-SQA- SCOTTISH QUALIFICATIONS AUTHORITY

NATIONAL CERTIFICATE MODULE: UNIT SPECIFICATION

GENERAL INFORMATION

-Module Number-   7181155   **-Session-** 1995-96

-Superclass-   RB

-Title-   **MATHEMATICS: CALCULUS A ($x^1/_2$)**

-DESCRIPTION-

GENERAL COMPETENCE FOR UNIT: Differentiating and integrating elementary algebraic functions and using calculus in applications.

OUTCOMES

1   use derivatives for elementary algebraic functions;
2   use standard integrals for elementary algebraic functions;
3   apply knowledge of calculus in a problem-solving context.

CREDIT VALUE: 0.5 NC Credit

ACCESS STATEMENT: Access to this unit is at the discretion of the centre. However, it would be beneficial if the candidate had competence in mathematics as evidenced by possession of National Certificate Module 7180401 Mathematics: Analysis/Algebra 1 or an equivalent level of experience.

NATIONAL CERTIFICATE MODULE: UNIT SPECIFICATION

STATEMENT OF STANDARDS

UNIT NUMBER: 7181155

UNIT TITLE: MATHEMATICS: CALCULUS A

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

OUTCOME

1   USE DERIVATIVES FOR ELEMENTARY ALGEBRAIC FUNCTIONS

PERFORMANCE CRITERIA

(a)   Differentiation of functions reducible to sums of powers of x is correct.

(b)   Calculation of both gradients and rates of change by differentiation is correct.

(c)   Calculation of both maxima and minima using differentiation is correct.

RANGE STATEMENT

The range for this outcome is fully expressed within the performance criteria.

EVIDENCE REQUIREMENTS

Calculations - oral and/or written evidence of the candidate's ability to use derivatives for elementary algebraic functions.

OUTCOME

2   USE STANDARD INTEGRALS FOR ELEMENTARY ALGEBRAIC FUNCTIONS

PERFORMANCE CRITERIA

(a)   Integration of functions reducible to sums of powers of x is correct.

(b)   Calculation of the area between two curves is correct.

RANGE STATEMENT

Integration: definite; indefinite.

EVIDENCE REQUIREMENTS

Calculations: oral and/or written evidence of the candidate's ability to use standard integrals for elementary algebraic functions.

OUTCOME

> **3**   APPLY KNOWLEDGE OF CALCULUS IN A PROBLEM-SOLVING CONTEXT

PERFORMANCE CRITERIA

> (a)   Identification of key factors of the problem is correct.
> (b)   Implementation of appropriate strategies is correct.
> (c)   Solution of the problem is satisfactory.
> (d)   Communication of the solution is clear and accurate.

RANGE STATEMENT

The range is fully expressed within the performance criteria.

EVIDENCE REQUIREMENTS

Assignment - evidence should show the candidate's ability to use calculus to solve a problem. The evidence should show the processes carried out during the problem solving, in addition to details of the solution.

ASSESSMENT RECORDS

In order to achieve this unit, candidates are required to present sufficient evidence that they have met all performance criteria for each outcome within the range specified. Details of these requirements are given for each outcome. The assessment instruments used should follow the general guidance offered by the SQA assessment model and an integrative approach to assessment is encouraged. (See references at the end of the support notes.)

Accurate records should be made of assessment instruments used showing how evidence is generated for each outcome, and giving marking schemes and/or checklists, etc. Records of candidates' achievements should be kept. These records will be available for external verification.

SPECIAL NEEDS

In certain cases, modified outcomes and range statements can be proposed for certification. See references at the end of the support notes.

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NATIONAL CERTIFICATE MODULE: UNIT SPECIFICATION

SUPPORT NOTES

UNIT NUMBER: 7181155

UNIT TITLE: MATHEMATICS: CALCULUS A

SUPPORT NOTES: This part of the unit specification is offered as guidance. None of the sections of the support notes is mandatory.

NOTIONAL DESIGN LENGTH: SQA allocates a notional design length to a unit on the basis of time estimated for achievement of the stated standards by a candidate whose starting point is as described in the access statement. The notional design length for this unit is 20 hours. The use of notional design length for programme design and timetabling is advisory only.

PURPOSE: This unit introduces candidates to calculus and should enable candidates to understand and apply the concepts of integration and differentiation of elementary algebraic functions.

The Appendix gives further guidance on mathematics modules in general and contains a grid showing the relationship between modules.

SQA publishes summaries of NC units for easy reference, publicity purposes, centre handbooks, etc. The summary statement for this unit is as follows:

This half module will enable you to differentiate and integrate elementary algebraic functions and use calculus in applications. A series of calculation exercises and an assignment will also be undertaken.

CONTENT/CONTEXT

1   Investigate relationships between functions and derivatives.

        Use rules of differentiation for elementary algebraic functions eg:

$$f(x) \,=\, 3x^2 - 5x + 2$$
$$f(x) \,=\, (2x - 1)(x + 4)$$
$$f(t) \,=\, \sqrt{t} + \frac{1}{t}$$
$$f(x) = \frac{(x^3 - 3)}{2x^2}$$

Calculation of gradients and rates of change using derivatives eg

gradient of $y = 3x^2$ at $x = 2$.

Instantaneous velocity and acceleration.

Rate of change of volumes and rate of change of temperature.

Curve sketching.

2   Investigate the calculation of area and of irregular shapes.

Integration as the inverse process of differentiation.

Use rules of integration for elementary algebraic functions eg

$$f(x) = 4x^3 - 6x^2 + 2$$
$$f(x) = (3x - 1)(2 - x)$$
$$f(x) = \frac{(1 + x)}{x^3}$$
$$f(t) = \sqrt{t} + \frac{1}{t^2}$$

Use rules of integration to calculate definite integrals eg

$$\int_1^4 (5x^3 - 3x^2 + 1)dx$$
$$\int_4^9 \left(\frac{x^2 - 1}{\sqrt{x}} \right)dx$$

Calculation of area between 2 curves eg $y = 2x$ and $y = x^2$

3   The problems could be used in the initial development of the concepts, techniques and skills encountered within the module, or they could involve the application and extension of these concepts, techniques and skills.

APPROACHES TO GENERATING EVIDENCE: The unit descriptor lists discrete outcomes, but the approaches adopted may change the order or integrate the outcomes as appropriate. Several approaches are possible depending on the availability of resources, experience of tutors/trainers and the type of candidate group. This may involve individualised learning, group work and class work. Multi-media approaches should be encouraged where possible: text, practical activities, simulations, computer programs, videos etc. Problem solving should be encouraged throughout the unit as part of the learning and teaching/ tutoring process, and as part of the assessment process. Likewise the investigation of mathematical ideas should be encouraged throughout the unit, Diagnostic and formative assessment should be used where appropriate. The summative assessment may form an integral part of the whole learning/teaching/ tutoring process or may consist of separate tests.

The candidate should be encouraged to keep a log book/workfile. This should form a complete record of the candidate's work throughout the unit. The workfile could contain the candidate's notes, class handouts, completed worksheets, exercises, assignments, projects, investigations, log of computer activities and a summary of the important details for later revision purposes.

The sensible use of appropriate technologies, (numeric scientific/graphics/ programmable calculators or computers etc) should be encouraged. Due account should be taken of estimation, rounding and errors introduced into calculations.

ASSESSMENT PROCEDURES Centres may use the instruments of assessment which are considered by tutors/trainers to be most appropriate. Examples of instruments of assessment which could be used are as follows:

Corresponding to outcomes:

1   Calculation Exercise

Topics may be assessed on the number of occasions indicated.

(a)	differentiation of algebraic functions	4
(b)	gradients	1
	rates of change	1
(c)	maximum	1
	minimum	1

One question may cover more than one topic.

Evidence may also show 3 correct responses for (a), and 2 correct responses for each of (b) and (c).

2   Calculation Exercise

(a)	Indefinite integrals	3
	Definite integrals	3
(b)	Area	1

One question may cover more than one topic.

Evidence may also show 5 correct responses for (a) and the correct response for (b).

3   Assignment

2 problems, expressed in a practical context, and testing the 4 processes in the performance criteria, which should demonstrate the candidate's ability to draw together the skills and techniques developed in the unit.

The 2 problems should take approximately 30 minutes in total to complete.

Evidence may also show satisfactory completion of all 4 processes in the performance criteria for at least one problem.

PROGRESSION: Refer to the Appendix and module grid following the support notes.

RECOGNITION: Many SQA NC units are recognised for entry/recruitment purposes. For up-to-date information see the SQA guide `Recognised Groupings of National Certificate Modules 1993-94'.

REFERENCES

1.   'Guide to Unit Writing'.
2.   SQA's National Standards for Assessment and Verification.
3.   For a fuller discussion on assessment issues, please refer to SQA's Guide to Assessment.
4.   Procedures for special needs statements are set out in SQA's guide `Students with Special Needs'.

APPENDIX

FRAMEWORK OF THE MATHEMATICS MODULES 94/95

The module grid summarises the complete structure of the mathematics modules and some of their relationships.

Progression through the grid is to the right.

When considering the suitability of a module, it is important to consider it in relation to others in the grid and not just in isolation.

The first module, Using Numbers in Everyday Situations, relates to the most elementary number concepts and skills.

Numeracy 1, 2, 3 and 4 are Core Skill modules. They can be used in a range of SQA programmes and awards and are currently embedded as a mandatory part of General Scottish Vocational Qualifications. A Core Skills Numeracy framework has been produced in conjunction with these modules.

The modules Using Basic Number Skills, Using Arithmetic Skills, Dealing with Basic Measurements, Dealing with Money, Using Measurement Skills Within Everyday Activities and Small Scale Planning, Estimating and Costing were developed for the BBC Basic Skills Numeracy project.

The modules Core Maths 2, 3 and 4 relate approximately to work done in Standard Grade Mathematics. These are appropriate as National Certificate modules because they allow for consolidation of mathematical skills and they provide candidates with a second opportunity to create a base from which they can develop their mathematical knowledge and skills.

The modules Business Numeracy, Construction Numeracy 1 and 2, Engineering Numeracy and Laboratory Numeracy have a vocational bias and cater for the mathematical needs of candidates on craft, operator, clerical or Skillseeker courses.

Craft Technology 1 and 2 are designed to consolidate the mathematical skills at craft level.

The remaining modules meet the needs of candidates requiring further mathematics in support of their other studies.

Modules Analysis/Algebra 1, Analysis/Algebra 2 and Calculus 1 relate approximately to work done in Higher Grade Mathematics, but alternative groupings are possible for candidates continuing or intending to continue, with college or university studies in, for example, business studies or engineering.

Specialist modules such as Business Statistics, Boolean Algebra, Numerical Methods, Operational Research and Spherical Trigonometry are available.