1. **Title of the module**

MAST5009 (MA5509) - Numerical Methods

1. **School or partner institution which will be responsible for management of the module**

School of Mathematics, Statistics and Actuarial Science

1. **The level of the module (Level 4, Level 5, Level 6 or Level 7)**

Level 5

1. **The number of credits and the ECTS value which the module represents**

15 credits (7.5 ECTS)

1. **Which term(s) the module is to be taught in (or other teaching pattern)**

Spring

1. **Prerequisite and co-requisite modules**

Pre-requisite: MAST4006 (Mathematical Methods 1)

Recommended: MAST4010 (Real Analysis 1)

1. **The programmes of study to which the module contributes**

BSc Mathematics, BSc Financial Mathematics, BA Mathematics, Accounting and Finance (including programmes with a Year in Industry), BSc Mathematics with a Foundation Year, MMath Mathematics

1. **The intended subject specific learning outcomes.  
   On successfully completing the module students will be able to:**

8.1 demonstrate knowledge and critical understanding of the well-established principles within a wide range of basic numerical methods, including iterative methods, interpolation, quadrature, finite difference approximation of initial-value problems for ordinary differential equations (ODEs);

8.2 demonstrate the capability to use a range of established techniques and a reasonable level of skill in calculation and manipulation of the material to solve problems in the following areas: root finding, interpolation, numerical quadrature, finite differences, initial-value problems for ODEs;

8.3 apply the concepts and principles in basic numerical approximation in well-defined contexts beyond those in which they were first studied, showing the ability to evaluate critically the appropriateness of different tools and techniques;

8.4 make appropriate use of MATLAB commands to implement numerical methods.

1. **The intended generic learning outcomes.  
   On successfully completing the module students will be able to:**

Demonstrate an increased ability to:

9.1 manage their own learning and make use of appropriate resources;

9.2 understand logical arguments, identifying the assumptions made and the conclusions drawn;

9.3 communicate straightforward arguments and conclusions reasonably accurately and clearly;

9.4 manage their time and use their organisational skills to plan and implement efficient and effective modes of working;

9.5 solve problems relating to qualitative and quantitative information;

9.6 make use of information technology skills such as online resources (Moodle), internet communication;

9.7 communicate technical material competently.

9.8 demonstrate an increased level of skill in numeracy and computation.

1. **A synopsis of the curriculum**

This module is an introduction to the methods, tools and ideas of numerical computation. In mathematics, one often encounters standard problems for which there are no easily obtainable explicit solutions, given by a closed formula. Examples might be the task of determining the value of a particular integral, finding the roots of a certain non-linear equation or approximating the solution of a given differential equation. Different methods are presented for solving such problems on a modern computer, together with their applicability and error analysis. A significant part of the module is devoted to programming these methods and running them in MATLAB.

Introduction: Importance of numerical methods; short description of flops, round-off error, conditioning

Solution of linear and non-linear equations: bisection, Newton-Raphson, fixed point iteration

Interpolation and polynomial approximation: Taylor polynomials, Lagrange interpolation, divided differences, splines

Numerical integration: Newton-Cotes rules, Gaussian rules

Numerical differentiation: finite differences

Introduction to initial value problems for ODEs: Euler methods, trapezoidal method, Runge-Kutta methods.

1. **Reading list (Indicative list, current at time of publication. Reading lists will be published annually)**

R. L. Burden, J. D. Faires, A. M. Burden. Numerical Analysis. 2016.

J. H. Matthews, K. D. Fink. Numerical methods using MATLAB. Pearson, 2004.

W. Gautschi. Numerical Analysis. Birkhäuser Boston, 2012 (ebook available from the Library)

1. **Learning and teaching methods**

Total contact hours: 42

Private study hours: 108

Total study hours: 150

1. **Assessment methods**
   1. Main assessment methods

Assessment 1 Exercises, requiring on average between 10 and 15 hours to complete 20%

Assessment 2 Exercises, requiring on average between 10 and 15 hours to complete 20%

Examination 2 Hours 60%

The coursework mark alone will not be sufficient to demonstrate the student’s level of achievement on the module.

13.2 Reassessment methods

Like-for-like

1. **Map of module learning outcomes (sections 8 & 9) to learning and teaching methods (section12) and methods of assessment (section 13)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Module learning outcome** | 8.1 | 8.2 | 8.3 | 8.4 | 9.1 | 9.2 | 9.3 | 9.4 | 9.5 | 9.6 | 9.7 | 9.8 |
| **Learning/ teaching method** |  |  |  |  |  |  |  |  |  |  |  |  |
| Private Study and Assessment | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |
| Lectures/Exercise classes | **X** | **X** | **X** |  |  | **X** | **X** |  | **X** |  | **X** | **X** |
| Terminal classes |  |  |  | **X** |  |  |  |  |  |  |  |  |
| Revision classes | **X** | **X** | **X** |  |  | **X** | **X** |  | **X** |  | **X** | **X** |
| **Assessment method** |  |  |  |  |  |  |  |  |  |  |  |  |
| Examination | **X** | **X** | **X** |  | **X** | **X** | **X** | **X** | **X** |  | **X** | **X** |
| Coursework | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |

1. **Inclusive module design**

The School recognises and has embedded the expectations of current equality legislation, by ensuring that the module is as accessible as possible by design. Additional alternative arrangements for students with Inclusive Learning Plans (ILPs)/declared disabilities will be made on an individual basis, in consultation with the relevant policies and support services.

The inclusive practices in the guidance (see Annex B Appendix A) have been considered in order to support all students in the following areas:

a) Accessible resources and curriculum

b) Learning, teaching and assessment methods

1. **Campus(es) or centre(s) where module will be delivered**

Canterbury

1. **Internationalisation**

Mathematics is an international language with techniques developed and refined by mathematicians across the globe. Mastery of the subject-specific learning outcomes, 8.1 to 8.4, will equip students to apply the theories and techniques of this module in a wide range of international contexts. The module team is drawn from the School of Mathematics, Statistics and Actuarial Science, which includes many members of staff with international experience of teaching and research collaboration.

In compiling the reading list, consideration has been given to the range of texts that are available internationally and a selection of texts has been identified to complement the delivery of the material.

Examples with an international dimension are included in the module where appropriate.

The support SMSAS provides to its students is also internationally attuned given our international student body.

**FACULTIES SUPPORT OFFICE USE ONLY**

**Revision record – all revisions must be recorded in the grid and full details of the change retained in the appropriate committee records.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Date approved | Major/minor revision | Start date of the delivery of revised version | Section revised | Impacts PLOs (Q6&7 cover sheet) |
| 11/04/2022 | Minor | September 2022 | 6 | No |
| July 2023 | Monor | September 2023 | 13 | No |