Higher National Unit Specification

General information for centres

Unit title: Applied Mathematics for Civil Engineering

Unit code: F02N 35

Unit purpose: This Unit is designed to enable candidates to use calculus, differential equations and numerical analysis to support applications in engineering. Candidates will develop skills in both differentiation and integration.

On completion of the Unit the candidate should be able to:

1 Solve problems involving calculus.
2 Apply statistical techniques.
3 Solve problems of linear equations and differential equations using numerical analysis.

Credit points and level: 1 HN Credit at SCQF level 8: (8 SCQF credit points at SCQF level 8*)

**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.*

Recommended prior knowledge and skills: Candidates should have a basic understanding of mathematical concepts and theorems as evidenced by completion of the Unit Mathematics for Construction Engineering or equivalent.

Core Skills: There are opportunities to develop the Core Skills of Numeracy and Problem Solving in this Unit, although there is no automatics certification of Core Skills or Core Skills components.

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.

Assessment: Teaching and assessment of this Unit in the context of applications in other Units is likely to assist candidate understanding and is encouraged.

It is possible to assess candidates either on an individual Outcome basis, combinations of Outcomes or by a single holistic assessment combining all Outcomes. The assessment paper/s should be composed of an appropriate balance of short answer, restricted response and structured questions. Assessment should be conducted under supervised, controlled conditions. A single assessment covering all Outcomes should not exceed two and a half hours in duration. It should be noted that candidates must achieve all the minimum evidence specified for each Outcome in order to pass this Unit.

General information for centres (cont)

Where assessment is conducted separately for each Outcome a duration of 45 minutes per Outcome should be allowed.

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. Candidates should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

An exemplar instrument of assessment and marking guidelines have been produced to provide examples of the type of evidence required to demonstrate achievement of the aims of this Unit and to indicate the national standard of achievement at SCQF level 8

Higher National Unit specification: statement of standards

Unit title: Applied Mathematics for Civil Engineering

Unit code: F02N 35

The sections of the Unit stating the Outcomes, knowledge and/or skills, and Evidence Requirements are mandatory.

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. Candidates 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 techniques for partial fractions
- Integration by parts
- Partial differentiation

Evidence Requirements

In any assessment of this Outcome **all** knowledge and/or skills items should be included.

Candidates must provide a satisfactory response to all items.

Candidates will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can:

- define and solve problems involving integration of functions

Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response and structured questions. Evidence should be generated through assessment undertaken in controlled, supervised conditions.

Assessment guidelines

Assessment should be conducted under open-book conditions.

Higher National Unit specification: statement of standards (cont)

Unit title: Applied Mathematics for Civil Engineering

Outcome 2

Apply statistical techniques

Knowledge and/or skills

- Probability distributions for continuous and discrete variables
- Significance and null hypothesis
- Distributions for extreme values
- Design of experiments/tests

Evidence Requirements

Candidates will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can:

- define and solve problems using statistical techniques

Evidence for the knowledge and /or skills for this Outcome will be provided on a sample basis. In any assessment of this Outcome a minimum of **two out of four** knowledge and/or skills items should be sampled. Candidates must provide a satisfactory response to both items.

Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response and structured questions. Evidence should be generated through assessment undertaken in controlled, supervised conditions.

Assessment guidelines

Assessment should be conducted under open-book conditions.

Outcome 3

Solve problems involving linear equations and differential equations using numerical analysis

Knowledge and/or skills

- Triangular decomposition
- Positive definitive matrices
- Gaussian elimination method
- Eulers and modified Eulers methods
- Fourth order Runge-Kutta method
- Finite difference

Higher National Unit specification: statement of standards (cont)

Unit title: Applied Mathematics for Civil Engineering

Evidence Requirements

Candidates will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can:

- solve systems of linear equations and differential equations using numerical analysis

Evidence for the knowledge and/or skills for this Outcome will be provided on a sample basis. In any assessment of this Outcome a minimum of **three out of six** knowledge and/or skills items should be sampled. Candidates must provide a satisfactory response to all three items.

Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response and structured questions. Evidence should be generated through assessment undertaken in controlled, supervised conditions.

Assessment guidelines

Assessment should be conducted under open-book conditions.

Administrative Information

Unit code: F02N 35

Unit title: Applied Mathematics for Civil Engineering

Superclass category: RB

Original date of publication: August 2006

Version: 01

History of Changes:

Version	Description of change	Date

Source: SQA

SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of Higher National qualifications.

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

Higher National Unit specification: support notes

Unit title: Applied Mathematics for Civil Engineering

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 Unit has been written in order to allow candidates to develop knowledge, understanding and skills in the following areas:

In developing this Unit the Unit writers have identified the range of subject they would expect to be covered by lecturers. The writers have also given recommendations as to how much time should be spent on each Outcome. 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 and because assessment exemplar pack for this Unit is based on the knowledge and/or skills and the list of topics in each of the Outcomes.

A list of topics is given below. Lecturers are advised to study this list of topics in conjunction with the assessment exemplar pack so that they can get a clear indication of the standard of achievement expected of Candidates in 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 candidate is following.

This Unit underpins most of the other Units in the Higher National Programme. The techniques covered have specific application in other Units. Importantly, this Unit also provides the necessary mathematical skills to enable candidates 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.

1 Solve problems involving calculus (12 hours)

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 intertia. *Partial differentiation.*

2 Application of statistical techniques (12 hours)

Binomial, Poisson and Normal distributions. Tests for significance and null hypothesis. Extreme value distributions for wind and precirpitation. Design of experiments/tests for strength of materials etc including sample size, sampling of attributes and application to several independent variable.

Higher National Unit specification: support notes (cont)

Unit title: Applied Mathematics for Civil Engineering

3 Solve problems of linear equations and differential equations using numerical analysis (16 hours)

Triangular decomposition. Positive definitive matrices. Gaussian elimination method. Eulers and modified Eulers methods for approximations. Runge-Kutta method. Change differential equations by finite difference.

Guidance on the delivery and assessment 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 candidate is following.

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

Where appropriate candidates 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.

Opportunities for developing Core Skills

The following grid provides a general guide to opportunities for the development of Core Skills in this Unit. Opportunities for the development of Core Skills at the output level are more fully identified in the Core Skills Signposting Guide.

Core Skill	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5
1 **Communication**					
Reading					
Writing					
Oral					
2 **Numeracy**					
Using Number	X	X	X		
Using Graphical Information	X	X	X		
3 **IT**					
Using Information Technology			X		
4 **Problem Solving**					
Critical Thinking	X	X	X		
Planning and Organising					
Reviewing and Evaluating					
5 **Working with others**					

Open learning

The theoretical aspects of this Unit could be delivered by distance learning, which may incorporate some degree of on-line support. However, with regard to assessment, planning would be required by the centre concerned to ensure the sufficiency and authenticity of candidate evidence. Arrangements would be required to be put in place to ensure that assessment whether done at single or at multiple events was conducted under controlled, supervised conditions.

It is recommended that a single assessment paper (taken by candidates at a single assessment event) be used for distance learning candidates.

For information on normal open learning arrangements, please refer to the SQA guide *Assessment and Quality of Open and Distance Learning* (SQA 2000)

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. For information on these, please refer to the SQA document *Guidance on Alternative Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs,* which is available on SQA's website: **www.sqa.org.uk**.

General information for candidates

Unit title: Applied Mathematics for Civil Engineering

On completion of the Unit you should be able to:

1 Solve problems involving calculus.
2 Apply statistical techniques.
3 Solve problems of linear equations and differential equations using numerical analysis.