and differential equations.

Evidence should be produced under closed-book, supervised conditions in response to an appropriate set of questions. And as such learners should not be allowed to bring textbooks or soft hand-outs/notes, programmable calculators, any other electronic devices to the assessment.

Assessment may be carried out:

- ◆ Outcome by Outcome
- ◆ Two or more Outcomes together
- ◆ All Outcomes together — holistic assessment of the Unit

Learners should be given access to normal scientific calculators. Sufficient working must be shown to demonstrate the method of solution.

Sampling of content may be appropriate, but assessment questions must be constructed to enable evidence to be produced which demonstrates achievements of all Outcomes to cover the Knowledge and/or Skills.

Where re-assessment is needed, a different set of questions must be used on each assessment occasion.

Under no circumstances should the learners be notified of the assessment questions prior to the assessment.

## SQA Advanced Unit Support Notes

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Unit Support Notes are offered as guidance and 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 Unit has been written in order to allow learners to develop knowledge, understanding and skills in the following areas:

- ◆ Calculus
- ◆ Linear algebra
- ◆ Numerical analysis

In developing this Unit the Unit writers have identified the range of subject they would expect to be covered by lecturers. This has been done to help lecturers decide what depth of treatment should be given to the topics attached to each of the Outcomes. Whilst it is not mandatory for the centres to use this list of topics it is strongly recommended that they do so to ensure continuity of teaching and learning across the mathematics Units.

The content comprises all the mathematics needed to achieve the Outcomes. The various topic areas should be addressed as and when they are needed to analyse problems in the discipline the learner is following.

This Unit underpins most of the other Units in the SQA Advanced Programme. The techniques covered have specific application in other Units. Importantly, this Unit also provides the necessary mathematical skills to enable learners to progress to higher studies.

#### Outcome 1

##### Solve problems involving calculus

Polar curves, areas bounded by curves, arc lengths for curves. Integration of algebraic functions. Integration by substitution. Integration by parts. Integration techniques involving centroids, second moments of area and moments of inertia. Partial differentiation.

#### Outcome 2

##### Solve problems using Matrices

- ◆ Solve linear systems and find matrix inverses, determinants, eigenvalues and eigenvectors
- ◆ Relate characteristics of solutions of a linear system to determinant and rank of its associated matrices
- ◆ Use eigenvector methods to solve a system of first-order ordinary differential equations
- ◆ Construct precise descriptions of curves, surfaces, and solids using parametrisations or equations/inequalities
- ◆ Compute work and mass integrals on curves, surfaces, and solids, respectively

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- ◆ Find lengths, areas, and volumes of curves, surfaces, and solids, respectively
- ◆ Choose co-ordinate systems (polar, spherical, cylindrical, rectangular) appropriate to a given problem

### Outcome 3

#### Solve problems of linear equations and differential equations using numerical analysis

- ◆ Taylor series and linear approximation:
  - Introduction
  - Taylor Series in 1D: McLaurin Series
  - Taylor Series in 2D
  - Error Analysis
- ◆ Introduction to Fourier series
- ◆ Positive definitive matrices
- ◆ Change differential equations by finite difference

### Guidance on approaches to delivery of this Unit

This Unit should be delivered in the context of civil engineering using appropriate examples.

The content comprises all the mathematics needed to achieve the Outcomes. The various topic areas should be addressed as and when they are needed to analyse problems in the discipline the learner is following.

This Unit underpins most of the other Units in the SQA Advanced Programme. The techniques covered have specific application in other Units. Importantly, this Unit also provides the necessary mathematical skills to enable learners to progress to higher studies.

Where appropriate learners should be allowed to use computer based systems for the solutions of complex problems but be required to demonstrate a good understanding of the methodology being used and the range of acceptable results.

### Guidance on approaches to assessment of this Unit

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to learners.

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

Assessments must be focused on the individual achievement of each learner. All Learning Outcomes can be assessed under supervised closed-book conditions.

The volume of evidence required for each assessment should take into account the overall number of assessments being contemplated within this Unit and the design of the overall teaching programme.

In designing the assessment instrument/s, opportunities should be taken to generate appropriate evidence to contribute to the assessment of Core Skills Units.

## Opportunities for 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 Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at [www.sqa.org.uk/e-assessment](http://www.sqa.org.uk/e-assessment).

## Opportunities for developing Core and other essential skills

This Unit has the Using Number component of Numeracy embedded in it. This means that when candidates achieve the Unit, their Core Skills profile will also be updated to show they have achieved Using Number at SCQF level 6.

## History of changes to Unit

Version	Description of change	Date

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SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of SQA Advanced Qualifications.

**FURTHER INFORMATION:** Call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our [Centre Feedback Form](#).

## General information for learners

### **Unit title:** Applied Mathematics for Civil Engineering (SCQF level 8)

This section will help you decide whether this is the Unit for you by explaining what the Unit is about, what you should know or be able to do before you start, what you will need to do during the Unit and opportunities for further learning and employment.

This Unit has been designed to allow you to develop your knowledge, understanding and skills in mathematics that underpin many of the subjects studied in the SQA Advanced Diploma in Civil Engineering. If you have studied some of these topics before, the early part of the Unit will provide you with an opportunity to revise the techniques you have learned on other courses.

Achievement of this Unit gives automatic certification of Using Number at SCQF level 6.

This Unit has been designed to equip you with the knowledge, skills and understanding to enhance your learning at a bachelor's degree level.

On successful completion of this Unit, you will be able to:

- ◆ solve problems involving calculus.
- ◆ solve problems using vectors and matrices.
- ◆ solve problems involving linear equations and differential equations using numerical analysis.