1. **Title of the module**

MAST6003 (MA576) - Groups and representations

MAST7003 (MA776) - Groups and representations

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 (MAST6003), Level 7 (MAST7003)

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 term

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

Level 6:

Pre-requisite: MAST4004 (Linear Algebra), MAST5003 (Groups and Symmetries)

Co-requisite: None

Level 7:

Pre-requisite: Students are expected to have studied introductory courses on linear algebra and groups.

Co-requisite: None

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

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

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

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

8.1 demonstrate systematic understanding of key aspects of the theory and practice of groups (with examples including permutation groups and matrix groups, and the combinatorics of the symmetric group), of linear algebra, and of representations and characters of groups;

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: calculations within permutation groups and matrix groups; computations of the character tables of small groups; derivation of structural information about a group from its character table; formulation and proof of simple statements about groups and representations in precise abstract algebraic language; breaking up representations into smaller simpler objects;

8.3 apply key aspects of group theory and representation theory in well-defined contexts, showing judgement in the selection and application of tools and techniques.

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

8.4 demonstrate systematic understanding of the theory and practice of groups (with examples including permutation groups and matrix groups, and the combinatorics of the symmetric group), of linear algebra, and of representations and characters of groups;

8.5 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: calculations within permutation groups and matrix groups; computations of the character tables of small groups; derivation of structural information about a group from its character table; formulation and proof of simple statements about groups and representations in precise abstract algebraic language; breaking up representations into smaller simpler objects;

8.6 apply a range of concepts and principles in group theory and representation theory in loosely defined contexts, showing good judgment in the selection and application of tools and techniques.

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), internet communication;

9.7 communicate technical material competently;

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

9.9 demonstrate the acquisition of the study skills needed for continuing professional development.

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

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

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

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

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

9.14 solve problems relating to qualitative and quantitative information;

9.15 make effective use of information technology skills such as online resources (moodle) and internet communication;

9.16 communicate technical material effectively;

9.17 demonstrate an increased level of skill in numeracy and computation;

9.18 demonstrate the acquisition of the study skills needed for continuing professional development.

1. **A synopsis of the curriculum**

Groups arise naturally in many areas of mathematics as well as in chemistry and physics. A concrete way to approach groups is by representing them as a group of matrices, in which explicit computations are easy. This approach has been very fruitful in developing our understanding of groups over the last century. It also helps students to understand aspects of their mathematical education in a broader context, in particular concepts from earlier modules (From Geometry to Algebra/Groups and Symmetries and Linear Algebra) have been amalgamated into more general and powerful tools.

This module will provide a rigorous introduction to the main ideas and notions of groups and representations. It will also have a strong computational strand: a large part of the module will be devoted to explicit computations of representations and character tables (a table of complex numbers associated to any finite group).

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)**

We will not follow a single text, and the lecture notes will cover the entire syllabus. Nevertheless contain a large amount of the material.

G.D. James and M. Liebeck, Representations and characters of groups, CUP (2001)

J.P. Serre, Linear representations of finite groups, Springer GTM (1977)

J.L. Alperin and R.B. Bell, Groups and Representations, Springer GTM (1995)

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 | 9.1 | 9.2 | 9.3 | 9.4 | 9.5 | 9.6 | 9.7 | 9.8 | 9.9 |
| **Learning/ teaching method** |  |  |  |  |  |  |  |  |  |  |  |  |
| Private Study  | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |
| Lectures/exercise classes | **X** | **X** | **X** |  | **X** | **X** |  | **X** |  | **X** | **X** |  |
| Revision classes |  | **X** | **X** |  | **X** | **X** |  | **X** |  | **X** | **X** |  |
| **Assessment method** |  |  |  |  |  |  |  |  |  |  |  |  |
| Examination | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |  | **X** | **X** | **X** |
| Coursework | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Level 7 Module learning outcome** | 8.4 | 8.5 | 8.6 | 9.10 | 9.11 | 9.12 | 9.13 | 9.14 | 9.15 | 9.16 | 9.17 | 9.18 |
| **Learning/ teaching method** |  |  |  |  |  |  |  |  |  |  |  |  |
| Private Study  | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |
| Lectures/Exercise classes | **X** | **X** | **X** |  | **X** | **X** |  | **X** |  | **X** | **X** |  |
| Revision classes |  | **X** | **X** |  | **X** | **X** |  | **X** |  | **X** | **X** |  |
| **Assessment method** |  |  |  |  |  |  |  |  |  |  |  |  |
| Examination | **X** | **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 8.6, 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.

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 |
|  |  |  |  |  |