SQA Advanced Unit specification

General information

Unit title: Mathematics for Civil Engineering (SCQF level 7)

Unit code: HR5R 47

Superclass:	RB
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Version:	01

Unit purpose

This Unit provides the learner with the opportunity to acquire knowledge of a range of mathematical techniques and will develop his/her understanding of how these techniques can be applied to solve engineering problems. Learners will also learn the value of mathematics as a method of communicating results.

Outcomes

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

1 Construct and solve equations representing engineering problems using matrix methods.
2 Differentiate using standard functions and applications in civil engineering context.
3 Use techniques of integration to solve problems in civil engineering.

Credit points and level

1 SQA Credit at SCQF level 7: (8 SCQF credit points at SCQF level 7)

Recommended entry to the Unit

Learners should have completed *Mathematics for Construction* or an equivalent Unit.

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 **(http://www.sqa.org.uk/sqa/46233.2769.html)**.

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**.

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

Construct and solve equations representing engineering problems using matrix methods.

Knowledge and/or Skills

- Add, subtract and multiply matrices
- Solve simultaneous linear equations using inverse of 2x2 matrices
- Solve problems involving 3x3 matrices using Gaussian elimination

Outcome 2

Differentiate using standard functions and applications in civil engineering context.

Knowledge and/or Skills

- Differentiation of standard functions {to include ax^n, $(ax+b)^n$, sin (ax+b), cos (ax+b), $e^{(ax+b)}$ and ln(ax+b)}
- Determine the maximum and minimum values of functions in one variable and solve optimisation problems
- Techniques of differentiation — product, quotient and chain rule

Outcome 3

Use techniques of integration to solve problems in civil engineering.

Knowledge and/or Skills

- Definite and indefinite integration of standard functions {to include ax^n, $(ax+b)^n$, sin (ax+b), cos (ax+b), $e^{(ax+b)}$ and ln(ax+b)}
- Use integration to solve engineering problems involving section properties of irregular shapes
- Integration by substitution, integration techniques for partial fractions, integration by parts

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:

- solve problems involving 2x2 and 3x3 matrices using inverse and Gaussian elimination respectively
- use techniques of differentiation and integration

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, hard and/or soft hand-outs or notes to the assessment.

Assessment may be carried out:

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

The total time allowed for the assessment(s) should not exceed two hours.

Learners should be given access to 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 and 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

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 also have specific application in some Units. Importantly, this Unit also provides the necessary mathematical skills to enable learners to progress to higher studies.

Recommended time allocations to each Outcome are given as guidance towards the depth of treatment which might be applied to each topic. This guidance has been used in the design of the assessment exemplar material provided with the Unit.

Outcome 1

Construct and solve equations representing engineering problems using matrix methods

Construct and solve algebraic equations representing engineering problems: matrix form of simultaneous linear equations. Role of the inverse matrix, Gaussian elimination. Construct and solve model equations.

Nonlinear equations representing engineering problems: 3pts to find the equation of a circle, Intersection of a parabola and line

Outcome 2

Differentiate using standard functions and applications in civil engineering context

Differentiating standard functions: negative and fractional powers, transition curves, super-elevation, maximum and minimum values, rate of change, second derivatives, location and classification of stationary points of functions of one variable.

Outcome 3

Use techniques of integration to solve problems in civil engineering

Definite and indefinite integration of standard functions {to include ax^n, $(ax+b)^n$, sin (ax+b), cos (ax+b), $e^{(ax+b)}$ and ln(ax+b)}

Techniques of calculus to calculate areas and/or volumes: calculation of areas and volumes, approximate integration (trapezoidal rule).

Engineering problems: Areas and volumes of irregular sections. Centroids and first and second moments of area, and radius of gyration.

Guidance on approaches to delivery of this Unit

This Unit underpins many of the analytical techniques required for applications in other Units in the SQA Advanced Programme.

Integrative assignments and project work linking the teaching and assessment of this Unit with applications in other related Units is encouraged.

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. Learning Outcomes 1, 2 and 3 must be conducted 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**.

Opportunities for developing Core and other essential skills

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

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: Mathematics for Civil Engineering (SCQF level 7)

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 award. 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.

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 completion of the Unit you should be able to:

1 Construct and solve equations representing engineering problems using matrix methods.
2 Differentiate using standard functions and applications in civil engineering context.
3 Use techniques of integration to solve problems in civil engineering.

The precise form of assessment will depend on the centre where you are taking the Unit.

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