NUMERICAL METHODS, NM (4776) AS

Objectives

To provide students with an understanding that many mathematical problems cannot be solved analytically but require numerical methods.

To develop a repertoire of simple numerical methods and to give experience in using them.

To state or prove theoretical results about the accuracy of these numerical techniques and to demonstrate the control of error in practice.

To implement these numerical methods on computers and to develop an awareness of the difficulties which can arise when computers are used to do mathematics.

Assessment

Examination   (72 marks)
1 hour 30 minutes
The examination paper has two sections:

    Section A: five questions, each worth at most 8 marks.
        Section Total: 36 marks

    Section B: two questions, each worth about 18 marks.
        Section Total: 36 marks

Coursework   (18 marks)
There is one assignment.

Assumed Knowledge

Candidates are expected to know the content of *C1* and *C2*.

Calculators

In the MEI Structured Mathematics specification, no calculator is allowed in the examination for *C1*. For all other units, including this one, a graphical calculator is allowed.

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NUMERICAL METHODS, NM		
Specification	**Ref.**	**Competence Statements**

SOLUTION OF EQUATIONS		
Bisection method. False Position (linear interpolation). Secant method. Fixed point iteration. Newton-Raphson method.	NMe1	Understand the graphical interpretations of these methods.
	2	Know how to solve equations to any required degree of accuracy using these methods.
	3	Understand the relative computational merits and possible failure of the methods.
	4	Know that fixed point iteration generally has first order convergence, Newton-Raphson generally has second order convergence.

ERRORS		
Absolute and relative error.	NMv1	Know how to calculate errors in sums, differences, products and quotients.
Error propagation by arithmetical operations and by functions.	2	Know how to calculate the error in $f(x)$ when there is an error in x.
	3	Understand the effects on errors of changing the order of a sequence of operations.
Errors in the representation of numbers: rounding; chopping.	4	Understand that computers represent numbers to limited precision.
	5	Understand the consequences of subtracting nearly equal numbers.

NUMERICAL DIFFERENTIATION		
Forward difference method. Central difference method.	NMc1	Know how to estimate a derivative using the forward and central difference methods with a suitable value (or sequence of values) of h.
	2	Have an empirical and graphical appreciation of the greater accuracy of the central difference formula.

NUMERICAL INTEGRATION		
Mid-point rule. Trapezium rule. Simpson's rule.	NMc3	Be able to evaluate a given definite integral to any desired degree of accuracy using these methods.
The relationship between methods.	4	Know the order of errors of the mid-point and trapezium rules. Understand the development of Simpson's rule from the mid-point and the trapezium rules.

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APPROXIMATIONS TO FUNCTIONS		
Newton's forward difference interpolation method.	NMf1	Be able to use Newton's forward difference interpolation formula to reconstruct polynomials and to approximate functions.
Lagrange's form of the interpolating polynomial.	2	Be able to construct the interpolating polynomial of degree n given a set of $n+1$ data points.

Numerical Methods (NM) Coursework

Rationale

This module aims to develop skills in the areas of problem identification, use of numerical methods and control of error in practice. The coursework assignment should enable students to demonstrate a facility with technology and an awareness of the difficulties that can arise when computers are used to do mathematics.

Description

Students are expected to investigate a problem which is suitable for numerical solution, using one of the methods in the specification. (Problems which have analytical solutions are acceptable only if the analytical solution is too time-consuming, or too advanced, to be feasible.) Students should use a computer to develop a solution which is both efficient and accurate. In particular they must show how the desired accuracy has been achieved, either by means of sufficient iterations of the numerical process to ensure that the accuracy has been achieved, or by means of a theoretical analysis of errors.

Since it is assumed that the coursework will be implemented on a computer, the coursework will often arise naturally from the work done in the module.

The coursework counts for 20% of the total assessment for this unit.

Assessment

The task must be assessed on the coursework assessment sheets.