1. **Title of the module**

MAST6002 (MA691) - Linear and Nonlinear Waves

MAST7002 (MA791) - Linear and Nonlinear Waves

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 6 (MAST6002)

Level 7 (MAST7002)

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)**

Autumn or Spring

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

Level 6:

Pre-requisite: MAST5005 (Linear Partial Differential Equations); MAST5012 (Ordinary Differential Equations)

Co-requisite: None

Level 7:

Pre-requisite: Students are expected to have studied material equivalent to that covered in the modules above.

Co-requisite: None

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

For the level 6 module, BSc Mathematics, BSc Mathematics and Statistics, BSc Mathematics and Accounting & Finance (including programmes with a Year in Industry), BSc Mathematics with a Foundation Year, MMath Mathematics, MMathStat Mathematics and Statistics, Graduate Diploma in Mathematics, International MSc in Mathematics and its Applications, MSc in Mathematics and its Applications (including programmes with an Industrial Placement).

For the level 7 module, MMath Mathematics, MMathStat Mathematics and Statistics, International MSc in Mathematics and its Applications, MSc in Mathematics and its Applications (including programme with an Industrial Placement).

1. **The intended subject specific learning outcomes.  
   On successfully completing level 6 the module students will be able to:**

8.1 demonstrate knowledge and critical understanding of the well-established principles within linear and nonlinear partial differential equations (PDEs);

8.2 demonstrate the capability to deploy established approaches accurately to analyse and solve problems using a reasonable level of skill in calculation and manipulation of the material in the following areas: Fourier transforms for linear differential equations, shock waves, exact solutions of nonlinear PDEs;

8.3 apply the concepts and principles in PDEs 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 MAPLE.

**On successfully completing the level 7 module students will be able to:**

8.5 demonstrate systematic understanding of linear and nonlinear PDEs;

8.6 demonstrate the capability to solve complex problems using a very good level of skill in calculation and manipulation of the material in the following areas: Fourier transforms for linear differential equations, shock waves, exact solutions of nonlinear PDEs;

8.7 apply a range of concepts and principles in PDEs in loosely defined contexts, showing good judgment in the selection and application of tools and techniques;

8.8 make effective and well-considered use of MAPLE.

1. **The intended generic learning outcomes.  
   On successfully completing the level 6 module students will be able 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 competent use of information technology skills such as online resources (Moodle);

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

**On successfully completing the level 7 module students will be able to:**

9.8 work competently and independently, be aware of their own strengths and understand when help is needed;

9.9 demonstrate a high level of capability in developing and evaluating logical arguments;

9.10 communicate arguments confidently with the effective and accurate conveyance of conclusions;

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

9.12 solve problems relating to qualitative and quantitative information;

9.13 make effective use of information technology skills such as using online resources (Moodle);

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

1. **A synopsis of the curriculum**

Linear PDEs. Dispersion relations. Review of d’Alembert’s solutions of the wave equation. Review of Fourier transforms for solving linear diffusion equations.

Quasi-linear first-order PDEs. Total differential equations. Integral curves and integrability conditions. The method of characteristics.

Shock waves. Discontinuous solutions. Breaking time. Rankine-Hugoniot jump condition. Shock waves. Rarefaction waves. Applications of shock waves, including traffic flow.

General first-order nonlinear PDEs. Charpit's method, Monge Cone, the complete integral.

Nonlinear PDEs. Burgers' equation; the Cole-Hopf transformation and exact solutions. Travelling wave and scaling solutions of nonlinear PDEs. Applications of travelling wave and scaling solutions to reaction-diffusion equations. Exact solutions of nonlinear PDEs. Applications of nonlinear waves, including to ocean waves (e.g. rogue waves, tsunamis).

At level 7, topics will be studied and assessed to greater depth.

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

M.J. Ablowitz, Nonlinear Dispersive Waves, Cambridge (2011)

J. Bellingham and A.C. King, Wave Motion, Cambridge (2000)

P.G. Drazin and R.S. Johnson, Solitons: an Introduction, Cambridge (1989)

R. Knobel, An Introduction to the Mathematical Theory of Waves, A.M.S. (2000)

J.D Logan, An Introduction to Partial Differential Equations, Wiley (1994)

I.N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill (1957)

1. **Learning and teaching methods**

Total contact hours: 42

Private study hours: 108

Total study hours: 150

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

**Level 6**

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.

**Level 7**

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)**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Level 6 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 |
| **Learning/ teaching method** |  |  |  |  |  |  |  |  |  |  |  |
| Private Study | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |
| Lectures/exercise classes | **x** | **x** | **x** | **x** | **x** | **x** | **x** |  | **x** |  | **x** |
| Revision classes | **x** | **x** | **x** |  |  | **x** | **x** |  | **x** |  |  |
| **Assessment method** |  |  |  |  |  |  |  |  |  |  |  |
| Examination | **x** | **x** | **x** |  | **x** | **x** | **x** | **x** | **x** |  | **x** |
| Coursework | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Level 7 Module learning outcome** | 8.5 | 8.6 | 8.7 | 8.8 | 9.8 | 9.9 | 9.10 | 9.11 | 9.12 | 9.13 | 9.14 |
| **Learning/ teaching method** |  |  |  |  |  |  |  |  |  |  |  |
| Private Study | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |
| Lectures/exercise classes | **x** | **x** | **x** | **x** | **x** | **x** | **x** |  | **x** |  | **x** |
| Revision classes | **x** | **x** | **x** |  |  | **x** | **x** |  | **x** |  |  |
| **Assessment method** |  |  |  |  |  |  |  |  |  |  |  |
| Examination | **x** | **x** | **x** |  | **x** | **x** | **x** | **x** | **x** |  | **x** |
| Coursework | **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 8.8, 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) |
| July 2023 | Minor | September 2023 | 6, 13 | No |
|  |  |  |  |  |