SQA Advanced Unit Specification

General information for centres

Unit title: Mathematics: Calculus and Matrices for Computing

Unit code: HR7E 47

Unit purpose: This Unit is designed to enable candidates to apply mathematical techniques applicable in computing. This could be achieved by incorporating, where possible, examples from the computing environment. It is primarily intended for candidates who wish to progress to higher education to advance their qualifications in this area. It could also be useful to all candidates who expect to work in a computing environment.

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

1 Use and apply matrices.
2 Use and apply techniques of differential calculus.
3 Use and apply techniques of integral calculus.

Credit points and level: *1 SQA Credit at SCQF level 7: (8 SCQF credit points at SCQF level 7*) *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 National 1 to Doctorates.*

Recommended prior knowledge and skills: Candidates should have good mathematical skills. Entry will be at the discretion of the centre and a pass at Higher Mathematics or equivalent would be preferred.

Core skills: The achievement of this Unit gives automatic certification of the following:

Numeracy at SCQF level 6

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: This Unit could be assessed by means of written/oral responses. Each Outcome could be assessed separately. Assessment should be carried out in controlled conditions, and should last approximately one hour per Outcome. The assessments should be closed book and any relevant formulae could be given with the assessment.

Candidates must achieve all of the minimum evidence specified for each Outcome in order to pass the Unit.

Unit specification: statement of standards

Unit title: Mathematics: Calculus and Matrices for Computing

Unit code: HR7E 47

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)**.

Unit specification: statement of standards

Unit title: Mathematics: Calculus and Matrices for Computing

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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

Use and apply matrices

Knowledge and/or skills

- matrix definitions
- matrix transformations
- use and knowledge of a computer package to manipulate matrices

Evidence requirements

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

- matrix definitions including order of a matrix, addition and subtraction of various orders and multiplication up to order 3x3, transposes, inverse of a 2x2 matrix
- apply matrix transformations including reflections, rotations, dilatations and combinations of these transformations in two dimensions
- solve a system of equations in three unknowns using a computer package eg Derive

Evidence for the knowledge and/or skills in this Outcome will be provided by an examination taken at a single assessment event lasting thirty minutes and carried out under supervised, controlled conditions. The evidence may be presented in responses to specific questions. Each candidate will need to demonstrate that he/she can achieve at least 60% of the marks available in the assessment. In any assessment of this Outcome all of the knowledge and/or skills items should be tested. Candidates should be provided with appropriate formula sheets, and should **not** have access to a computer algebra for the first two K/S but **must** have access to a computer algebra for the last K/S.

In order to ensure that candidates will not be able to foresee the exact form of the assessment, a different examination is required each time the Outcome is assessed.

Assessment guidelines

Questions used to elicit candidate evidence may take the form of an appropriate balance of short answer, restricted response and structured questions.

Outcome 2

Use and apply techniques of differential calculus

Knowledge and/or skills

- differentiation of various functions using standard derivatives
- use and knowledge of a computer algebra package

Evidence requirements

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

- differentiate standard functions {to include a^n, $(ax + b)^n$, $\sin(ax + b)$, $\cos(ax + b)$, $e^{(ax + b)}$ and $\ln(ax + b)$}
- use a computer algebra package such as Derive to evaluate rates of change, find turning points and sketch a curve

Evidence for the knowledge and/or skills in this Outcome will be provided by an examination taken at a single assessment event lasting not more than one hour and carried out under supervised, controlled conditions. The evidence may be presented in responses to specific questions. Candidates must have access to a computer algebra for the second K/S part of this assessment, their solutions must be fully documented showing all major steps and inferences. Each candidate will need to demonstrate that he/she can achieve at least 60% of the marks available in the assessment. In any assessment of this Outcome all of the knowledge and/or skills items should be tested.

In order to ensure that candidates will not be able to foresee the exact form of the assessment, a different examination is required each time the Outcome is assessed.

Assessment guidelines

Questions used to elicit candidate evidence may take the form of an appropriate balance of short answer, restricted response and structured questions.

The assessment of this Outcome can be combined with that of Outcome 3 to form a single assessment paper, details of which are given below.

The assessment of Outcomes2 and 3 could be combined to form a single assessment paper for the Unit. The single assessment paper would be taken at the end of the Unit in an examination lasting no longer than one and a half hours carried out under supervised, controlled conditions. Such a paper could be composed of an appropriate balance of short answer, restricted response and structured questions. Candidates should be provided with appropriate formula sheets, but should **not** have access to a computer algebra for the questions on those parts of the assessment that do not specify access to one. Candidates **must** have access to a computer algebra for any part of the assessment specifying the use of one, and their solutions must be fully documented showing all major steps and inferences. A pass mark of 60% is recommended for this single paper.

Outcome 3

Use and apply techniques of integral calculus

Knowledge and/or skills

- standard functions
- use and knowledge of a computer algebra package
- Simpson's rule
- first order differential equations

Evidence requirements

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

- integrate standard functions {to include a^n, $(ax + b)^n$, $\sin(ax + b)$, $\cos(ax + b)$ and $e^{(ax + b)}$}
- use a computer algebra package to solve relevant problems involving integration, which should include areas
- use Simpson's rule to estimate irregular areas or non-standard integrals
- solve simple first order differential equations using separation of variables

Evidence for the knowledge and/or skills in this Outcome will be provided by an examination taken at a single assessment event lasting not more than one hour and carried out under supervised, controlled conditions. The evidence may be presented in responses to specific questions. Candidates must have access to a computer algebra for the second K/S part of this assessment, their solutions must be fully documented showing all major steps and inferences. Each candidate will need to demonstrate that he/she can achieve at least 60% of the marks available in the assessment. In any assessment of this Outcome all of the knowledge and/or skills items should be tested.

In order to ensure that candidates will not be able to foresee the exact form of the assessment, a different examination is required each time the Outcome is assessed.

Assessment guidelines

Questions used to elicit candidate evidence may take the form of an appropriate balance of short answer, restricted response and structured questions.

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Administrative Information

Unit code: HR7E 47

Unit title: Mathematics: Calculus and Matrices for Computing

Superclass category: RB

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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.

Unit specification: support notes

Unit title: Mathematics: Calculus and Matrices for Computing

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 was developed for the SQA Advanced Certificate in Computer Games Development award but may be appropriate for other awards in the computing field. The object of the Unit is to enable candidates to apply mathematical methods to problems in computing. Where possible this should be taken into account when delivering the Unit by using examples in context. For example, problems could relate to the field of computer graphics. The transformations section of Outcome 1 could relate to moving objects on a computer screen. The rate of change section in Outcome 2 could be used to find velocity of objects moving on screen. Integration could be applied in finding distance travelled between points on screen. Finally differential equations could be used to describe a physical system such as how waves form in water or how a person walks across the ground. It should be pointed out the simulation of physical systems normally leads to numerical solutions of differential equations but an understanding of the analytical solution is a prerequisite to this.

Outcome 1

The first Outcome should give an understanding of how matrices operate and how they can be applied in computing. Particular emphasis should be placed on the transformations and how they are used to move/size objects in computer graphics.

It would be helpful if three dimensional transformations were introduced at this stage. These would be non-assessable. The importance of matrix equations in computer graphics should be mentioned. Examples such as finding best position and orientation to match one object to another, and simulation of materials like water are examples that require numerical solutions to matrix equations. Although these applications may be beyond the scope of this course their relevance should be indicated.

Outcome 2

Differential calculus has broad application in any physical system. In the area of computer graphics moving objects across a screen is essential. Finding the velocity of an object as it moves on screen is one example of how rate of change can be applied. Curve sketching could be used to describe the trajectory of a moving object such as the parabolic path of a ball or missile as it is thrown or fired through the air. Finding turning points would determine the maximum altitude of the object in this case. The gradient of the tangent to the curve at the end of the trajectory could be used to find the angle of impact as the object hits it target.

Outcome 3

The use of integral calculus also lends itself to the movement of objects in computer graphics. Calculating the area under a velocity/time graph would enable the calculation of the distance travelled by an object in a given time.

Guidance on the delivery and assessment of this Unit

Assessment

Details on approaches to assessment for each Outcome can be found in the Evidence Requirements and Assessment Guidelines in the SQA Advanced Unit Specification: statement of standards section. These should be read carefully before assessing candidates. A formulae booklet could be given for whole unit if required, or individual formulae sheets for each outcome assessment.

Delivery

The delivery should take the form of lecturer exposition with candidate materials consisting of notes and tutorials with some examples in the context of computing. Suggestions for examples that could be used refer to the Guidance on the content and context for this Unit in the SQA Advanced Unit specification: support notes section.

A computer algebra package such as Derive for windows could be used to demonstrate how these packages can perform some of the operations in each Outcome.

The following delivery schedule is a guideline based on 40 hours and includes candidate tutorial work:

Outcome 1	Matrix operations	2 hours
	Transformations	4 hours
	Solve equations	2 hours
	Use Derive	3 hours
	Assess/reassess	2 hours
Outcome 2	Differentiation	2 hours
	Rates of change	3 hours
	Curve sketching	3 hours
	Use Derive	3 hours
	Assess/reassess	2 hours
Outcome 3	Integration	2 hours
	Areas	2 hours
	Simpson's rule	2 hour
	Differential equations	3 hours
	Use Derive	3 hours
	Assess/reassess	2 hours

Opportunities for developing Core Skills

The achievement of this unit gives automatic certification of the following:

Complete Core Skill	Numeracy at SCQF level 6
Core Skills component(s)	None

Open learning

This Unit may be delivered using open/distance learning provided that candidates are assessed in a controlled, closed book environment. Centres delivering this unit using open or distant learning should refer to the SQA document Assessment and Quality Assurance of Open and Distant Learning (SQA, 2000).

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.

General information for candidates

Unit title: Mathematics: Calculus and Matrices for Computing

In this Unit you could learn about and use mathematical techniques that are applicable to computing. Where possible throughout the unit specific examples could be used and their relevance indicated.

The Unit consists of three Outcomes. Outcome 1 covers matrices and how to manipulate and use matrices in a context meaningful to your subject area. Outcome 2 looks at Differential Calculus, and demonstrates how differentiation can be used to calculate rates of change and its application to curve sketching. Integral Calculus is covered in Outcome 3 and shows how integration can be used to find areas and solve simple differential equations.

The Outcomes could be assessed under closed book conditions and any relevant formulae given. Each Outcome could be assessed separately. Outcomes 2 and 3 could be combined into a single assessment. Each Outcome will have the use of a computer algebra package such as Derive to solve problems. You could be expected to have a good level of mathematics on entry, preferably a pass at Higher mathematics or equivalent. The Unit is normally for those who wish to progress to higher education but would be of great use to anyone intending to work in a computing environment.