Higher National Unit specification

General information for centres

Unit title: Mathematics for Interactive Computing: Essential Techniques

Unit code: F20B 34

Unit purpose: This Unit is designed to enable candidates to apply techniques in 3D matrices and essential calculus in problem solving applicable to interactive computing. This could be achieved by contextualising the content of the Unit and its assessments where applicable. It is primarily intended for candidates who wish to progress to higher education to advance their qualifications in this area. It would be considered 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 skills to problems involving matrices in three dimensions.
2 Use and apply skills to problems involving differential calculus.
3 Use and apply skills to problems involving integral calculus.

Credit points and level: 1 HN 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 Access 1 to Doctorates.*

Recommended prior knowledge and skills: Candidates should have good mathematical skills. Entry will be at the discretion of the centre. A minimum of a 'C' level pass at Higher Mathematics or equivalent, or successful completion of the HN Unit *Mathematics for Interactive Computing: Fundamental Techniques* is recommended.

Core Skills: There are opportunities to develop the Core Skills of Numeracy and Problem Solving in this Unit, although there is no automatic 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: Candidates must achieve all of the minimum evidence specified for each Outcome in order to pass the Unit.

Evidence is required that candidates have achieved all Outcomes.

General information for centres (cont)

Written and/or oral recorded, performance and product evidence is required which demonstrates that the candidate has achieved the requirements of all the Outcomes. Assessment/re-assessment should be carried out under supervised and should last approximately one hour.

It is possible to assess candidates either on an Outcome by Outcome basis or by a single holistic assessment combining all three Outcomes.

Higher National Unit specification: statement of standards

Unit title: Mathematics for Interactive Computing: Essential Techniques

Unit code: F20B 34

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 skills to problems involving matrices in three dimensions

Knowledge and/or Skills

- Matrix operations
- Matrix applications

Evidence Requirements

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

- Perform essential matrix operations to include at least TWO of the following:
  - Establish conformability
  - Addition
  - Subtraction
  - Multiplication
  - Inverse of a matrix (using either co-factor theorem OR using the elementary row operations method)

- Matrix applications: Carry out:
  - Solution of linear equations in three unknowns using the inverse matrix (using either the inverse matrix OR Gaussian elimination).
  - Combination of matrix transformations to include at least TWO from: rotation, reflection and dilatation

Assessment Guidelines

Evidence is required that the candidate can determine the inverse of at least one matrix. Problems that can enlist a number of the Evidence Requirements are encouraged.

If each Outcome is assessed individually, evidence for all the Knowledge and/or Skills for Outcome 1 will be provided by an assessment taken at a single assessment event lasting no more than one hour, carried out under closed-book conditions.

Alternately, the assessment of Outcome 1 can be combined with Outcomes 2 and 3 into a single end of Unit assessment. This assessment should last no more than two hours, carried out under closed-book conditions.

Candidates should be provided with appropriate formula sheets and the use of scientific calculators is permitted. Where re-assessment is required it should contain a different sample from the range of mandatory content.

Outcome 2

Use and apply skills to problems involving differential calculus

Knowledge and/or Skills

- Factorising polynomials
- Differentiate standard functions
- Applications of differentiation

Evidence Requirements

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

- Factorise a polynomial of degree greater than two

- Differentiate at least ONE of the following functions:
  - Polynomial,
  - Exponential
  - Natural logarithmic
  - Trigonometric

- Differentiate a function using the chain rule

- Applications of differentiation:
  - Determine rates of change
  - Sketch and annotate a polynomial (sketch must include x and y intercepts, stationary points and their natures)

Bullet points 2 and 3 must be assessed separately.

Assessment Guidelines

Factorise polynomials using the quadratic function, synthetic division and trinomial factorisation

Differentiate polynomials using standard functions $\{x^n, (ax + b)^n, x^n + x^m + C\}$, exponential and natural logarithmic functions $\{e^{(ax+b)}, \ln (ax + b)\}$ and trigonometric functions $\{\sin (ax + b), \cos (ax + b)\}$

Differentiate using the chain rule $\{{}^{dy}/_{dx} = {}^{dy}/_{du} \,.\, {}^{du}/_{dx}\}$ for any of the above functions

Determine rates of change and stationary points of polynomials only. Sketch and fully annotate polynomial curves.

If each Outcome is assessed individually, evidence for all the Knowledge and/or Skills for Outcome 2 will be provided by an assessment taken at a single assessment event lasting no more than one hour, carried out under closed-book conditions.

Alternately, the assessment of Outcome 2 can be combined with Outcomes 1 and 3 into a single end of Unit assessment. This assessment should last no more than two hours, carried out under closed-book conditions.

Candidates should be provided with appropriate formula sheets and the use of scientific calculators is permitted. Where re-assessment is required it should contain a different sample from the range of mandatory content.

Outcome 3

Use and apply skills to problems involving integral calculus

Knowledge and/or Skills

- Integrate standard functions
- Applications of integration

Evidence Requirements

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

- Indefinite integrals: integrate one of the following functions:
  - Exponential
  - Of the form $^{1}/_{(ax + b)}$

- Definite integrals: integrate one of the following functions given the limits:
  - Polynomials
  - Trigonometric

- Applications of integration:
  - Determine the area enclosed by a curve and the x-axis with unknown limits OR between two curves with unknown limits
  - Anti-differentiation: determine a function from an integral given initial conditions

Assessment Guidelines

Integrate indefinite polynomials using:

- standard functions: x^{n}, $(ax + b)^{n}$, $x^{n} + x^{m} + C$
- exponential and natural logarithmic functions $\{e^{(ax+b)}$, $^{1}/_{(ax + b)}$
- trigonometric functions sin (ax + b), cos (ax + b)

Find definite integrals of the above standard functions.

If each Outcome is assessed individually, evidence for all the Knowledge and/or Skills for Outcome 3 will be provided by an assessment taken at a single assessment event lasting no more than one hour, carried out under closed-book conditions.

Alternately, the assessment of Outcome 2 can be combined with Outcomes 1 and 2 into a single end of Unit assessment. This assessment should last no more than two hours, carried out under closed-book conditions.

Candidates should be provided with appropriate formula sheets and the use of scientific calculators is permitted. Where re-assessment is required it should contain a different sample from the range of mandatory content.

Administrative Information

Unit code: F20B 34

Unit title: Mathematics for Interactive Computing: Essential Techniques

Superclass category: RB

Original date of publication: December 2007

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: Mathematics for Interactive Computing: Essential Techniques

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 as a first level Mathematics Unit for the HNC Interactive Media and the HNC Computer Games Development awards but may be appropriate for other awards in the computing or engineering fields. The aim of the Unit is to enable candidates to apply mathematical methods to problems in computing. Where possible, most examples, questions and assessments should be contextualised. For example, problems could relate to the field of computer graphics. Transformations (Outcome 1) could be used to the movement of objects about a computer screen in three dimensions. The ability to find the velocity or angles of projectile motion (Outcome 2) could be examined in a two dimensional frame. The distance travelled by objects or the area and volumes of figures (Outcome 3) generated on a computer screen could be applied.

Outcome 1

The first Outcome should give an understanding of how matrices operate and how they can be applied in computing. Matrices used in three dimensions and their transformations with respect to computing could be emphasised. The ability to manipulate and apply matrices to varying mathematical models would be of use. Solving linear equations which depict three dimensional vectors or planes would be beneficial for future work pertaining to the physical environment and mechanics. Delivery of this Outcome includes optional methods for the determination of the inverse matrix and for solving linear equations. The method most appropriate to the candidate's ability should be used. It is not intended that every method be investigated.

Outcome 2

Differential calculus has broad application in any physical system. Having the skills to manipulate polynomials, and from them, being able to predict their form in two dimensions could assist in constructing curves onto the computer screen. From functions which may depict a line or plane on a screen, or a relationship between displacement and time, then the rate of change of these functions could be used to find gradients or velocities of objects on a screen. Projectile motion may require finding the angle at which they are shot or land. The ability to find stationary points and their natures would allow in finding whether a function has a maximum or minimum.

Outcome 3

Integral calculus can also be used in the physical system. The ability to manipulate a derivative to discover the original function could have applications within the context of computer graphics. Projectiles or functions that depict velocity versus time have areas under the curve which indicate the distances travelled by objects. Objects which are drawn upon a computer screen may require their areas or volumes to be calculated, therefore, integral calculus can be used.

Higher National Unit specification: support notes (cont)

Unit title: Mathematics for Interactive Computing: Essential Techniques

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 Higher National Specification: statement of standards section. These should be read carefully before assessing candidates. A formulae sheet/booklet could be given for each assessment.

For Outcome 2, the following could be used specifically to assess the candidates Knowledge and/or Skills:

- factorise polynomials using the quadratic function, synthetic division and trinomial factorisation
- differentiate polynomials using standard functions $\{x^n, (ax + b)^n, x^n + x^m + C\}$, exponential and natural logarithmic functions $\{e^{(ax+b)}$, ln (ax + b)$\}$ and trigonometric functions {sin (ax + b), cos (ax + b)}
- differentiate using the chain rule $\{{}^{dy}/_{dx} = {}^{dy}/_{du} \,.\, {}^{du}/_{dx}\}$ for any of the above functions
- determine rates of change and stationary points of polynomials only
- sketch and fully annotate polynomial curves.

For Outcome 3, the following could be used specifically to assess the candidates Knowledge and/or Skills:

- integrate indefinite polynomials using standard functions $\{x^n, (ax + b)^n, x^n + x^m + C\}$, exponential and natural logarithmic functions $\{e^{(ax+b)}, {}^{1}/_{(ax + b)}\}$ and trigonometric functions {sin (ax + b), cos (ax + b)}
- find definite integrals of the above standard functions
- determine functions from integrals given initial conditions
- find the area under a polynomial given limits and where limits are unknown
- find the area between intersecting polynomials where intersecting points are known or unknown

Delivery

The delivery should take the form of lecturer exposition with candidate materials consisting of notes and tutorials with 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 Higher National Unit specification: support notes section.

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

Outcome 1	Matrix operations and conformability	2 hours
	The Inverse Matrix	3 hours
	Solving Linear Equations	3 hours
	Transformations	2 hours
	Assess/Reassessment	2 hours

Higher National Unit specification: support notes (cont)

Unit title: Mathematics for Interactive Computing: Essential Techniques

Outcome 2	Factorising Polynomials	2 hours
	Differentiation of standard functions	2 hours
	Chain Rule	2 hours
	Rates of change	2 hours
	Stationary points & Curve sketching	3 hours
	Assess/Reassessment	2 hours
Outcome 3	Indefinite Integrals: standard functions	2 hours
	Anti-differentiation	2 hours
	Definite integrals	2 hours
	Area under the curve	3 hours
	Area between intersecting curves	3 hours
	Assess/Reassessment	2 hours
Holistic assessment, remediation and reassessment		6 hours

* where Outcomes are assessed on an individual basis

Opportunities for developing Core Skills

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

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).

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. Further advice can be found in the SQA document *Guidance on Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs* **(www.sqa.org.uk)**.

General information for candidates

Unit title: Mathematics for Interactive Computing: Essential Techniques

In this Unit you could learn about and use mathematical techniques that are applicable to computing. Where possible throughout the delivery of this 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 functions.

The Outcomes will be assessed under closed-book conditions and any relevant formulae given. 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.