Programme Specification: Undergraduate

For students starting in Academic Year 2018/2019

1. Course Summary

Names of programme(s) and award title(s)	BSc (Hons) Mathematics Combined Honours BSc (Hons) Mathematics Combined Honours with International Year (see Annex A for details) BSc (Hons) Mathematics Combined Honours with Work Placement Year (see Annex B for details)
Award type	Combined Honours *NB:* all students who study a science Principal subject are candidates for the degree of Bachelor of Science (with Honours) (BSc Hons) irrespective of their second Principal subject.
Mode of study	Full time
Framework of Higher Education Qualification (FHEQ) level of final award	Level 6
Duration	3 years 4 years with International Year or Work Placement Year
Location of study	Keele University – main campus
Accreditation (if applicable)	Not applicable
Regulator	Office for Students (OfS)
Tuition Fees	**UK/EU students:** Fee for 2018/19 is £9,250* **International students:** Fee for 2018/19 is £14,000** *or* £14,360** *(if combined with a laboratory-based Principal Subject)* The fee for the international year abroad is calculated at 15% of the standard year fee. The fee for the Work Placement Year is calculated at 20% of the standard year fee.
Additional Costs	Refer to section 18

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* These fees are regulated by Government. We reserve the right to increase fees in subsequent years of study in response to changes in government policy and/or changes to the law. If permitted by such change in policy or law, we may increase your fees by an inflationary amount or such other measure as required by government policy or the law. Please refer to the accompanying Student Terms & Conditions. Further information on fees can be found at http://www.keele.ac.uk/studentfunding/tuitionfees/

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2. What is a Combined Honours programme?

Combined Honours degrees are degrees that are taken in two different subjects, resulting in an *X and Y* degree title, for example *Mathematics and Economics.* If you are taking a Combined Honours programme, these will be the two subjects you applied for. These are referred to as your Principal Subjects.

In a Combined Honours degree you must take at least 180 credits in Mathematics, accrued over all three levels of study, with at least 60 credits at each level of study (Levels 4, 5 and 6). The remaining available credits can be filled with modules from the other Principal subject or possibly other disciplines entirely (subject to the specific Combined route).

As a Combined Honours student you can choose to study just one subject in your final year of study, taking a minimum of 90 credits in this subject. This will result in an *X with Y* degree title, for example *Mathematics with Astrophysics*.

Students choosing to specialise in their non-Mathematics Principal Subject might not necessarily be able to demonstrate that they have achieved all of the Programme's learning outcomes.

3. Overview of the Programme

Mathematics is a traditional discipline with a very long history. The Programme provides a broad coverage of two of the main discipline areas of pure and applied mathematics. Pure mathematics is concerned with mathematical proof (the derivation of results), logical argument and abstraction. Applied mathematics is concerned with methods and their application to modelling real-world problems. The Programme also provides a limited coverage of the other main discipline area of Statistics. Statistics concerns mathematical modelling of uncertainty and the analysis of data. The Programme has been designed to give maximum flexibility with many options in the final year, which allows students to pick options within their broad field of interest. In addition to subject-specific skills, the Programme also provides students with generic and employability skills.

4. Aims of the Programme

The broad aims of the programme are to:

- provide students with knowledge, understanding and skills relevant to discrete and continuous mathematics, including logical argument, rigorous mathematical proof, problem solving and mathematical modelling;
- further develop students' interest in mathematics within a caring and intellectually stimulating environment;
- cultivate students' appreciation of the beauty, elegance and practicality of mathematics;
- produce skilled and motivated graduates who are suitably prepared for further study or for employment within or outside their field;
- equip students with a range of generic and employability skills particularly in any area where precise, logical thought and problem-solving skills are valued;
- provide a foundation for life-long learning, study and enquiry in mathematics;
- foster the intellectual breadth of students who choose to study Mathematics as one of two Principal components of a Combined Honours degree.

5. What you will learn

The intended learning outcomes of the programme (what students should know, understand and be able to do at the end of the programme), can be described under the following headings:

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- Subject knowledge and understanding
- Subject specific skills
- Intellectual Skills
- Key or transferable skills (including employability skills)

Subject knowledge and understanding

Successful students will be able to demonstrate knowledge and understanding of:

U1   mathematical methods and techniques in calculus and algebra, ordinary differential equations, vector calculus and complex variable;

U2   the use of mathematical notation;

U3   the role of logical mathematical argument and deductive reasoning, including the formal process of mathematical proof, through the study of algebra, real analysis, complex variable and optional modules;

U4   using a structured mathematical or analytical approach to problem solving;

U5   the science of data investigation and data visualisation;

U6   probability-based models, hypothesis testing, statistical inference and likelihood;

U7   the application of statistics;

U8   the power of generalisation and abstraction through the study of abstract algebra and optional modules;

U9   mathematical modelling by dedicated modules and through the study of optional modules in dynamics, fluid mechanics, waves and mathematical biology;

U10   mathematical word processing packages and the symbolic manipulation package Mathematica;

U11   the use of a specialist statistical computing package in optional modules;

U12   more specialised areas of mathematics and statistics in optional modules at Level 6.

Subject specific skills

Successful students will be able to:

S1   demonstrate knowledge of key mathematical and statistical concepts, both explicitly and by applying them to the solution of problems;

S2   comprehend problems, abstract their essentials and formulate them in symbolic form so as to facilitate their analysis and solution, and understand how mathematical and statistical processes may be applied to them;

S3   select and apply appropriate mathematical and statistical techniques;

S4   use models to analyse an underlying problem and to interpret the results of this analysis;

S5   understand the importance of assumptions made in mathematical and statistical models, be aware of when and where they are used and possible consequences of their violation;

S6   construct and develop logical mathematical arguments with clear identification of assumptions and conclusions;

S7   reason critically, carefully and logically and derive (prove) mathematical results;

S8   demonstrate facility with mathematical abstraction;

S9   demonstrate skills relating particularly to the design and conduct of experimental and observational studies and the analysis of data resulting from them;

S10   formulate and test hypotheses;

S11   use an advanced symbolic manipulation package such as Mathematica;

S12   use an advanced statistical package in optional modules;

S13   use mathematics typesetting software such as *LaTeX* or *Word*.

Intellectual skills

Successful students will be able to:

I1   analyse and solve problems;

I2   make reasoned decisions;

I3   think carefully and logically;

I4   persist with a problem until its successful conclusion;

I5   make critical interpretations of data and text;

I6   abstract and synthesise information;

I7   develop a reasoned argument;

I8   take responsibility for their own learning and reflect upon that learning.

Key or transferable skills (including employability skills)

Successful students will be able to:

E1   develop and sustain effective approaches to learning and study, including time management, organisational skills, flexibility, creativity and intellectual integrity;

E2   acquire, analyse, synthesise, summarise and present information and ideas from a range of sources;

E3   be adaptable, in particular display a readiness to address new problems from new areas;

E4   work effectively with information technology;

E5   communicate effectively and coherently by written and spoken means using appropriate techniques;

E6   transfer knowledge from one context to another, and to approach problems analytically and to assess them logically;

E7   work comfortably with numerate concepts and arguments in all stages of work;

E8   work independently or with others to achieve an objective;

E9   motivate themselves and sustain that motivation over an extended period of time.

Keele Graduate attributes

Engagement with this programme will enable you to develop your intellectual, personal and professional capabilities. At Keele, we call these our ten Graduate Attributes and they include independent thinking, synthesizing information, creative problem solving, communicating clearly, and appreciating the social, environmental and global implications of your studies and activities. Our educational programme and learning environment is designed to help you to become a well-rounded graduate who is capable of making a positive and valued contribution in a complex and rapidly changing world, whichever spheres of life you engage in after your studies are completed.

Further information about the Keele Graduate Attributes can be found here: http://www.keele.ac.uk/journey/

6. How is the Programme taught?

Learning and teaching methods used on the programme vary according to the subject matter and level of the module. They include the following:

- **Traditional lectures** where the lecturer provides students with detailed notes, very often backed up by pre-prepared notes, in electronic or printed form, together with references to text books, as is the norm in the discipline

- **Tutorial Classes** are more informal than the lectures and provide the class tutor with the opportunity to revise and enforce core ideas and to provide students with more worked examples. It is also often the opportunity for students to try problems themselves and to discuss solutions with their peers, under the supervision of the tutor, who provides immediate feedback

- **Practical sessions** in the computer laboratories, in which students use the PCs interactively and are provided with feedback by the computer and the tutor

- **Independent study** based on processing lecture notes and reading text books, together with attempting regular coursework assignments

- **Web-based learning** using the University's virtual learning environment (KLE). The KLE is used to give students easy access to a wide range of resources, and as a platform for online discussions

- For those students who take the **project module** in their final year, the opportunity to undertake a piece of independent study supervised and supported by a member of staff

Apart from these formal activities, students are also provided with regular opportunities to talk through particular areas of difficulty, and any special learning needs they may have, with their Personal Tutors or module lecturers on a one-to-one basis.

These learning and teaching methods enable students to achieve the learning outcomes of the programme in a variety of ways. For example:

- Lectures and independent study allow students to gain knowledge and understanding of the three broad areas of mathematics

- Tutorial Classes provide opportunities for students to ask questions about, and suggest answers to mathematical problems, and to present their own ideas to members of staff and other students using an

appropriate medium of communication

- Independent study, in particular, the regular coursework assignments, encourages students to reflect on their own learning and take responsibility for its development by addressing areas of difficulty, perhaps by discussing them with their fellow students or by getting additional help from a member of staff

- Undertaking a project with the support of an experienced researcher allows students to formulate relevant research questions and devise a feasible strategy to answer them.

7. Teaching Staff

The Mathematics academic staff comprises of a number of Professors, Senior Lecturers, Lecturers and Teaching Fellows. Most members of staff are active in research. A number of members of the Mathematics Division hold teaching qualifications. Currently, several staff members are Fellows of the Higher Education Academy and one member of the Mathematics Division holds Senior Fellowship.

The University will attempt to minimise changes to our core teaching teams, however, delivery of the programme depends on having a sufficient number of staff with the relevant expertise to ensure that the programme is taught to the appropriate academic standard.

Staff turnover, for example where key members of staff leave, fall ill or go on research leave, may result in changes to the programme's content. The University will endeavour to ensure that any impact on students is limited if such changes occur.

8. What is the Structure of the Programme?

The academic year runs from September to June and is divided into two semesters. The number of weeks of teaching will vary from course to course, but you can generally expect to attend scheduled teaching sessions between the end of September and mid-December, and from mid-January to the end of May.

Our degree courses are organised into modules. Each module is usually a self-contained unit of study and each is usually assessed separately with the award of credits on the basis of 1 credit = 10 hours of student effort. An outline of the structure of the programme is provided in the tables below.

There are three types of module delivered as part of this programme. They are:

- Compulsory modules – a module that you are required to study on this course;
- Optional modules – these allow you some limited choice of what to study from a list of modules;
- Elective modules – a free choice of modules that count towards the overall credit requirement but not the number of subject-related credits.

A summary of the total credit requirements per year is as follows, with a minimum of 90 subject credits (compulsory plus optional) required for each year across both of your Principal Subjects. Combined Honours Mathematics students must study 60 Mathematics credits in each academic year. This document has information about *Mathematics* modules only; please also see the document for your other subject.

Year	Compulsory	Optional		Electives	
		Min	Max	Min	Max
1	60	0	0	0	0
2	15	45	45	0	0
3*	0	60	60	0	0

* in year 3 there is the option to choose to specialise in one of your subjects, taking a minimum of 90 credits in this subject rather than taking modules from both subjects

Module lists

Year 1 (Level 4)

Compulsory modules	Credits	Optional modules	Credits
Algebra	30	None	
Calculus	30		

Year 2 (Level 5)

Compulsory modules	Credits	Optional modules	Credits
Differential Equations	15	Probability	15
		Computational Mathematics	15
		Complex Variable I and Vector Calculus	15
		Dynamics	15
		Abstract Algebra	15
		Linear Statistical Models	15
		Introduction to Mathematics Education	15
		Optional Modules: in each semester students take two 15-credit modules. The choice will depend on any timetabling restrictions and will be subject to the student having met the necessary prerequisites.	

Students choosing the international year take the 120 credit compulsory module `MAT-20030 International Study Module'. This is a Level 5 module.

Students choosing the placement year take the non-credit bearing compulsory module `MAT-30035 Work Placement Year'. This is a Level 6 module.

Year 3 (Level 6)

Optional modules	Credits	Optional modules	Credits
Nonlinear Differential Equations	15	Waves	15
Partial Differential Equations	15	Medical Statistics	15
Professional Mathematics	15	Mathematical Biology	15
Graph Theory	15	Number Theory and Cryptography	15
Project	15	Introduction to Mathematics Teaching	15
Project (30 credits)	30	Complex Variable II	15
Optional Modules: students normally choose two 15-credit modules in each semester. The choice will depend on any timetabling restrictions and will be subject to the student having met the necessary prerequisites. Some modules may not be available every year.			

For further information on the content of modules currently offered, including the list of elective modules, please visit: www.keele.ac.uk/recordsandexams/az

Learning Outcomes

The table below sets out what students learn in each year of the Programme, the modules in which that learning takes place, and the main ways in which students are assessed on their learning. In Year 1 (Level 4) and Year 2 (Level 5) these learning outcomes are achieved in the compulsory modules which all students are required to take. Some of these outcomes may also be achieved or reinforced in elective modules together with other outcomes not stated here. In Year 3 (Level 6) the stated outcomes are achieved by taking any of the modules offered in each semester.

Subject Knowledge and Understanding		
Learning Outcome *Successful students will be able to demonstrate knowledge & understanding of:*	**Module in which this is delivered**	**Principal forms of assessment (of the Level Outcome) used**
U1. mathematical methods and techniques in calculus and algebra, ordinary differential equations, vector calculus and complex variable	Calculus Algebra Differential Equations Complex Variable I and Vector Calculus	Coursework, Examples Class participation, class test and examination
U2. the use of mathematical notation	All modules	Coursework, Example Class participation, class test, short report, group project, examination, and project presentation and dissertation
U3. the role of logical mathematical argument and deductive reasoning, including the formal process of mathematical proof, through the study of algebra, real analysis, complex variable and optional modules	Algebra Abstract Algebra Complex Variable I and Vector Calculus Level 6 optional core modules	Coursework, Example Class participation, class test, examination and project presentation and dissertation
U4. using a structured mathematical or analytical approach to problem solving	All modules	Coursework, Example Class participation, class test, short report, group project, examination, and project presentation and dissertation
U5. the science of data investigation and data visualisation	Probability Medical Statistics Level 6 project	Coursework, class test, short report and examination Project presentation and dissertation
U6. probability-based models, hypothesis testing, statistical inference and likelihood	Probability Financial Mathematics Medical Statistics Level 6 project	Coursework, class test and examination Project presentation and dissertation
U7. the application of statistics	Medical Statistics Financial Mathematics Level 6 project	Coursework, class test, short report and examination Project presentation and dissertation
U8. the power of generalisation and abstraction through the study of abstract algebra and optional modules	Abstract Algebra Graph Theory Number Theory and Cryptography Linear Algebra	Coursework, class test, group project, short report and examination Project presentation and dissertation

	Level 6 project	
U9. mathematical modelling by dedicated modules and through the study of optional modules in dynamics, fluid mechanics, waves and mathematical biology	Probability Financial Mathematics Dynamics Fluid Mechanics Waves Mathematical Biology Professional Mathematics Level 6 project	Coursework, Example Class participation, class test, short report, group project, examination, and project presentation and dissertation
U10. mathematical word processing packages and the symbolic manipulation package *Mathematica*	Differential Equations Computational Mathematics Level 6 Project	Coursework and short report Project dissertation
U11. the use of a specialist statistical computing package in optional modules	Financial Mathematics Medical Statistics Level 6 project	Coursework, class test, short report, project and examination Project presentation and dissertation
U12. more specialised areas of mathematics and statistics in optional modules at Level 6	All Level 6 modules	Coursework, class test, examination, and project presentation and dissertation

Subject Specific Skills		
Learning Outcome *Successful students will be able to:*	**Module in which this is delivered**	**Principal forms of assessment (of the Level Outcome) used**
S1. demonstrate knowledge of key mathematical and statistical concepts, both explicitly and by applying them to the solution of problems	All modules	Coursework, Examples Class participation, class test, short report, group project, examination, and project presentation and dissertation
S2. comprehend problems, abstract their essentials and formulate them in symbolic form so as to facilitate their analysis and solution, and understand how mathematical and statistical processes may be applied to them	Algebra Differential Equations Probability Dynamics Nonlinear Differential Equations Partial Differential Equations Fluid Mechanics Waves Medical Statistics Financial Mathematics Mathematical Biology	Coursework, Examples Class participation, class test, short report, poster, group project and examination Project presentation and dissertation

	Professional Mathematics Level 6 project	
S3. select and apply appropriate mathematical and statistical techniques	All modules	Coursework, Examples Class participation, class test, short report, group project, examination, and project presentation and dissertation
S4. use models to analyse an underlying problem and to interpret the results of this analysis	Differential Equations Dynamics Fluid Mechanics Waves Medical Statistics Financial Mathematics Mathematical Biology Professional Mathematics Level 6 Project	Coursework, class test, short report, poster, group project and examination Project presentation and dissertation
S5. understand the importance of assumptions made in mathematical and statistical models, be aware of when and where they are used and possible consequences of their violation	Differential Equations Dynamics Fluid Mechanics Waves Medical Statistics Financial Mathematics Mathematical Biology Professional Mathematics Level 6 Project	Coursework, class test, short report, poster, group project and examination Project presentation and dissertation
S6. construct and develop logical mathematical arguments with clear identification of assumptions and conclusions	All modules	Coursework, Examples Class participation, class test, short report, group project, examination, and project presentation and dissertation
S7. reason critically, carefully and logically and derive (prove) mathematical results	Calculus Algebra Abstract Algebra Complex Variable I and Vector Calculus Graph Theory Number Theory and Cryptography Linear Algebra Level 6 project	Coursework, Examples Class participation, class test, short report, group project and examination Project presentation and dissertation
S8. demonstrate facility with	Abstract Algebra	Coursework, class test, group project, short report, examination,

mathematical abstraction	Graph Theory Number Theory and Cryptography Linear Algebra	and project presentation and dissertation
S9. demonstrate skills relating particularly to the design and conduct of experimental and observational studies and the analysis of data resulting from them	Medical Statistics Professional Mathematics Financial Mathematics Level 6 project	Coursework, Examples Class participation, poster, group project short report and examination Project presentation and dissertation
S10. formulate and test hypotheses	Algebra Probability Fluid Mechanics Waves Medical Statistics Professional Mathematics Mathematical Biology Level 6 project	Coursework, Examples Class participation, class test, short report, poster, group project and examination Project presentation and dissertation
S11. use an advanced symbolic manipulation package such as *Mathematica*	Differential Equations Computational Mathematics Level 6 project	Coursework and short report Project dissertation
S12. use an advanced statistical package in optional modules	Medical Statistics Financial Mathematics Level 6 project	Coursework, class test, short report and examination Project presentation and dissertation
S13. use mathematics typesetting software such as *LaTeX* or *Word*	Professional Mathematics Mathematical Biology Level 6 project	Coursework and short report Project presentation and dissertation

Intellectual Skills		
Learning Outcome *Successful students will be able to:*	**Module in which this is delivered**	**Principal forms of assessment (of the Level Outcome) used**
I1. analyse and solve problems	All modules	Coursework, Examples Class participation, class test, short report, group project, examination and project dissertation
I2. make reasoned decisions	All modules	Coursework, Examples Class participation, class test, short report, group project, examination and project dissertation
I3. think carefully and logically	All modules	Coursework, Examples Class participation, class test, short

		report, group project, examination and project dissertation
I4. persist with a problem until its successful conclusion	All modules	Coursework, Examples Class participation, class test, short report, group project, examination and project dissertation
I5. make critical interpretations of data and text	Probability Dynamics Professional Mathematics Level 6 core option modules Level 6 project	Coursework, Examples Class participation, class test, poster, short report, group project and examination Project presentation and dissertation
I6. abstract and synthesise information	All modules	Coursework, Examples Class participation, class test, short report, group project, examination and project dissertation
I7. develop a reasoned argument	All modules, in particular: Professional Mathematics Level 6 project	Coursework, class test, examination, short report, group project and project dissertation
I8. take responsibility for their own learning and reflect upon that learning	Professional Mathematics Level 6 project	Short report, poster, group project and project presentation and dissertation Personal development planning

Key or Transferable Skills (graduate attributes)		
Learning Outcome *Successful students will have the opportunity to develop:*	**Module in which this is delivered**	**Principal forms of assessment (of the Level Outcome) used**
E1. develop and sustain effective approaches to learning and study, including time management, organisational skills, flexibility, creativity and intellectual integrity	All modules	Coursework, Examples Class participation, class test, short report, group project, examination, and project presentation and dissertation
E2. acquire, analyse, synthesise, summarise and present information and ideas from a range of sources	All modules, in particular the Level 6 project	Coursework, short report, group project and project presentation and dissertation
E3. be adaptable, in particular display a readiness to address new problems from new areas	Level 6 modules, particularly the Level 6 project	Coursework, class test, examination, and project presentation and dissertation
E4. work effectively with information technology	All modules	Coursework, including on-line assessment, short report, group project and project presentation and dissertation
E5. communicate effectively and coherently by written and spoken	All modules	Coursework, Examples Class participation, class test, group

means using appropriate techniques		project, examination, short report, and project presentation and dissertation
E6. transfer knowledge from one context to another, and to approach problems analytically and to assess them logically	All modules	Coursework, class test, group project, examination, short report and project dissertation
E7. work comfortably with numerate concepts and arguments in all stages of work	All modules	Coursework, Examples Class participation, class test, group project, short report, examination, and project presentation and dissertation
E8. work independently or with others to achieve an objective	All modules	Coursework, Examples Class participation, class test, group project, short report, examination, and project presentation and dissertation
E9. motivate themselves and sustain that motivation over an extended period of time	All modules, in particular the Level 6 project	Coursework, group project, short report, and project presentation and dissertation

9. Final and intermediate awards

Credits required for each level of academic award are as follows:

Honours Degree	360 credits	You will require at least 120 credits at levels 4, 5 and 6. **Combined Honours:** A minimum of 180 credits in Mathematics (270 credits in total), with at least 60 credits at each level of study (Levels 4, 5 and 6). Your degree title will be X *and* Y (e.g. 'Mathematics and Economics'). If you choose to study Mathematics as your one Principal subject in your final year of study a minimum of 105 credits in Mathematics is required. Your degree title will be X *with* Y (e.g. 'Mathematics with Astrophysics').
Diploma in Higher Education	240 credits	You will require at least 120 credits at level 4 or higher and at least 120 credits at level 5 or higher
Certificate in Higher Education	120 credits	You will require at least 120 credits at level 4 or higher

Mathematics with International Year: in addition to the above students must pass a module covering the international year in order to graduate with a named degree in Mathematics with international year. Students who do not complete, or fail the international year, will be transferred to the three-year Mathematics programme.

Mathematics with Work Placement Year: in addition to the above students must pass MAT-30035, the non-credit bearing module covering the work placement year, in order to graduate with the 'with work placement year' version of the Honours degree. Students who do not complete or fail the work placement year will be transferred to the three-year mathematics programme. Failure of the work placement year will be recorded on a student's final transcript.

10. How is the Programme assessed?

The wide variety of assessment methods used within Mathematics at Keele reflects the broad range of knowledge and skills that are developed as you progress through the degree programme. Teaching staff pay particular attention to specifying clear assessment criteria and providing timely, regular and constructive feedback that helps to clarify things you did not understand and helps you to improve your performance. The following list is representative of the variety of assessment methods used within Mathematics:

- **Unseen examinations:** test a student's knowledge and understanding of mathematics. They are the usual, primary mode of assessment in mathematics programmes across the HE sector. Such examinations are of two hours in length and all questions are compulsory. Virtually all taught modules in Levels 4 to 6 have unseen examinations as part of the assessment profile.

- **Class tests:** these are taken during the course of a module, usually in a lecture slot. They are intended to assess a student's current understanding and subject knowledge in that module in a structured and focused manner. Virtually all taught modules in Levels 4 to 6 have class tests as part of the assessment profile.

- **Coursework:** normally consists of regular short assignments designed to assess, in more depth than class tests, a student's knowledge and understanding of the course material. Some of these assignments may be computer-based and some may take the form of short reports.

- **Short reports:** for which students are required to write up their own account of small group studies and discussions on particular topics.

- **Project Reports:** are formal summaries of the work done by a student undertaking a project. Where the project is the review of an area of mathematics the report tests the student's ability to evaluate the material and identify and summarise the key points. Statistics projects often involve the analysis of real-world data and the report will test the student's ability to make critical judgements concerning the appropriateness of different strategies for the collection and analysis of such data. For projects involving mathematical modelling the report tests the student's ability to construct appropriate models, make realistic simplifying assumptions, and use the model effectively to analyse the problem.

- **Video presentations:** where students produce an informative video presentation suitable for a general audience which explains their project, its purpose and the outcomes. These videos are presented to the class and can be live, animated, or a combination of both.

- **Oral presentations:** assess a student's ability to communicate their knowledge and understanding, both visually and orally, to both general and academic audiences.

Marks are awarded for summative assessments designed to assess your achievement of learning outcomes. You will also be assessed formatively to enable you to monitor your own progress and to assist staff in identifying and addressing any specific learning needs. Feedback, including guidance on how you can improve the quality of your work, is also provided on all summative assessments within three working weeks of submission, unless there are compelling circumstances that make this impossible, and more informally in the course of tutorial and seminar discussions.

11. Contact Time and Expected Workload

This contact time measure is intended to provide you with an indication of the type of activity you are likely to undertake during this programme. The data is compiled based on module choices and learning patterns of students on similar programmes in previous years. Every effort is made to ensure this data is a realistic representation of what you are likely to experience, but changes to programmes, teaching methods and assessment methods mean this data is representative and not specific.

Undergraduate courses at Keele contain an element of module choice; therefore, individual students will experience a different mix of contact time and assessment types dependent upon their own individual choice of

modules. The figures below are an example of activities that a student may expect on your chosen course by year/stage of study. Contact time includes scheduled activities such as: lecture, seminar, tutorial, project supervision, demonstration, practical classes and labs, supervised time in labs/workshop, fieldwork and external visits. The figures are based on 1,200 hours of student effort each year for full-time students.

Activity	Year 1 (Level 4)	Year 2 (Level 5)	Year 3 (Level 6)
Scheduled learning and teaching activities	31%	30%	24%
Guided independent Study	69%	70%	76%
Placements	0%	0%	0%

12. Accreditation

This programme does not have accreditation from an external body.

13. Regulations

The University Regulations form the framework for learning, teaching and assessment and other aspects of the student experience. Further information about the University Regulations can be found at: http://www.keele.ac.uk/student-agreement/

A student who has completed a semester abroad will not normally be eligible to transfer onto the International Year option.

Course Regulations

i. **Transfer onto the Single Honours BSc Mathematics Programme**
   a) Regulation 1A, paragraph 6.2 states the times when a course change is permitted.
   b) Combined Honours BSc Mathematics students will normally be permitted to transfer onto the Single Honours BSc Mathematics programme provided they do so within three weeks of the commencement of a semester in Level 4, subject to having met any relevant progression criteria. Transfer to Single Honours BSc Mathematics will not normally be permitted after the second week of the autumn semester in Level 5. Transfer onto the Single Honours BSc Mathematics programme must be approved by the Programme Director.

ii. **Transfer onto the MMath Programme**
   a) Regulation 1F, paragraph 2.1 states the rules governing admission onto an Integrated Masters programme. This regulation will apply to the MMath Mathematics Programme with the following exceptions to the progression requirements in section 10.1:
      i. In section 10.1, disregard 10.1.(b);
      ii. In section 10.2 replace 'Lower Second Class' with 'Upper Second Class'.

   b) Combined Honours BSc Mathematics students will normally be permitted to transfer onto the four-year MMath Programme provided they do so within two weeks of the commencement of Level 5, subject to having met any relevant progression criteria. Transfer onto the MMath programme must be approved by the Programme Director.

iii. **Degree Award**
   a) The algorithm for the award of a given degree classification can be found at the following web address:
      http://www.keele.ac.uk/paa/academicadministration/degreeclassification/dualhonourssinglehonoursbachelordegrees/dualhonourssinglehonoursbachelordegreesregulation1afromseptember2013/
   b) The rules governing module condonement are the subject of University Regulation and can also be found at the above web address.

c) In addition to module condonement, Mathematics also applies module compensation at Levels 5 and 6. This allows for, in exceptional circumstance, the granting by the Mathematics Examination Board of full credits for a module in which the student has scored less than 29%.

d) The maximum amount of condonement and compensation that can be applied can be found at the following web address:
https://www.keele.ac.uk/qa/degreeclassification/dualhonourssinglehonoursbachelordegrees/dualhonourssinglehonoursbachelordegreesregulation1afromseptember2013/modulecompensation/
Compensation is entirely at the discretion of the Mathematics Exam Board. At Level 5, normally the Mathematics Exam Board will not compensate 15 credits where another Level 5 15 credit module is failed between 30 and 38.

14. What are the typical admission requirements for the programme?

Subject	A-level	Subjects not included	International Baccalaureate	BTEC	Access to Higher Education Diploma	GCSE requirements
Mathematics (Combined Honours)	BBC Maths at grade B or above	None	30 points to include Higher Level Mathematics at 5 or above	DDM You must have taken sufficient Mathematics units, please contact us for advice.	Obtain Access to Higher Education Diploma with 30 Level 3 credits at Distinction. You must also have taken sufficient Mathematics credits, please contact us for advice.	Maths @ C (or 4) English Language @ C (or 4)

Applicants who are not currently undertaking any formal study or who have been out of formal education for more than 3 years and are not qualified to A-level or BTEC standard may be offered entry to the University's Foundation Year Programme.

Applicants for whom English is not a first language must provide evidence of a recognised qualification in English language. The minimum score for entry to the Programme is Academic IELTS 6.0 or equivalent.

Please note: All non-native English speaking students are required to undertake a diagnostic English language assessment on arrival at Keele, to determine whether English language support may help them succeed with their studies. An English language module may be compulsory for some students during their first year at Keele.

Accreditation of Prior Learning (APL) is considered on a case-by-case basis and those interested should contact the Programme Director. The University's guidelines on this can be found here:
http://www.keele.ac.uk/qa/accreditationofpriorlearning/

15. How are students supported on the programme?

Support for student learning on the Programme is provided in the following ways:

• Module lecturers and Examples Class tutors are responsible for providing support for learning on the modules. They also give individual feedback on coursework assignments and more general feedback on examinations. The Mathematics Division has an Open Door policy so that lecturers and tutors are happy to see and advise students at any reasonable time.

• The Mathematics Learning and Technology Officer provides help and advice to students concerning the use of the computers.

• Every student is allocated to a Personal Tutor who is responsible for reviewing and advising on students' academic progress in Mathematics and on their other Principal Programme. There is also a Dual Honours Tutor who provides advice and support in Mathematics in particular.

- Personal Tutors also act as a first point of contact for students on non-academic issues which may affect their learning and can refer students on to a range of specialist health, welfare and financial services co-ordinated by the University's Student Services.

16. Learning Resources

Mathematics is taught, primarily, in lecture theatres equipped with whiteboards and screens for use with either visualisers or PC tablets. The majority of modules provide partial or full lecture notes in paper or electronic form (or both). There is a computer laboratory within Mathematics and, in addition, as part of the School of Computing and Mathematics, students have access to the large computer science laboratory. There is also a room reserved exclusively for private study.

The learning resources available to students on the Programme include:

- the extensive collection of books and journals relevant to undergraduate study held in the University library (much of this material is also accessible online);
- detailed printed notes and other paper resources supplied in certain modules;
- the Keele Learning Environment (KLE) which provides easy access to a range of learning resources including lecture notes, examples with solutions, past examination papers, module details and reading lists, and guidance notes for project work.

17. Other learning opportunities

Study abroad (semester)

Students on the Mathematics programme have the potential opportunity to spend a semester abroad in their second year studying at one of Keele's international partner universities.

Exactly which countries are available depends on the student's choice of degree subjects. An indicative list of countries is on the website (http://www.keele.ac.uk/studyabroad/partneruniversities/); however this does not guarantee the availability of study in a specific country as this is subject to the University's application process for studying abroad.

No additional tuition fees are payable for a single semester studying abroad but students do have to bear the costs of travelling to and from their destination university, accommodation, food and personal costs. Depending on the destination they are studying at additional costs may include visas, study permits, residence permits, and compulsory health checks. Students should expect the total costs of studying abroad to be greater than if they study in the UK, information is made available from the Global Education Team throughout the process, as costs will vary depending on destination

Whilst students are studying abroad any Student Finance eligibility will continue, where applicable students may be eligible for specific travel or disability grants. Students studying in Erasmus+ destinations may be eligible for grants as part of this programme. Students studying outside of this programme may be eligible for income dependent bursaries at Keele.

Students travel on a comprehensive Keele University insurance plan, for which there are currently no additional charges. Some governments and/or universities require additional compulsory health coverage plans; costs for this will be advised during the application process.

Study Abroad (International Year)

A summary of the International Year, which is a potential option for students after completion of year 2 (Level 5), is provided at Annex A.

Work Placement Year

A summary of the Work Placement Year, which is a potential option for students after completion of year 2 (Level 5), is provided at Annex B.

18. Additional costs

As to be expected there will be additional costs for inter-library loans and potential overdue library fines, print and graduation.

We do not anticipate any further costs for this undergraduate programme.

19. Quality management and enhancement

The quality and standards of learning in Mathematics are subject to a continuous process of monitoring, review and enhancement.

- • The Learning and Teaching Committee of the School of Computing and Mathematics is responsible for reviewing and monitoring quality management and enhancement procedures and activities across the School.

- • Individual modules and the Mathematics Programme as a whole are reviewed and enhanced every year in the annual programme review which takes place at the end of the academic year and as part of the University's Curriculum Annual Review and Development (CARD) process.

- • The programmes are run in accordance with the University's Quality Assurance procedures and are subject to periodic reviews under the Internal Quality Audit (IQA) process.

Student evaluation of, and feedback on, the quality of learning on every Mathematics module takes place every year using a variety of different methods:

- • The results of student evaluations of all modules are reported to module leaders and reviewed by the Programme Committee as part of the Curriculum Annual Review and Development (CARD) process.

- • Findings related to the Mathematics Programme from the annual National Student Survey (NSS), and from regular surveys of the student experience conducted by the University, are subjected to careful analysis and a planned response at programme and School level.

- • Feedback received from representatives of students in all three years of the Mathematics Programme is considered and acted on at regular meetings of the Student Staff Voice Committee.

The University appoints senior members of academic staff from other universities to act as external examiners on all programmes. They are responsible for:

- • Approving examination questions
- • Confirming all marks which contribute to a student's degree
- • Reviewing and giving advice on the structure and content of the programme and assessment procedures

Information about current external examiner(s) can be found here:
http://www.keele.ac.uk/qa/externalexaminers/currentexternalexaminers/

20. The principles of programme design

The Mathematics Programme described in this document has been drawn up with reference to, and in accordance with the guidance set out in, the following documents:

a. UK Quality Code for Higher Education, Quality Assurance Agency for Higher Education:
http://www.qaa.ac.uk/en/quality-code/

b. QAA Subject Benchmark Statement: Mathematics, Statistics and Operational Research (2015) –

http://www.qaa.ac.uk/docs/qaa/subject-benchmark-statements/sbs-mathematics-15-masters.pdf?sfvrsn=7891f681_20

c. Keele University Regulations and Guidance for Students and Staff: http://www.keele.ac.uk/regulations

d. Keele University Placement Learning Code of Practice:
https://www.keele.ac.uk/policyzone/viewbyowner/planningandacademicadministration/name,117421,en.php

21. Document Version History

Date of first approved version (v1.0): 22nd September 2017

Revision history

Version number[1]	Author	Date	Summary of and rationale for changes
1.1	Yibin Fu	May 2018	Updated to reflect module option offering for 2018-19: changes to year 2 and 3 optional modules. Updated 13.2(a) so that it is self-contained and does not make reference to separate Course Regulations document.
1.2	Yibin Fu	August 2018	Deleted "Ring and Field Theory" optional module. Rephrased Compensation Course Regulation to align with University's changes to Condonement and Compensation.
2.0	Yibin Fu	January 2019	Changes to reflect the addition of Work Placement option
2.1	Yibin Fu	June 2019	Optional module changes: At Level 5: added "Linear Statistical Models"; removed "Mathematical Modelling". At Level 6: removed "Metric Spaces and Topology"; removed "Medical Statistics Project"; added "Complex Variable II"; added "Project (30-credits)". (All optional modules.) Minor changes to "Learning Outcomes" table that listed modules not listed in the module table.

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[1] 1.1, 1.2 etc. are used for minor changes and 2.0, 3.0 etc. for major changes (as defined in the University's Guidance on processes supporting curriculum changes)

Annex A

BSc (Hons) Mathematics Combined Honours with International Year

Please note: in order to be eligible to take the International Year option your other subject must also offer this option. Please refer to the information published in the course document for your other subject.

International Year Programme
Students registered for Combined Honours Mathematics may either be admitted for or apply to transfer during their period of study at Level 5 to the Combined Honours programme in both their principal subjects, providing that they meet the progression criteria outlined in this document. Students accepted onto the International Year programme will have an extra year of study at an international partner institution after they have completed Year 2 (Level 5) at Keele. Students who successfully complete both the second year (Level 5) and the International Year will be permitted to progress to Level 6. Students who fail to satisfy the examiners in respect of the International Year will normally revert to the Combined Honours programme without the International Year and progress to Level 6 on that basis. The failure will be recorded on the student's final transcript. Study at Level 4, Level 5 and Level 6 will be as per the main body of this document. The additional detail contained in this annex will pertain solely to students registered for 'BSc (Hons) Mathematics Combined Honours with International Year'.

International Year Programme Aims
In addition to the programme aims specified in the main body of this document, the international year programme of study aims to provide students with: 1. Personal development as a student and a researcher with an appreciation of the international dimension of their subject 2. Experience of a different culture, academically, professionally and socially

Entry Requirements for the International Year
Students may apply to the 4-year programme during Level 5. Admission to the International Year is subject to successful application, interview and references from appropriate staff. The criteria to be applied are: • Academic Performance (an average of 60% across all modules at Level 5 is normally required) • General Aptitude (to be demonstrated by application for study abroad, interview during the 2nd semester of year 2 (Level 5), and by recommendation of the student's personal tutor, 1st and 2nd year tutors and programme director)

Student Support
Students will be supported whilst on the International Year via the following methods: • Phone or Skype conversations with Study Abroad tutors, in line with recommended Personal Tutoring meeting points. • Support from the University's Global Education Team

Learning Outcomes
In addition to the learning outcomes specified in the main text of the Programme Specification, students who complete a Keele undergraduate programme with International Year will be able to:

i) Describe, discuss and reflect upon the cultural and international differences and similarities of different learning environments
ii) Discuss the benefits and challenges of global citizenship and internationalisation
iii) Explain how their perspective on their academic discipline has been influenced by locating it within an international setting.

In addition, students who complete 'BSc (Hons) Mathematics Combined Honours with International Year' will be able to:

iv) be able to communicate effectively in an international setting;
v) be able to reflect on previous learning within an international context.

Please note that students on Combined Honours programmes with International Year must meet the subject-specific learning outcomes for BOTH their principal subjects.

These learning outcomes will all be assessed by the submission of a satisfactory individual learning agreement, the successful completion of assessments at the partner institution and the submission of the reflective portfolio element of the international year module.

Course Regulations

Students registered for the 'BSc (Hons) Mathematics Combined Honours with International Year' are subject to the course specific regulations (if any) and the University regulations. In addition, during the International Year, the following regulations will apply:

Students undertaking the International Year must complete 120 credits, which must comprise *at least 40%* in the student's discipline area.

This may impact on your choice of modules to study, for example you will have to choose certain modules to ensure you have the discipline specific credits required.

Students are barred from studying any Mathematics module with significant overlap to Level 6 modules to be studied on their return. Significant overlap with Level 5 modules previously studied should also be avoided.

Additional costs for the International Year

Tuition fees for students on the International Year will be charged at 15% of the annual tuition fees for that year of study, as set out in Section 1. The International Year can be included in your Student Finance allocation, to find out more about your personal eligibility see: www.gov.uk

Students will have to bear the costs of travelling to and from their destination university, accommodation, food and personal costs. Depending on the destination they are studying at additional costs may include visas, study permits, residence permits, and compulsory health checks. Students should expect the total costs of studying abroad be greater than if they study in the UK, information is made available from the Global Education Team throughout the process, as costs will vary depending on destination.

Students studying in Erasmus+ destinations may be eligible for grants as part of this programme. Students studying outside of this programme may be eligible income dependent bursaries at Keele.

Students travel on a comprehensive Keele University insurance plan, for which there are currently no additional charges. Some Governments and/or universities require additional compulsory health coverage plans; costs for this will be advised during the application process.

Annex B: BSc (Hons) Mathematics Combined Honours with Placement Year

Placement Year Programme

Students have the opportunity to apply directly for the 4-year with Work Placement Year degree programme or to transfer onto the 4-year degree programme at the end of Year-1 and in Year-2 at the end of Semester 1. Students accepted onto this programme will have an extra year (the Placement Year) with a relevant placement provider after they have completed Year 2 (Level 5) at Keele. Students wishing to transfer onto this programme should discuss this with student support, the academic tutor for the work placement year, and the Programme Director.

To proceed to the Placement Year, students must normally achieve an average of 55% across all Level 4 and 5 modules and undergo an interview with the Programme Director or the Academic Tutor for the Work Placement Year. If students do not meet these requirements they will revert back to the Combined Honours Mathematics Programme.

Students who successfully complete both the second year (Level 5) and the Placement Year will be permitted to progress to Level 6. Students who fail to satisfactorily complete the Placement Year will normally revert to the BSc (Hons) Mathematics Combined Honours programme and progress to Level 6 on that basis. The failure will be recorded on the student's final transcript.

Study at Level 4, Level 5 and Level 6 will be as per the main body of this document. The additional detail contained in this annex will pertain solely to students registered for the BSc (Hons) Mathematics Combined Honours with Work Placement Year.

Work Placement Year Programme Aims

In addition to the programme aims specified in the main body of this document, the Placement Year programme aims to provide students with:

a) Substantial experience of work with a relevant placement provider, including familiarisation with the professional working environment;

b) enable you to apply academic theory learned as part of your taught degree to real situations in the work place, and to expand your employability skills.

Entry Requirements for the International Year

Admission to the Placement Year is subject to successful application, interview and references from appropriate staff. Students have the opportunity to apply directly for the 4-year `with work placement' degree programme, or to transfer onto the 4-year degree programme at the end of Year 1 (Level 4) and in Year 2 (Level 5) at the end of Semester 1. Students who are initially registered for the 4-year degree programme may transfer onto the 3-year degree programme at any point in time, prior to undertaking the year-long work placement. Students who fail to pass the work placement year, and those who fail to meet the minimum requirements of the work placement year module (minimum 30 weeks full-time (1,050 hours), or equivalent, work placement), will automatically transfer onto the 3-year degree programme.

The criteria applied are:

a) Students must have a good University attendance record and be in `good academic standing'.

b) Students must have passed all Year-1 and Year-2 Semester 1 modules with an overall module average of 55% or higher.

c) General Aptitude (to be demonstrated by the application(s) to relevant placement providers with prior agreement from the Programme Director or the Academic Tutor for the Work Placement Year, interview during the 2nd semester of Year 2 (Level 5), and by recommendation of the student's personal tutor and as necessary, other staff members).

d) Students undertaking work placements will be expected to complete a Health and Safety checklist prior to commencing their work placement and will be required to satisfy the Health and Safety regulations of the company or organization at which they are based.

e) Students must have met the progression requirements to proceed to their final year of study prior to commencing a work placement. Failure to complete reassessment work in the summer reassessment period due to a work placement position will not be classed as exceptional circumstances.

f) (International students only) Due to visa requirements, it is not possible for international students who require a Tier 4 Visa to apply for direct entry onto the 4-year with Work Placement Year degree programme. Students should be aware that there are visa implications for this transfer, and it is the student's responsibility to complete any and all necessary processes to be eligible for this programme. There may be additional costs, including applying for a new Visa from outside of the UK for international students associated with a transfer to the work placement programme.

A student that has completed an International Year (see Annex A) will not be allowed to transfer onto the Work Placement Year Programme. Students registered for BSc (Hons) Mathematics Combined Honours with Work Placement are exempt from studying an International Year.

Student Support

Students will be supported whilst on the Placement Year via the following methods:

a) Regular contact between the student and a named member of staff (Academic Tutor for Work Placement Year) who will be assigned to the student as their University supervisor. The University supervisor will be in regular contact with the student throughout the year, and be on hand to provide advice (pastoral or academic) and liaise with the placement supervisor on the student's behalf if required.

b) Two formal contacts with the student during the academic year: the University supervisor will visit the student in their placement organisation at around the 5th week after the placement commenced, and then visit again (or conduct telephone/video call tutorial) around the 15th week after the placement commenced.

c) Weekly supervision session will take place with the placement supervisor (or their nominee) throughout the duration of the placement.

Learning Outcomes

In addition to the learning outcomes specified in the main text of the Programme Specification, students who complete BSc (Hons) Mathematics Combined Honours with Placement Year will be able to:

a) evaluate their own employability skills (via a SWOT analysis);

b) create Intended Learning Outcomes for their placement in order to develop the skills areas which they have identified as needing further enhancement;

c) develop, through practice in the work place, the work-related skills identified through their SWOT analysis and Intended Learning Outcomes;

d) apply academic theory learned as part of their taught degree to real situations in the work place;

e) reflect on their work placement activities and evaluate their impact on their own employability skills;

f) explain how the sector of the placement operates and identify the skills required to pursue careers within the sector.

These learning outcomes will be assessed through the non-credit bearing Work Placement Year module

(MAT-30035) which involves:

g) the submission of a SWOT analysis and action plan and an evaluation of the student's performance based on the placement supervisor's initial report;

h) the submission of a monthly reflective diary to the University supervisor and an evaluation of the student's performance based on the placement supervisor's final report;

i) a presentation about their placement experience to an audience of other students coming off placement and those about to go out on placement. The audience is also likely to contain the University supervisor and other staff from Mathematics;

Course Regulations

Students registered for the 'BSc (Hons) Mathematics Combined Honours with Work Placement Year' are subject to the course specific regulations (if any) and the University regulations. In addition, during the Placement Year, the following regulations will apply.

Students undertaking the Work Placement Year must successfully complete the 0 credit `Work Placement Year' module (MAT-30035). In particular, the following regulations will apply:

a) Students must pass Assessment 1 (mid-placement portfolio) with a mark of 40% in order to continue with their work placement and pass the Work Placement Year module. Students will not be permitted to take reassessment of this component of the module.

b) Students failing Assessment 1 at first attempt will be required to withdraw from the Work Placement Year module and will be transferred onto the 3-year degree programme.

c) Students will be permitted to take reassessment of Assessment 2 (Final Placement Portfolio) and Assessment 3 (Oral Presentation), as appropriate. Students are not permitted to repeat the Work Placement Year.

Students will be expected to behave professionally in terms of:

d) conforming to the work practices of the organisation; and

e) remembering that they are representatives of the University and their actions will reflect on the Mathematics Division and have an impact on that organisation's willingness (or otherwise) to remain engaged with the mathematics placement.

Additional costs/payments for the Placement Year

Tuition fees for students on the Placement Year will be charged at 20% of the annual tuition fees for that year of study, as set out in Section 1. The Work Placement Year can be included in your Student Finance allocation, to find out more about your personal eligibility see www.gov.uk. It is the student's responsibility to notify Student Finance (England, Wales, Scotland, Northern Ireland, as appropriate), the Student Loans Company, and any other relevant funding bodies (as appropriate) of any change in their status. Students who undertake paid work placements should discuss the implications of this with Student Finance, the Student Loans Company and any other relevant funding body prior to commencing the placement.

Students will have to bear the costs of travelling to and from their placement provider, accommodation, food and personal costs. Depending on the placement provider additional costs may include parking permits, travel and transport, suitable clothing, DBS checks, and compulsory health checks.

International students who require a Tier 4 visa should check with the Immigration Compliance team prior to commencing any type of paid placement to ensure that they are not contravening their visa requirements.