1. **Title of the module**

MAST6023 (MA6523) – Mathematics for Music

MAST9680 (MA968) - Mathematics for Music

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 (e.g. Level 4, Level 5, Level 6 or Level 7)**

MAST6023: Level 6; MAST9680: Level 7

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:**

For delivery to students completing Stage 1 before September 2016:

Pre-requisite: MA588 (Mathematical Techniques and Differential Equations)

Co-requisite: None

For delivery to students completing Stage 1 after September 2016:

Pre-requisite: MAST5005 (Linear Partial Differential Equations); MAST5013 (Real Analysis 2)

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 (including programme with a Year in Industry), BSc Mathematics with a Foundation Year, MMath Mathematics, Graduate Diploma in Mathematics, International MSc in Mathematics and its Applications.

For the level 7 module, MMath Mathematics, 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 the level 6 module students will be able to:**

1. demonstrate systematic understanding of key aspects of discrete Fourier analysis and the geometry of world rhythms;
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: Chladni patterns, digital signal processing, the mathematical construction of world rhythms;
3. apply key aspects of discrete Fourier analysis in well-defined contexts, showing judgement in the selection and application of tools and techniques;
4. show judgement in the selection and application of Maple and musical composition software as appropriate.

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

1. demonstrate systematic understanding of discrete Fourier analysis, the geometry of world rhythms and rhythmic tilings, and the geometry of harmony space;
2. 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: Chladni patterns, digital signal processing, the mathematical construction of world rhythms;
3. apply a range of concepts and principles in discrete Fourier analysis in loosely defined contexts, showing good judgment in the selection and application of tools and techniques;
4. make effective and well-considered use of Maple and musical composition software as appropriate.
5. **The intended generic learning outcomes.**

**On successfully completing the level 6 module students will be able to:**

1. manage their own learning and make use of appropriate resources;
2. understand logical arguments, identifying the assumptions made and the conclusions drawn;
3. communicate straightforward arguments and conclusions reasonably accurately and clearly;
4. manage their time and use their organisational skills to plan and implement efficient and effective modes of working;
5. solve problems relating to qualitative and quantitative information;
6. make competent use of information technology skills such online resources (Moodle), internet communication);
7. communicate technical material competently;
8. demonstrate an increased level of skill in numeracy and computation;
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:**

1. work competently and independently, be aware of their own strengths and understand when help is needed;
2. demonstrate a high level of capability in developing and evaluating logical arguments;
3. communicate arguments confidently with the effective and accurate conveyance of conclusions;
4. manage their time and use their organisational skills to plan and implement efficient and effective modes of working;
5. solve problems relating to qualitative and quantitative information;
6. make effective use of information technology skills such as online resources (Moodle), internet communication;
7. communicate technical material effectively;
8. demonstrate an increased level of skill in numeracy and computation;
9. demonstrate the acquisition of the study skills needed for continuing professional development.
10. **A synopsis of the curriculum**

This module is divided into two - one part is about the mathematics of sound, both acoustic and digital, and the other is about the structure of music as it affects musical composition.

The mathematics of sound includes the study of the linear wave equation, in particular, the mathematics of drums and Chladni patterns. We then move on the mathematics of digital sound - the discrete Fourier transform, the short time Fourier transform and the Gabor transform. Here we can answer questions like, does Louis Armstrong play the trumpet the same way he sings? And, how to slow down music without losing pitch?

The mathematics of rhythm and harmony are two very different fields of study. Many world music rhythms can be studied using the Euclidean algorithm. Finally, the harmonic progression of a musical composition can be modelled as a path in chord space. In this part of the module, we will look at how simple geometric ideas are used to model voice leading and harmony . For this last part, familiarity with the keyboard would be helpful but is not a prerequisite.

Indicative syllabus:

Part 1

1. The mathematics of the drum
2. Solutions of the linear wave equation in two dimensions in terms of Bessel functions
3. Standing waves and Chladni patterns
4. The mathematics of digital music processing
5. Aliasing, Sampling, Filtering
6. Discrete Fourier Transform, Convolutions
7. Gabor transform and applications
8. Spectrograms and applications

Part 2

1. The mathematics of rhythm: Euclidean rhythms in world music
2. The mathematics of harmony in tonal music: Introduction to a mathematical chord space, the Tonnetz.

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)**

D. Benson, Music: A Mathematical Offering Cambridge University Press, Cambridge, 2006.

G. Loy, Musimathics: The Mathematical Foundations of Music MIT Press, Vols 1 and 2, 2007.

N. Collins, Introduction to Computer Music, Wiley, 2010.

J.S. Walker and G.W. Don, Mathematics and Music: Composition, perception and performance, CRC Press, 2013

D. Tymoczko, A Geometry of Music, Oxford University Press, 2011.

G. Toussaint, The Geometry of Musical Rhythm, CRC Press, 2013.

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 module:**

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

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

Examination 2 hours 80%

The Exercise sheets will require the use of Maple.

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

**Level 7 module:**

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

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

Examination 3 hours 80%

The Exercise sheets will require the use of Maple.

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 | 9.8 | 9.9 |
| **Learning/ teaching method** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Private Study and Assessment | **X** | **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** | **X** |
| Coursework | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Level 7 Module learning outcome** | 8.5 | 8.6 | 8.7 | 8.8 | 9.10 | 9.11 | 9.12 | 9.13 | 9.14 | 9.15 | 9.16 | 9.17 | 9.18 |
| **Learning/ teaching method** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Private Study and Assessment | **X** | **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** | **X** |
| Coursework | **X** | **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
2. **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) |
|  |  |  |  |  |
|  |  |  |  |  |