Whilst every effort has been made to ensure that the information contained in this document is accurate, details are subject to change.

**Term Dates**

**Academic Year 2019-2020**

**Michaelmas Term**: 4 October 2019 to 13 December 2019 (Welcome Week: 30 September 2019)
**Lent Term**: 10 January 2020 to 20 March 2020
**Summer Term**: 17 April 2020 to 26 June 2020

**Exam Periods**

All Part II exams occur during the Summer Term (Weeks 21 – 30). Typically, they occur between Weeks 23 and 28. NOTE: exams may be scheduled on a Saturday.
Points of Contact

Academic Staff

The following is a list of key members of academic staff who are relevant to Part II undergraduate students. Also, each student is allocated an Academic Advisor who will hold termly interviews; see Page 9 for more about Academic Advisors.

**Part II BSc Director of Studies:** Dr Jonathan Evans, Room B64, Fylde Building
Telephone (01524) 5-94177. E-mail: j.d.evans@lancaster.ac.uk

**Part II MSci Director of Studies:** Dr Dirk Zeindler, Room B39a, Fylde Building
Telephone (01524) 5-93644. E-mail: d.zeindler@lancaster.ac.uk

**Part II FST Director of Studies:** Professor Steve Power, Room B26, Fylde Building
Telephone (01524) 5-93958. E-mail: s.power@lancaster.ac.uk

**Part II Non FST Director of Studies:** Dr Alex Gibberd, Room B37, Fylde Building
Telephone (01524) 5-95068. E-mail: a.gibberd@lancaster.ac.uk

**Natural Science Coordinator:** Dr Łukasz Grabowski, Room B39, Fylde Building
Telephone (01524) 5-93444. E-mail: lukasz.grabowski@lancaster.ac.uk

**Head of Department:** Professor Alexander Belton, Room B55, Fylde Building
Telephone (01524) 5-92371. E-mail: a.belton@lancaster.ac.uk

**Director of Undergraduate Teaching:** Dr Mark MacDonald, Room B12, Fylde Building
Telephone (01524) 5-93955. E-mail: m.macdonald@lancaster.ac.uk

**Study Abroad Director:** Dr Yemon Choi, Room B60a, Fylde Building
Telephone (01524) 5-92350. E-mail: y.choi1@lancaster.ac.uk

**Placement Director:** Dr David Pauksztello, Room B04, Science & Technology Building.
Telephone (01524) 5-94649. E-mail: d.pauksztello@lancaster.ac.uk

**Academic Employability Champion:** Dr David Pauksztello, Room B04, Science & Technology Building. Telephone (01524) 5-94649. E-mail: d.pauksztello@lancaster.ac.uk

**Academic Employability Champion - Deputy:** Dr Derek Kitson, Room B06a, Fylde Building
Telephone (01524) 5-94914. E-mail: d.kitson@lancaster.ac.uk

**Disability Officer:** Dr Sean Prendiville, Room B44, Fylde Building
Telephone (01524) 6-64638. E-mail: s.prendiville@lancaster.ac.uk

**Assessment Officer:** Dr Daniel Elton, Room B6, Fylde Building
Telephone (01524) 5-93890. E-mail: d.m.elton@lancaster.ac.uk

External Examiners: Dr Olga Maleva – University of Birmingham (Pure Mathematics)
Professor Emma McCoy – Imperial College, London (Statistics)
Professor Paul Baxter – University of Leeds (Year 4 Statistics)

*(Note: Students should not contact External Examiners directly, but in the first instance raise any issues with the Assessment Officer or Head of Undergraduate Teaching.)*

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Administrative Office Support

All Enquiries: mathsteaching@lancaster.ac.uk

The Teaching Office is open for general enquiries, Room B02/B03, Fylde Building. Telephone (01524) 5-93960 / (01524) 5-92397. E-mail: mathsteaching@lancaster.ac.uk

Teaching Coordinator (Part II): Callum Forsyth, Room B02, Fylde Building. Telephone (01524) 5-92397. E-mail: c.forsyth@lancaster.ac.uk

Student Programmes Officer: Amy Pearson, Room B03, Fylde Building. Telephone (01524) 5-93798. E-mail: a.pearson6@lancaster.ac.uk

Departmental Administrator: Lauren Emery, Room B04, Fylde Building. Telephone (01524) 5-93963. E-mail: l.emery@lancaster.ac.uk

Noticeboard for class information etc. in the area of the homework pigeonholes Fylde Building.

Web pages for information about the Department are at http://www.lancaster.ac.uk/maths/

Module information/timetables https://portal.lancaster.ac.uk/student_portal#myarea

Online Courses Handbook http://www.lusi.lancaster.ac.uk/CoursesHandbook/
General Information

Information and advice which applies to all Lancaster undergraduates can be found here:

http://www.lancaster.ac.uk/current-students/undergraduate-core-information/

What follows below is information which is particularly relevant to Part II students in the Department of Mathematics and Statistics.

Lectures and workshops

Lectures are the basic method of transmitting the content of this course. Workshops take place weekly in small groups, each one under the supervision of a tutor; these are an important part of the course. We believe that attendance at these timetabled events is an important part of your learning journey. Your attendance and coursework submission will be monitored, and if we are concerned about your academic progress, then we may contact you. If you are absent for a legitimate reason, then please let us know; for example, you can self-certify your absences online.

Printed course notes

Printed notes are provided for most modules. Some of these notes have gaps, which are filled in during lectures. At the end of each module all students should ensure that they have a complete copy of the course notes and any other course materials that have been circulated. The notes are available in pdf format from the course web pages on Moodle:

https://modules.lancaster.ac.uk

Coursework

Each week you will be asked to hand in, to your workshop group tutor, solutions to certain questions relating to the course material seen in lectures. The pigeonholes for this purpose are opposite B4c in the Mathematics and Statistics department. Solutions should be clearly written, and each page should have your name at the top. The tutor will return the marked assignments at the tutorial or workshop, together with any comments on the exercise. Clarity and accuracy of presentation are important in Mathematics and Statistics.

Students benefit from attempting more questions than those strictly required: it is only by trying to do Mathematics that one learns it. The problems presuppose acquaintance with the material covered in lectures.

In addition, many modules have a weekly assessment component consisting of an online quiz. For modules with project components, work will normally be returned to you within 4 weeks of submission excluding university closure periods.

Late coursework

The Lecturer will state the deadline before which coursework should be submitted. Work submitted up to three days late without an agreed extension will receive a penalty of 10%, and additionally the mark will be capped at 70%. Saturdays and Sundays are included as days in this regulation. However, when the third day falls on a Saturday or Sunday, students will have until 10.00 a.m. on Monday to hand in work without receiving further penalty. Work submitted more than three days late without an agreed extension will be awarded a zero and will be considered a non-submission.
The lecturer will state when the solutions will be available to students, and due to the desire to provide prompt feedback, that may fall within the three-day period. In which case, late coursework will be awarded a zero if it is submitted after the solutions have been published.

For projects and other pieces of coursework that are given letter grades, the late penalty will be as described by university regulations, which usually means a reduction of one full letter grade (see MARP GR 2.3.4).

Fairness is one of the main principles that justifies our policy on late coursework.

Books

Although lectures are intended to contain all the material required, you should use textbooks to supplement your understanding and to see alternative presentations of the subject matter. Copies of most of the relevant books (see the recommendations given in the Module Catalogue) are available from the University Library; where a book proves to be popular, multiple copies are kept. Most Mathematics and Statistics books are in the AQN section on A floor; some texts are kept in the Short Loan Section. The online library catalogue is at http://www.lancaster.ac.uk/library/.

Calculators

For those Mathematics and Statistics examinations where the use of calculators is permitted, you will be issued with a standard Casio FX-85GT PLUS Scientific Calculator for the duration of the examination; this will be provided in the examination venue, and is not to be removed. If you would like to familiarise yourself with this model, sample calculators may be tried out in the Teaching office. Personal calculators are not permitted for Mathematics and Statistics examinations, but may be used for other assessments during the year including end-of-module tests (as long as calculators are allowed).

Illness/Mitigating circumstances

If you are ill, or have some other good reason for missing a single coursework, or a small amount of class time, you should let your Academic Tutor, Director of Studies or the Teaching Office know promptly. Absences should also be logged online (using the Absence Notification link in the Online Student Services section of your Student Portal).

You need to make a claim for mitigating circumstances if you want the Department to take into account any illness or other good reason which has resulted in you missing a significant amount of coursework or an examination, or if you feel your performance in coursework or an examination has been negatively affected by adverse circumstances.

Claims for mitigating circumstances need to be supported by appropriate evidence. For a medical condition affecting performance this will normally mean a report completed by an appropriate professional who should comment on how the medical condition concerned would be likely to have affected your ability to prepare for or carry out the assessment(s) in question. Medical certificates that merely confirm attendance at a clinic are unlikely to be considered sufficient. The Assessment Officer can provide advice about mitigating circumstances and, in particular, what evidence might be appropriate.

Claims for mitigating circumstances, together with appropriate supporting evidence, should be submitted to the Teaching Office. This should be done as early as possible and certainly by the end of the examinations period in May/June.

All cases will be reviewed by the Mitigating Circumstances Committee. In cases where good cause has been demonstrated the Committee may propose a number of actions as appropriate to the case. Examples of such actions include the extension of a deadline, or the opportunity to resit an examination or coursework as if it were a first attempt (for which there will be no fee and the
marks will not be capped). However students should note that it is not possible to change the marks obtained for any assessment.

Mitigating circumstances are generally not an appropriate means to deal with chronic medical issues or other relevant long-standing personal circumstances. Such cases are better handled via appropriate support arrangements, such as an integrated learning plan or alternative assessment arrangements.

**Contact Time**

Below we estimate the total amount of contact time you can expect to have with our staff on an annual basis through lectures / seminars / practicals / workshops etc. However, it should be noted that your actual experience will vary due to your module choices, for example dissertation units and modules with a large proportion of blended learning (i.e. using online resources) typically have less face-to-face contact and a greater amount of independent study.

For six out of eight Year 2 modules in this department, every two weeks will consist of 5 hours of lectures as well as two hours of workshops. Additionally, every module will have a 2 hour scheduled revision session prior to the exam. So a student who takes all eight second year mathematics modules should have a combined total of 296 contact hours for the whole year.

Typically, this department offers approximately 215 contact hours in Year 3, and 180 contact hours in Year 4.

Lecturers for each module will offer weekly office hours for additional assistance.

**Academic Advisors**

Every student is assigned to an academic tutor for the duration of their degree. They will arrange a meeting with you in intro-week of your first year, and termly thereafter. Your advisor can provide help with module choices, monitor and advise on your progress, support your career planning, and sign-post you to services available elsewhere in the university. They are also available for consultation on any problems that might arise in connection with your course, such as choice of modules, absence, illness, difficulty with work etc.

If you are unsure who your academic advisor is, then just ask any member of the administrative staff, and they will be happy to let you know.

**Independent Learning**

It is very important to recognise that timetabled teaching forms only a small part of your work at the University. Your overall workload for the year is expected to be around 1200 hours – this includes not only formal teaching hours but also time spent on other activities including self-directed reading, checking your understanding of what you have been taught, undertaking assignments, revision for tests and exams, etc. Over the thirty weeks of term-time this should average about 40 hours per week – the equivalent of a full-time job. It is your responsibility to organise your working time accordingly.

**Video recording of lectures**

Although individual lecturers may choose to have their lectures recorded, this will be done on a case-by-case basis. The department’s Undergraduate Teaching Committee believes there are reasons for not recording lectures by default. A lecture should be an interactive event, which demands input from both lecturer and students, and not a passive experience.
Computing

Several Part II modules in Mathematics and Statistics have associated Computer Laboratory classes and assessment linked to these. Wherever possible the software is open source and students are expected to download it onto their own machines.

Lab A1 (Engineering) is often used for the department laboratory classes, and for individual use when available. Postgraduate students have access to labs in the PSC. There are also several general access computer laboratories available on campus for student use. Computing advice is provided by ISS.

Information on the internet

Useful information, such as timetables, previous examination papers and coursework marks are available online, on the Student Registry website:
https://portal.lancaster.ac.uk
You will need your username and password to access your personal information. There is also a wide variety of useful links for current students available here:
http://www.lancaster.ac.uk/current-students/

Moodle

Moodle provides activities and resources to support your learning. Lecturers utilise Moodle in a wide variety of ways to deliver learning materials (handouts, presentations, bibliographies etc), engage you in active learning (exercises and online tests, discussion spaces and learning logs) and update you with information about your modules.

iLancaster

iLancaster App provides an alternative link into Moodle when on the move, together with other useful information and advice. It is also used for checking-in to lectures and workshops. If you are not able to check-in using the iLancaster App then you are required to sign a register at your workshop. For more about iLancaster, see here:
http://m.lancaster.ac.uk/

Communication by e-mail

Your Lancaster email address will be used for all official correspondence from the University. You are expected to check it on a daily basis during term time.
Awards

Second Year Prizes

The Lloyd Prize in Mathematics is awarded each year for the best performance by a second year undergraduate who is reading mathematics as a major subject, either alone or in combination with another major subject. The prize consists of books to the value of £60.

The Striding Edge Scholarship is an award of £500 available for a 2nd year Mathematics (single or combined) major student who is experiencing some financial hardship, and who has obtained a first class result at the end of Year 1. The award is made on the basis of academic achievement in Year 2. Any student who wishes to be considered for this award should contact the Teaching Office or their Director of Studies before the 31st May of their 2nd year.

Final Year Prizes

The David Astley Memorial Prize is awarded to that undergraduate reading for a degree in mathematics with honours, who at the end of his/her final year is judged to have displayed the best combination of breadth of mathematical abilities with clarity of exposition. This prize is now donated by the Department and has been given to the value of £100.

The IMA Prizes are 2 prizes to be awarded for outstanding performance in the final year. The prizes give a year's free membership of the Institute.

The Royal Statistical Society Prize is awarded to the best statistician graduate. The prize is one year's graduate statistician membership of the Royal Statistical Society.

The Amelia Carney Memorial Prize is awarded to the graduating student reading for a joint degree in Computer Science and Mathematics with honours, who is judged to have displayed the best overall academic performance throughout their degree.

Lancaster Award

At Lancaster we not only value your academic accomplishments, but also recognise the importance of those activities you engage with outside your programme of study. The student experience is enhanced by including extra-curricular activities and, with more graduates than ever before and increasing competition for jobs upon leaving University, these are vital to your future prospects. We want to encourage you to make the very most of your University experience and to leave Lancaster as a well-rounded graduate. We have a wealth of opportunities to get involved in with initiatives such as work placements, volunteering, extracurricular courses, societies and sports. The Lancaster Award aims to encourage you to complete such activities, help you to pull them together in one place and then be recognised for your accomplishments. We want you to stand out from the crowd - the Lancaster Award will help you to do this. For more information see https://www.lancaster.ac.uk/careers/students/the-lancaster-award/
Module Enrolment

In October when you arrive, and each subsequent year (normally in April/May) you will be asked to enrol for the individual courses or modules which make up your programme of study. Enrolment will be available online, and you will be advised by email, from Student Registry, when enrolment is available. Manual enrolments can be made via the Directors of Studies and the Teaching Office.

There will be a one hour timetabled advice session towards the end of the Lent Term, primarily for Year 2 students regarding their Year 3 choices. Also you can ask your Academic Tutor or your Director of Studies regarding your academic module options.

Changing your Major or your Modules

You may change your intended major subject at Part II enrolment to any major for which your Part I subjects qualify you. However, any changes are reliant on your achieving a majorable mark in any subject you wish to take as a major. You are still permitted to change your major (Part I subjects and results permitting) at any time before the start of your second year.

If you decide to change your major before Part II enrolment in May you need to discuss this with the department(s) involved and then enrol in the normal way. If you decide after you have enrolled for Part II courses (for example, on receipt of examination results) then you should contact the Student Registry as soon as possible after you receive your results.

Please seek advice from your Director of Studies or the Teaching Office. Changes in Part II enrolment will only be accepted in the first two weeks of the course module for normal 5 or 10 week modules, and during the first two days for short intensive statistics modules.

You can download a change of major form, or a change of enrolment form, from: http://www.lancaster.ac.uk/sbs/registry/undergrads/forms.htm

Online Courses Handbook

The online courses handbook provides information on all taught undergraduate and postgraduate programmes of study and course modules in any one academic year. This includes syllabuses and pre-requisites.

http://www.lusi.lancaster.ac.uk/CoursesHandbook/
Student support and representation

Lancaster has adopted a student-centred approach in which access to high quality support across a range of areas is provided by different agencies in a way which best meets each student’s individual circumstances and needs. This is summarised in the Student Support Policy which can be found at:

http://www.lancaster.ac.uk/about-us/our-principles/student-support/

In addition, during the first year of study, you will be assigned to a named College Advisor. That person can also provide advice and support to you on accessing these services, or upon any other issues you may need help with.

The university also has an academic tutorial system where you will be allocated an academic tutor within your major department who will meet with you on a one to one basis each term. This tutor will be interested in and be knowledgeable about your progress and be in a position to provide academic advice and support.

Student Representatives

Student representatives are elected from each year to act as representative of Mathematics and Statistics students. The representatives have the right to attend Department meetings, and generally advise the Department of any student concerns. There is one meeting per term.

The Staff-student consultative committee comprises the student Year Representatives, an MSc representative, a postgraduate, the Directors of Studies and the Directors of Undergraduate and Postgraduate Teaching. The committee considers any teaching issues which are raised at the meeting. Meetings are chaired by a postgraduate student, and are usually held in the weeks 3, 8, 13, 18 and 23.

Student Feedback

At the end of each module you will be emailed and asked to provide feedback through an online questionnaire. This feedback is then used by us in a number of ways, all of which contribute to our processes for assuring the quality of our teaching. These processes include:-

- Consideration by your module organisers and teaching staff when reviewing their courses at the end of the year and planning future developments. The Head of Department also receives and reviews summaries of all module feedback.

- Discussion at the department’s teaching and staff-student committees to identify module strengths and weaknesses, develop proposals for module refinement.

- Analysis within the department’s annual teaching report to identify examples of good practice and areas for improvement; this report is discussed at faculty and university teaching committees.

Module evaluations are uploaded to Moodle, and lecturers respond accordingly.

The NSS is a survey of mostly final year undergraduates in England, Northern Ireland, Wales and the majority of institutions in Scotland. FE colleges with directly funded HE students (i.e. students in their final year of a course leading to undergraduate qualifications or credits) in England and Wales will also participate. The survey is part of the revised system of quality assurance for higher education, which replaces subject review by the QAA, and is designed to run alongside the QAA institutional audit to generate more detailed public information about teaching quality. Ipsos MORI, https://www.ipsos-mori.com/, an independent research company, administers the survey.
Students’ Charter

Central to the mission of Lancaster University is a strong and productive partnership between students and staff. The University and Lancaster University Students’ Union have worked together on a Students’ Charter to articulate this relationship and the standards to which the University and its students aspire.

You can read the full Charter here:

http://www.lancaster.ac.uk/current-students/student-charter/
Assessment and feedback code of practice

The Quality Assurance Agency for Higher Education defines the following terms:

- **Formative assessment** has a developmental purpose and is designed to help learners learn more effectively by giving them feedback on their performance and on how it can be improved and/or maintained.
- **Summative assessment** is used to indicate the extent of a learner's success in meeting the assessment criteria used to gauge the intended learning outcomes of a module or programme.

The summer examinations are the main summative assessments used in our department. Weekly homework is partially summative, since it counts towards the final grade, but for most modules it should be considered as primarily formative assessment.

In this section we set out a code of good practice regarding undergraduate assessment and feedback within the Department of Mathematics and Statistics at Lancaster University. Below "lecturer" refers to the course convenor of a given module, "tutor" refers to anyone who is grading work for that module, and "student" refers to anyone enrolled in that module.

**Responsibilities of the lecturer**

1. The lecturer should communicate to the students at the start of the module how their final grade will be calculated. The proportion of the grade which comes from coursework, projects, exams, etc., should be stated in the LUSI module catalogue.
2. Lecturers should ensure their formative assessment is designed to promote learning and improve understanding.
3. For weekly assignments, and other multi-question work, the lecturer is expected to state how many marks are allocated to each question well before the due date.
4. For projects, and other student work that is not purely quantitative, it is important for the lecturer to communicate to the students how they will be graded well before the due date.
5. Once any piece of formative work has been collected, the lecturer should provide the students with model solutions and/or a marking scheme before or shortly after the students are given back their graded work. It is also preferable that solutions and/or marking schemes are made available on Moodle.
6. The lecturer should provide their tutors with a marking scheme for any assessed work, to ensure that student work can be graded consistently. It is sometimes sufficient to assign partial marks for individual steps on the model solutions.
7. The lecturer is responsible for resolving any grading inconsistencies between tutors which are brought to their attention.
8. If any inaccuracies are discovered in the model solutions or marking scheme, then the lecturer should promptly distribute a corrected version.
9. When setting the final examination, lecturers should ensure they are assessing the learning outcomes of the module, as they have been stated to the students.

**Responsibilities of the tutors**

1. Tutors should be familiar with the document "Guidelines for tutors" (available on the shared drive).
2. Tutors are expected to grade work in a timely manner. In particular, weekly coursework should be graded before the weekly workshops, and project feedback should be given to the students within 4 weeks of submission.
3. Tutors should learn and understand the marking scheme and/or guidelines given to them by the lecturer.
4. When giving feedback, tutors should encourage critical reflection by the student.
Responsibilities of the students

1. Students should learn how they are being assessed in each module.
2. Students are expected to consider all feedback given to them by their tutors. If any piece of feedback is unclear, then the student should seek further explanation from their tutor.
3. If grading inconsistencies between students are discovered, then these should be brought to the attention of their tutors. If the issue cannot be resolved after consulting the marking scheme, then it should be brought to the attention of the lecturer.
4. Students are expected to complete an anonymous module evaluation at the end of each module, which provides feedback to the lecturer and the department.

Guidelines for marking schemes

It is important that any summative or formative assessment be consistent and fair between tutors within a module.

Coursework: Most weekly assignments are graded based on their mathematical and notational correctness, but may also be partially graded on their precision of expression, or presentation. Lecturers and tutors may differ in their grading practices. So, in the interests of transparency and fairness, it is recommended that lecturers produce marking schemes and/or grading guidelines for all coursework, so that both the students and the tutors know how work should be graded.

For example, an otherwise correct answer which incorrectly uses a certain piece of mathematical notation may or may not be penalized. Also, the extent to which partial marks are awarded for incorrect answers may differ between lecturers. The purpose of a marking scheme is to clarify these ambiguities.

Examinations: For most modules in our department, the main summative assessment is the examination in summer term. No feedback is given on these examinations, and neither the solutions nor the marking schemes are made public. Past examination papers from previous years (without solutions) can be found on the Student Registry website.

For each of the Year 2 modules (except MATH240, MATH245), the summer exam is worth 85% of the overall grade. In Years 3 and 4, modules without a project or major coursework component have an exam component of 90%. See the LUSI online courses handbook for details of individual modules.

The exam marks are moderated by undertaking a comparative analysis of marking trends to compare individual students’ marks on an individual course with their average mark on all their other courses. If you wish to be informed on any aspect of the regulations regarding exams, please consult Student Registry in University House.

Projects and dissertations: Our department offers several modules which, as part of their assessment, include written projects. Students do not have to use LaTeX for final project work for any module other than MATH240. Like all assessment, it is important that the students are informed of the marking scheme well before the due date. Projects are usually graded with letter grades, and it is often not possible to give a precise numerical grade breakdown. Nevertheless, in the interests of transparency and fairness, it is recommended that the lecturer indicates specific criteria considered during grading.

The following are the project marking guidelines, which are intended to ensure consistency of project grading across the department. The lecturer should specify a set of categories on which the assessment will be based, and the weighting given to each category. Categories can include, for example, Content and Understanding, Organisation and Style, Initiative, etc. For shorter projects, a single category is appropriate. Within each category the lecturer should state specific learning outcomes. A category should be awarded the appropriate letter grade if it meets the requirements of the corresponding descriptor in the table below; if the descriptor is met but there
is particular strength or weakness, a plus or minus should be appended. The overall grade is given by the weighted average of the aggregate scores corresponding to the letter grades in each category.

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>Aggr. Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+</td>
<td>24</td>
<td>Exemplary range and depth of attainment of intended learning outcomes, secured by discriminating command of a comprehensive range of relevant materials and analyses, and by deployment of considered judgement relating to key issues, concepts and procedures.</td>
</tr>
<tr>
<td>A</td>
<td>21</td>
<td>Conclusive attainment of virtually all intended learning outcomes, clearly grounded on a close familiarity with a wide range of supporting evidence, constructively utilised to reveal appreciable depth of understanding.</td>
</tr>
<tr>
<td>A-</td>
<td>18</td>
<td>Clear attainment of most of the intended learning outcomes, some more securely grasped than others, resting on a circumscribed range of evidence and displaying a variable depth of understanding.</td>
</tr>
<tr>
<td>B+</td>
<td>17</td>
<td>Acceptable attainment of intended learning outcomes, displaying a qualified familiarity with a minimally sufficient range of relevant materials, and a grasp of the analytical issues and concepts which is generally reasonable, albeit insecure.</td>
</tr>
<tr>
<td>B</td>
<td>16</td>
<td>Attainment deficient in respect of specific intended learning outcomes, with mixed evidence as to the depth of knowledge and weak deployment of arguments or deficient manipulations.</td>
</tr>
<tr>
<td>B-</td>
<td>15</td>
<td>Attainment of intended learning outcomes appreciably deficient in critical respects, lacking secure basis in relevant factual and analytical dimensions.</td>
</tr>
<tr>
<td>C+</td>
<td>14</td>
<td>Attainment of intended learning outcomes appreciably deficient in respect of nearly all intended learning outcomes, with irrelevant use of materials and flawed explanation.</td>
</tr>
<tr>
<td>C</td>
<td>13</td>
<td>No convincing evidence of attainment of any intended learning outcomes, such treatment of the subject as is in evidence being directionless and fragmentary.</td>
</tr>
<tr>
<td>C-</td>
<td>12</td>
<td>Such treatment of the subject as is in evidence being directionless and fragmentary.</td>
</tr>
<tr>
<td>D+</td>
<td>11</td>
<td>Such treatment of the subject as is in evidence being directionless and fragmentary.</td>
</tr>
<tr>
<td>D</td>
<td>10</td>
<td>Such treatment of the subject as is in evidence being directionless and fragmentary.</td>
</tr>
<tr>
<td>D-</td>
<td>9</td>
<td>Such treatment of the subject as is in evidence being directionless and fragmentary.</td>
</tr>
<tr>
<td>Marginal Fail</td>
<td>7</td>
<td>Such treatment of the subject as is in evidence being directionless and fragmentary.</td>
</tr>
<tr>
<td>Fail</td>
<td>4</td>
<td>Such treatment of the subject as is in evidence being directionless and fragmentary.</td>
</tr>
<tr>
<td>Poor Fail</td>
<td>2</td>
<td>Such treatment of the subject as is in evidence being directionless and fragmentary.</td>
</tr>
<tr>
<td>Very Poor Fail</td>
<td>0</td>
<td>Such treatment of the subject as is in evidence being directionless and fragmentary.</td>
</tr>
</tbody>
</table>

**Presentations:** Some modules, such as MATH240, include an oral presentation component. Presentations will be graded using some or all of the following assessment criteria.

An excellent academic presentation is one in which the following components are present.

- There is a clear structure (introduction, main body and conclusion) in which key themes are presented in a logical order.
- Information is accurately extracted and communicated, items for investigation are clearly identified and analysed, tangible conclusions are drawn and arguments are fully supported by relevant evidence or reference to theory.
- Visual material is accurate (no typographic, spelling or grammatical errors), effective in supporting the key messages of the presentation and not distracting.
- The words and terminology used are appropriate for an academic presentation.
- Body language and attitude are appropriate throughout the presentation.
- The pace is appropriate (not too fast and not too slow with appropriate use of pauses), voices are clear (pitch, tone and volume are used effectively to aid audience audibility, interest and understanding) and pronunciation of words and technical terms are correct and clear.
- If there are multiple presenters, then they support each other and do not interrupt others unnecessarily.
- Timing is used to good effect and time limits are not exceeded.
Data Protection in Student Projects

If as part of any student project you collect personal/sensitive data on living people which would identify them, you need to ensure you are compliant with the UK Data Protection Act 2018 and the EU General Data Protection Regulation (GDPR).

This means that you should gain consent from participants, only collect information needed for your project, handle and store all data securely and anonymously where possible and you should be informing participants of:

- Your study objectives
- How long you will retain their information
- How you will secure their data before it is anonymised or deleted
- How a participant could withdraw their data from the project
- An appropriate person to receive complaints, e.g. your supervisor

This should be part of your project design and you should discuss this with your supervisor.
Plagiarism Framework for Mathematics and Statistics

Plagiarism involves the unacknowledged use of someone else’s work and passing it off as if it were one’s own. This includes the following examples.

- Copying or paraphrasing from a source text without acknowledgement. This includes quoting text from a referenced source without distinguishing it with quotation marks or similar. It does not include the statement of standard results, definitions and so forth, which is permissible without attribution.
  1. One single line or a few words. This will not usually be considered an issue.
  2. A whole paragraph or more. This is in general a major offence.
  3. Somewhat less, but several lines. This is poor academic practice and a minor offence.

- Submission of another student’s work or a part thereof.
  1. In the case of weekly coursework students are allowed to work together, but each student should write up separately and not submit the same work.
  2. For a project or a dissertation it is a major offence.

- Directly copying from model solutions made available in previous years. This is taken very seriously as a major offence.
- Reproduction of the same or almost identical work for more than one assessment is, in general, a major offence.
- Submission of purchased work is a major offence.
- Copying computer code from the internet for project work is a major offence.

The level of intent will be taken into consideration; unintentional plagiarism is a minor offence. If there is no intent to gain an unfair advantage, then it is likely due to poor study skills, but the matter will usually still be raised with the student concerned.

Preventing plagiarism

All members of the department involved in teaching are expected to raise awareness and give advice on good study practice, while being clear about expected standards, including referencing and the use of quotations.

All markers are required to act if plagiarism is suspected. Graduate Teaching Assistants will consult the course lecturer on what action to take. The Academic Officer and the Heads of Undergraduate and Postgraduate Teaching can provide guidance if desired.

How suspected plagiarism is handled

In the case of a minor offence, marks will be deducted for poor academic practice and feedback will identify the problem. A meeting with the student will usually be offered, to discuss the matter. The Academic Practice and Support (APS) section of the student's LUSI record will be updated by a member of admin staff, to note that marks have been lost through poor academic practice. A copy of the relevant material will be passed to the Academic Officer. Students may appeal the judgement to the Academic Officer. Persistent offenders will be referred to their Director of Studies. Any suspected major offence must be referred to the Academic Officer, and no mark will be recorded until the case is resolved; copies will be made of the material which is under suspicion. The student will be informed that their mark is withheld and that they may appeal to the Academic Officer. An entry will be made in the APS section of the student’s LUSI record to the effect that the case has been referred to the Academic Officer.

This advice is provided to give a better understanding of the university's Plagiarism Framework.

https://gap.lancs.ac.uk/ASQ/Policies/Pages/PlagiarismFramework.aspx
Assessment regulations and degree classification

For Bachelor’s degrees (BSc and BA), a student normally needs to have studied 360 credits over three years, with at least 90 credits at level 6 (that is, from third-year modules). Usually this will be composed of 120 credits from year one (Part I) and 120 credits from each of years two and three (Part II).

For integrated Master’s degrees (MSci), a student normally needs to have studied 480 credits over four years, with at least 120 credits at level 7 (that is, fourth-year modules). Usually this will be composed of 120 credits from year one (Part I) and 120 credits from each of years two, three and four (Part II).

Only Part II credits contribute to the final degree classification. Each module contributes to the overall mean in proportion to the number of credits it is worth.

Aggregation score

In October 2011 the university implemented new undergraduate assessment regulations, which are now in place for all undergraduate students. These changes have been introduced to simplify the existing regulations, ensure markers use the full range of available marks across all disciplines and deal with mitigating circumstances in a more transparent way.

The main features are:-

- Assessed work which is quantitative will be marked in percentages. These marks will be converted to an aggregation score on a 24 point scale, as described in the table below.

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Aggregation score</th>
<th>Letter grade</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>24</td>
<td>A-, A, A+</td>
<td>First</td>
</tr>
<tr>
<td>90</td>
<td>22.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>19.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>16.5</td>
<td>B-, B, B+</td>
<td>Upper Second</td>
</tr>
<tr>
<td>60</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>13.5</td>
<td>C-, C, C+</td>
<td>Lower Second</td>
</tr>
<tr>
<td>50</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>10.5</td>
<td>D-, D, D+</td>
<td>Third</td>
</tr>
<tr>
<td>40</td>
<td>9</td>
<td>F</td>
<td>Fail</td>
</tr>
<tr>
<td>20</td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Some assessed work, such as project work, will be marked using letter grades. These grades will be converted to an aggregation score on a 24 point scale for the purposes of calculating your overall module results and your final degree class.

- Degree classifications will be based on your overall aggregation score and there will be clear definitions for borderline scores and departmental criteria for considering borderline cases.

- To progress between years, any failed modules must be resat. Only one resit opportunity is permitted.

- To qualify for a degree any modules which you have not passed must be condoned, that is you are given credit for taking them even though you have not achieved a pass mark. Failed module marks may only be condoned above a minimum aggregation score indicating a reasonable attempt has been made.
To be awarded an honours degree, you must attain an overall pass grade and have no more than 30 credits condoned.

The penalty for work submitted late is a reduction of one full grade for up to three days late and zero thereafter.

To see the full undergraduate assessment regulations and a student FAQ with answers to the most common questions relating to how you are assessed and how your overall degree result will be determined go to:

http://www.lancaster.ac.uk/sbs/registry/undergrads/AssessmentRegs.htm

**Resits**

A student who fails any module will have the opportunity of reassessment; for lecture modules, this normally involves taking a resit examination in the same academic year as the first attempt. For modules not in the student’s final year, the maximum aggregation score that the student can gain by reassessment is 9. For modules in the student’s final year, the reassessment will only be to gain sufficient credit to qualify for a degree.

Resits usually take place in August. Students are encouraged to contact lecturers over the summer to support during their revision, who will be happy to help. Be aware that out of term time some lecturers may not respond to emails promptly, so allow plenty of time for a response. In particular, we recommended that you contact lecturers at least two weeks before your exams.

When a student resits an examination, the department will submit a resit mark which is the maximum of:

- the original mark;
- the resit examination mark;
- the original coursework mark, with the resit examination mark.

A fee at a rate determined from time to time shall be payable by a student who is given permission to resit any examination or resubmission of dissertation.

In exceptional circumstances students may be allowed to take a re-sit exam as their first sitting with no fees applied. Such cases would include for example illness or family circumstances all would need appropriate signed written evidence.

**Progression Requirements**

In order to progress from Year 2 to Year 3 of a BA/BSc/MSci degree a student must achieve (following any opportunities for reassessment) an overall aggregation score of 9 or above with no more than 30 credits condoned.

If at the end of Year 3 a student enrolled in an **MSci** degree (excluding Study Abroad degrees) does not achieve the criteria for a 2.1 BSc degree, they will be automatically switched to a BSc degree, graduated, and will not be allowed to progress to Year 4.

If you are enrolled on a **Placement Year** or **Industry** degree scheme, and you failed to achieve a 14.5 average at the end of Year 2, then you might not be allowed to continue on your placement year, depending on your potential employer. In this case, you would be automatically transferred onto the corresponding BSc degree, and you would continue onto Year 3 the following year. If you do not manage to secure a placement or decide you no longer intend to take a placement year you will be transferred back onto the three year variant of your degree.
Students entering the third year on a **Study Abroad MSci** scheme are committed to the MSci from then on. If such a student wishes to change to a BSc, they are encouraged to contact the Study Abroad Director, who may be able to offer other options in exceptional cases.

**Condonation**

For students who entered Year 1 in 2015/16 or before, the examination board can condone up to 30 credits of failed modules for a classified 3 year degree, and up to 45 credits for a classified 4 year degree, but only if the student has taken reassessment and all of the aggregation scores in the failed modules are greater than or equal to 4 after reassessment.

For students who started in 2016/17 or after, the examination board can condone up to 30 credits of failed modules for a classified 3 year degree, and up to 45 credits for a classified 4 year degree, but only if the student has taken reassessment and all of the aggregation scores in the failed modules are greater than or equal to 7 after reassessment.

Some modules may be paired (to a maximum size of 30 credits) for the consideration of condonation. Pairing for condonation information can be found in Appendix 6 of the Undergraduate Assessment MARP regulations: [here](#)

**Examinations**

For most of the **Year 2** modules, the summer exam is worth 85% of the overall grade. In **Year 3**, with the exception of MATH361 and MATH362, most third year MATH modules have an exam assessment component of either 70% or 90%. In **Year 4**, most modules without a project or major coursework component have an exam component of 90%. See the online courses handbook for details: [http://www.lusi.lancaster.ac.uk/CoursesHandbook/](http://www.lusi.lancaster.ac.uk/CoursesHandbook/)

Past examination papers from previous years (without solutions) can be found here: [http://www.lancaster.ac.uk/student-based-services/exams-and-assessment/past-papers/](http://www.lancaster.ac.uk/student-based-services/exams-and-assessment/past-papers/)

Model solutions are not provided to examinations, because we wish students to use their own initiative, to learn to work independently and to develop their skills in problem solving. Using your own understanding to produce a solution, assisted by related examples from lecture notes, workshops and assessed exercises, is more valuable and develops mathematical insight far more than rote learning of a fixed method. If, despite your best efforts, the desired solution is still elusive, help may be sought from the lecturer, either during the relevant revision lecture, via email or by arranging a meeting.

**Intercalations**

Sometimes because of medical, financial or personal difficulties students feel they have no alternative but to apply to suspend their studies for a year. Whilst this option can be of benefit to some students, it is not without its drawbacks: one of the major ones being the fact that students are not permitted to claim benefits if they would normally be excluded under the full-time education rules. Intercalating students are regarded as continuing students on the grounds that they intend to resume their studies.

Don’t allow yourself to drift into a situation that ends with intercalation being the only option, because without some assured financial support - a guaranteed job or financial help from your family - you could be left with no source of income.

Do ensure that you seek help early if you are experiencing any problems that may adversely affect your academic work. Speak to someone in the department or any of the various welfare agencies or call into the Base, part of Student Based Services, in University House, who will put you in touch with someone in the Student Registry if necessary.

If personal circumstances mean that you are left with no alternative but to seek a period of intercalation, please contact the Base and your Director of Studies to arrange to discuss your application.
Withdrawals

If you feel uncertain about carrying on at Lancaster, it is important that you talk it through with your Director of Studies or one of the other support services such as your personal College Advisor or someone in Student Based Services. Some initial written advice is also available via http://www.lancaster.ac.uk/sbs/registry/undergrads/withdrawal.htm. It may be, for example, that you need time to adjust to a new and unfamiliar lifestyle.

Should you decide to leave, it is essential that you do not just walk out. You should contact the Student Registry within Student Based Services who will discuss your plans with you and formally approve your withdrawal. The Student Registry will notify Student Finance England to have payment of your loan and tuition fees stopped, as appropriate. If you have any books on loan from the Library or are in possession of any university equipment or property, please make sure that you return these - it will save you and us a lot of unnecessary letters and telephone calls.

In order to safeguard your entitlement to funding for any future course you should seek advice as soon as possible. Full details on this, and information regarding a transfer to another course/college, may be obtained from the Student registry.

Repeated years or repeated courses

A widely held, but incorrect, belief is that you can repeat a year of study if you haven’t done very well, repeat an individual course, or replace a course in which you have done badly with another one. This is not the case. The University’s examination and assessment regulations contain the following statement:

"No student shall be given an unfair advantage over fellow students through being allowed to automatically repeat individual modules, periods of study or a whole programme of study. Exceptional permission to repeat work may be granted by the designated Pro-Vice-Chancellor, the Provost for Student Experience, Colleges and the Library, an Academic Appeal or Review Panel as defined in the chapter on Academic Appeals, the Intercalations Committee or by the Standing Academic Committee in cases where a student’s academic performance has been adversely affected by personal, health or financial problems and where such cases have been properly documented.

No student shall normally be allowed to automatically replace modules in which he or she has failed or performed poorly by taking a different module in order to achieve better marks. Exceptional permission to do so may be granted by the designated Pro-Vice-Chancellor, the Provost for Student Experience, Colleges and the Library, by an Academic Appeal or Review Panel, as defined in the chapter on Academic Appeals, the Intercalations Committee or by the Standing Academic Committee in cases where a student’s academic performance has been adversely affected by personal, health or financial problems and where such cases have been properly documented."

Degree Classification

At the end of the degree programme a student’s overall mean will be calculated from their module aggregation scores taking into account the relative weightings (credit value) of the modules. That

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Aggregation score</th>
<th>Degree class</th>
</tr>
</thead>
<tbody>
<tr>
<td>68.3 to 100</td>
<td>17.5 to 24.0</td>
<td>First</td>
</tr>
<tr>
<td>67.0 to 68.0</td>
<td>17.1 to 17.4</td>
<td>Borderline</td>
</tr>
<tr>
<td>58.3 to 66.7</td>
<td>14.5 to 17.0</td>
<td>2.1</td>
</tr>
<tr>
<td>57.0 to 58.0</td>
<td>14.1 to 14.4</td>
<td>Borderline</td>
</tr>
<tr>
<td>48.3 to 56.7</td>
<td>11.5 to 14.0</td>
<td>2.2</td>
</tr>
<tr>
<td>47.0 to 48.0</td>
<td>11.1 to 11.4</td>
<td>Borderline</td>
</tr>
<tr>
<td>40.0 to 46.7</td>
<td>9.0 to 11.0</td>
<td>Third</td>
</tr>
<tr>
<td>36.0 to 39.6</td>
<td>8.1 to 8.9</td>
<td>Borderline</td>
</tr>
<tr>
<td>0.00 to 35.7</td>
<td>0.0 to 8.0</td>
<td>Fail</td>
</tr>
</tbody>
</table>
overall mean will then be rounded to one decimal place and be used to determine the class of degree to be awarded as follows:-

If a student’s overall mean falls into one of the borderline ranges defined above, the examining bodies will apply the following rubric for deciding the degree class to be recommended:

(a) For all students, where a student falls into a borderline then the higher award should be given where either half or more of the credits from Part II are in the higher class or the final year average is in the higher class.

(b) For all students on integrated masters programmes, where a student falls into a borderline then the higher award should be given where half or more of the credits from Part II are in the higher class.

(c) Borderline students not meeting either of the criteria described in (a) or (b) above would normally be awarded the lower class of degree unless (d) applies.

(d) That for all students, borderline or not, Examination Boards should continue to make a special case to the Committee of Senate for any student where the class of degree recommended by the Board deviates from that derived from a strict application of the regulations. Such cases would be based around circumstances pertaining to individual students where these circumstances have not already been taken into account.

Full details of the degree classification regulations are given within the Manual of Academic Regulations and Procedures (MARP) which can be found at:

https://gap.lancs.ac.uk/ASQ/QAE/MARP/Pages/default.aspx

Conversion between BSc and Msci

Single majors may change between the three-year BSc and the four-year MSci degree schemes at any time during their second or third year.

In order to continue into the fourth year of the MSci, a Lancaster-based student must meet the criteria for at least a 2.1 BSc degree at the end of year 3; any student, who fails to achieve this will instead be considered for the award of a classified BSc at the end of the third year.

For students on Study Abroad or Placement Year schemes, however, a certain level of performance is required in the second year, measured by the average mark over second-year modules: 14.5 Aggregation Score, achieved at the first sitting. Any Study Abroad student who doesn’t achieve that will be transferred to a Lancaster based MSci. Students entering the third year on a Study Abroad MSci scheme are committed to the MSci from then on. Placement Year students who don’t achieve 14.5 might be required to transfer to a non-placement year scheme, depending on their potential employer.

Lancaster-based students who withdraw during the fourth year of the MSci, or whose achievement at the end of the year does not qualify them to be awarded an MSci degree, may be awarded a classified BSc degree with Honours, in accordance with the regulations for the corresponding BSc award. The decision on the class of their degree may not be made until the end of the following exam period; however, the student will have access to their university transcript, detailing the marks obtained in the second and third year.

Complaints procedure

The University Student Complaints Procedure can be found at

https://gap.lancs.ac.uk/complaints/Pages/default.aspx
This procedure applies to complaints made by current Lancaster University students, or leavers within 3 months of the date of their graduation or withdrawal (the Complaints Coordinator may accept complaints beyond this period if exceptional circumstances apply), in respect of:

- the delivery and/or management of an academic module or programme, or supervised research;
- any services provided by academic, administrative or support services (other than the Students’ Union, who operate their own Complaints Procedure)

This procedure does not apply to complaints relating to:

- decisions of Boards of Examiners (these are governed by the Academic Review and Appeal Procedures)
- suspected professional malpractice (if it is established that misconduct of staff or students has occurred that is governed by other disciplinary procedures or external legal systems, then these procedures will be invoked and the complaint will not be dealt with under the student complaints procedure)
- any suspected potential breach of criminal law.
Careers Information

The department’s academic employability champions are listed at the start of this handbook and they can provide you with information on ways to develop your employability skills and the types of careers available to you. For more careers information and details of upcoming events, please see the Maths Careers page on Moodle.

Also, the central Careers Service will have department specific sessions in each of your undergraduate years. We strongly advise you to visit Careers regularly so that you can use their expertise to ensure that by the start of your final year you have the necessary work experience, other extra-curricular activities and knowledge of the job market to put together a successful application for your first graduate job. For more information see:

http://www.lancaster.ac.uk/careers/

Accreditation and membership of professional societies

Graduates with a single-major degree in Mathematics and/or Statistics are recommended to take advantage of membership of one of the following three professional societies.

- The London Mathematical Society (LMS) http://www.lms.ac.uk/
- The Royal Statistical Society (RSS) http://www.rss.org.uk/
- The Institute of Mathematics and its Applications (IMA) http://www.ima.org.uk/

Both the RSS and the IMA accredit the following degrees.

- BSc Mathematics*
- BSc Mathematics with Statistics
- BSc Statistics
- MSci Mathematics*
- MSci Mathematics with Statistics
- MSci Statistics
- MSci Mathematics (Study Abroad)*
- MSci Mathematics with Statistics (Study Abroad)
- MSci Statistics (Study Abroad)

* Some conditions apply for the RSS accreditation, see below.

Graduates of the MSci degrees should have taken the MATH492 Statistics Dissertation in order to be accredited, although those who have taken MATH491 might be eligible for GradStat status on an individual basis depending on what other modules have been chosen.

Graduates of the BSc Mathematics, MSci Mathematics and MSci Mathematics with Study Abroad who want their degree to be RSS-accredited should have taken at least four Statistics modules in Years 3-4 (totalling 60 credits).

The Royal Statistical Society will also consider individual applications from graduates of BSc or MSci in Mathematics who would need to produce suitable transcripts to gain accreditation.

The Institute of Actuaries grants an exemption from CT3 for students who obtain an average of 60% or more in each of MATH230 and MATH235.

http://www.actuaries.org.uk/
Inclusive learning, medical conditions, and disabilities

You are admitted to the University on your academic record. The University welcomes all students and has an array of support services to ensure no student feels disadvantaged. This department follows University Policy and strives to make itself an inclusive department. Some students create an Inclusive Learning and Support Plan (ILSP) with the University’s Disability Service, and that is the primary mechanism for communication between the Disability Service and the departments. You can contact the Disabilities Service at any time if you feel you might need advice (for example, you might want to be assessed for dyslexia).

The department of Maths and Stats uses the ILSPs in the following way. At the start of each module, your lecturers and workshop tutors will be provided access to these documents, and they are told that they are expected to comply with the recommendations. Our department has also developed some general guidance for Inclusive Learning that addresses some of the more common items listed in student ILSPs; and all lecturers are expected to follow that guidance at all times. If there are items in your ILSP which are not covered by our Inclusive Learning guidance and require the attention of our lecturer or workshop tutor, then these will be flagged up and emphasized to them by a staff member in our Teaching Office.

If you believe that someone in our department is not fully adhering to one or more items listed in your ILSP, then please contact the Teaching Office at mathsteaching@lancaster.ac.uk and we will do our best to address the issue to your satisfaction. If you would prefer us not to forward your comments about a lecturer or workshop tutor directly to them, then please say so in your message.

If you believe there are items that should be in your ILSP but are not there, then please contact the Disability Office (disability@lancaster.ac.uk). They are able to update their records; they will then pass the updated version to us, which we will immediately act on as appropriate.

Confidentiality: If it is useful for you, do talk in confidence to staff, but please remember that you may not be able to access all the support available to you unless we can inform other staff involved in support arrangements. You may also find it helpful to look at some of the following web pages for local and national background.

Lancaster Disabilities Service: http://www.lancaster.ac.uk/student-based-services/disability/

You can also easily reach the site above via the alphabetical list on the University home page.

Lancaster Equal Opportunities web pages: http://www.lancaster.ac.uk/edi/

See also: http://www.equalityanddiversity.co.uk/
For Year 2 students

The following eight modules are offered in Year 2; each is worth 15 credits.

**Weeks 1-10**
- MATH210 Real Analysis
- MATH220 Linear Algebra II
- MATH230 Probability II
- MATH240 Project Skills*

**Weeks 11-20**
- MATH215 Complex Analysis
- MATH225 Abstract Algebra
- MATH235 Statistics II
- MATH245 Computational Mathematics

*MATH240 also has a group project which runs in Weeks 11-20.

Any single-major degree scheme requires the student to take all eight of these modules. Students enrolled in a combined major scheme would normally take four of the above modules.

See page 32 for more information about the modules required for the various degree schemes.

Short descriptions of modules can be found on page 38. More information about the modules themselves, such as their syllabuses and assessment format can be found online at the Module Catalogue: [http://www.lusi.lancaster.ac.uk/CoursesHandbook/](http://www.lusi.lancaster.ac.uk/CoursesHandbook/)

One important factor when choosing second-year modules is the effect of the decisions taken on the options available in the third year. As a guide, please see page 38 for the expected list of third-year modules next year with their prerequisites. (However, some further changes may occur.)

For Year 3 students

Any single-major degree scheme requires the student to take eight MATH3xx modules. All Year 3 modules are worth 15 credits. Students enrolled in a combined major scheme would normally take four MATH3xx modules, see page 32 for details.

The provisional timetable for Year 3 modules is a separate document, but should be attached as an appendix.

Some details of these modules are provided after page 38; further details can be found in the LUSI online Courses Handbook [http://www.lusi.lancaster.ac.uk/CoursesHandbook/](http://www.lusi.lancaster.ac.uk/CoursesHandbook/)

However, please note that **it is possible that not all of the courses listed below may actually be given**. If you enrol in a module that ends up not being given, then you will be informed by the end of Week 25 of the preceding academic year, and you will be asked to change your registration accordingly.

Please note that changes into or out of a module are only allowed up to and including the Friday of the second week of the module concerned.

**Pre-requisites for Third Year options**

The following table lists the pre-requisites for third-year modules.

If you are registered for a 4 year MSci programme, please also see the table of fourth-year modules on page 29 and ensure that your module choices for Year 3 are compatible with the modules you intend to take in year 4.
### Third-year module

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Title</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH313</td>
<td>Probability Theory</td>
<td>MATH210, MATH230</td>
</tr>
<tr>
<td>MATH314</td>
<td>Lebesgue Integration</td>
<td>MATH210; Excl MATH414</td>
</tr>
<tr>
<td>MATH316</td>
<td>Metric Spaces</td>
<td>MATH210, MATH220</td>
</tr>
<tr>
<td>MATH317</td>
<td>Hilbert Spaces</td>
<td>MATH210, MATH220, (MATH316 helpful); (Excl.MATH417)</td>
</tr>
<tr>
<td>MATH318</td>
<td>Differential Equations</td>
<td>MATH210</td>
</tr>
<tr>
<td>MATH319</td>
<td>Linear Systems</td>
<td>MATH215, MATH220</td>
</tr>
<tr>
<td>MATH321</td>
<td>Groups and Symmetry</td>
<td>MATH225</td>
</tr>
<tr>
<td>MATH322</td>
<td>Commutative Algebra</td>
<td>MATH111, MATH225</td>
</tr>
<tr>
<td>MATH323</td>
<td>Algebraic Curves</td>
<td>MATH225, (MATH240 recommended)</td>
</tr>
<tr>
<td>MATH325</td>
<td>Representation Theory of Finite Groups</td>
<td>MATH220, MATH225, (MATH321 recommended)</td>
</tr>
<tr>
<td>MATH326</td>
<td>Graph Theory</td>
<td>MATH220</td>
</tr>
<tr>
<td>MATH327</td>
<td>Combinatorics</td>
<td>MATH111, MATH112, MATH220</td>
</tr>
<tr>
<td>MATH328</td>
<td>Number Theory</td>
<td>MATH111; (MATH225 helpful)</td>
</tr>
<tr>
<td>MATH329</td>
<td>Geometry of Curves and Surfaces</td>
<td>MATH115 or MATH220</td>
</tr>
<tr>
<td>MATH330</td>
<td>Likelihood Inference</td>
<td>MATH235</td>
</tr>
<tr>
<td>MATH331</td>
<td>Bayesian Inference</td>
<td>MATH235</td>
</tr>
<tr>
<td>MATH332</td>
<td>Stochastic Processes</td>
<td>MATH230</td>
</tr>
<tr>
<td>MATH333</td>
<td>Statistical Models</td>
<td>MATH330, (MATH240 recommended)</td>
</tr>
<tr>
<td>MATH334</td>
<td>Time series analysis</td>
<td>MATH330, (MATH240 recommended)</td>
</tr>
<tr>
<td>MATH335</td>
<td>Medical Statistics</td>
<td>MATH235, (MATH240 recommended)</td>
</tr>
<tr>
<td>MATH336</td>
<td>Multivariate Statistics in Machine Learning</td>
<td>MATH220, MATH235, MATH245</td>
</tr>
<tr>
<td>MATH345</td>
<td>Financial Mathematics</td>
<td>MATH230, MATH332</td>
</tr>
<tr>
<td>MATH361</td>
<td>Mathematical Education</td>
<td>None</td>
</tr>
<tr>
<td>MATH362</td>
<td>Mathematical Education Placement</td>
<td>MATH361</td>
</tr>
</tbody>
</table>

For the purposes of the regulations on pp.31-33,

- MATH313-329 are Mathematics modules;
- MATH330-345 are Statistics modules;
- MATH361-362 are neither;
- All of the above are MATH3xx modules.

- See list of module choices at the end of this booklet.

### For Year 4 students

In Year 4 single-major students must take 120 credits, including six 15 credit MATH4xx modules and either a Mathematics or Statistics dissertation, worth 30 credits. See page 32 for specific degree scheme requirements. Students enrolled in combined major schemes should also see page 32 for details.

The provisional timetable for Year 4 modules is a separate document, but should be attached as an appendix.

Some details of these modules are provided after page 38; further details can be found in the LUSI online Courses Handbook [http://www.lusi.lancaster.ac.uk/CoursesHandbook/](http://www.lusi.lancaster.ac.uk/CoursesHandbook/)
However, please note that it is possible that not all of the courses listed below or in the provisional timetable may actually be given. If you enrol in a module that ends up not being given, then you will be informed by the end of Week 25, and you will be asked to change your registration accordingly.

Please note that changes into or out of a module are only allowed up to and including the Friday of the second week of the module concerned.

**Module names, prerequisites and exclusions**

The following table lists the pre-requisites for fourth year modules.

<table>
<thead>
<tr>
<th>Fourth Year Module</th>
<th>Pre-requisites</th>
<th>Exclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH411 Operator Theory</td>
<td>MATH317 or MATH417</td>
<td></td>
</tr>
<tr>
<td>MATH412 Topology and Fractals</td>
<td>MATH210</td>
<td></td>
</tr>
<tr>
<td>MATH413 Probability Theory</td>
<td>MATH210; MATH230</td>
<td>MATH313</td>
</tr>
<tr>
<td>MATH414 Lebesgue Integration</td>
<td>MATH210</td>
<td>MATH314</td>
</tr>
<tr>
<td>MATH416 Metric Spaces</td>
<td>MATH210; MATH220</td>
<td>MATH316</td>
</tr>
<tr>
<td>MATH417 Hilbert Spaces</td>
<td>MATH210 or MATH211, MATH220; (MATH316 or MATH416 helpful)</td>
<td>MATH317</td>
</tr>
<tr>
<td>MATH423 Algebraic Curves</td>
<td>MATH225, (MATH240 is recommended)</td>
<td>MATH323</td>
</tr>
<tr>
<td>MATH424 Galois Theory</td>
<td>MATH225, MATH322; (MATH321 recommended)</td>
<td></td>
</tr>
<tr>
<td>MATH425 Representation Theory of Finite Groups</td>
<td>MATH220, MATH225 or MATH226; (MATH321 recommended)</td>
<td>MATH325</td>
</tr>
<tr>
<td>MATH426 Lie Groups and Lie Algebras</td>
<td>MATH225 (MATH115 or MATH329 helpful; MATH321 or MATH325 helpful)</td>
<td></td>
</tr>
<tr>
<td>MATH432 Stochastic Processes</td>
<td>MATH230</td>
<td>MATH332</td>
</tr>
<tr>
<td>MATH440 Stochastic Calculus for Finance</td>
<td>MATH332 or MATH432, (MATH313/413 recommended)</td>
<td></td>
</tr>
<tr>
<td>MATH445 Financial Mathematics</td>
<td>MATH230, MATH332 or MATH432</td>
<td>MATH345</td>
</tr>
<tr>
<td>MATH451 Likelihood Inference</td>
<td>MATH235</td>
<td>MATH330</td>
</tr>
<tr>
<td>MATH452 Generalised Linear Models</td>
<td>MATH330 or MATH451</td>
<td></td>
</tr>
<tr>
<td>MATH453 Bayesian Inference</td>
<td>MATH235</td>
<td>MATH331</td>
</tr>
<tr>
<td>MATH454 Computer Intensive Methods</td>
<td>MATH330 or MATH451, MATH331 or MATH453, (MATH240 recommended)</td>
<td></td>
</tr>
<tr>
<td>MATH463 Clinical Trials</td>
<td>MATH235, MATH240</td>
<td></td>
</tr>
<tr>
<td>MATH464 Principles of Epidemiology</td>
<td>MATH235, MATH240</td>
<td></td>
</tr>
<tr>
<td>CHIC465 Environmental Epidemiology</td>
<td>MATH330 or MATH451</td>
<td></td>
</tr>
<tr>
<td>MATH466 Longitudinal Data Analysis</td>
<td>MATH330 or MATH451, MATH333 or MATH452</td>
<td></td>
</tr>
<tr>
<td>MATH482 Assessing Financial Risk: Extreme Value Methods</td>
<td>MATH330 or MATH451, MATH332 or MATH432</td>
<td></td>
</tr>
<tr>
<td>MATH491 Mathematics Dissertation</td>
<td>MATH240</td>
<td></td>
</tr>
<tr>
<td>MATH492 Statistics Dissertation</td>
<td>MATH240</td>
<td></td>
</tr>
</tbody>
</table>
For the purposes of the regulations on pp.31-33,

- MATH411-426 are taught MATH4xx Mathematics modules;
- MATH432-482 and CHIC465 are taught MATH4xx Statistics modules;
- MATH491-492 are neither.
- All of the above, apart from MATH491-492, are taught MATH4xx modules.

• See list of module choices at the end of this booklet.
Single-major degree schemes

The following rules apply to students to begin Year 2 in 2017/18 or later. For students who began Year 2 in 2016/17 or earlier, please see the 2016/17 version of this handbook.

Students may change degree schemes by submitting the appropriate change of scheme form. For example, the BSc Mathematics with Statistics degree scheme is accredited by the RSS, so some students who are currently on the BSc Mathematics degree who are planning on taking 4 or more statistics modules in their third year may wish to switch.

All degree schemes require students to take a total of 120 credits in each year. All single major degree schemes, including Year Abroad schemes, require students to take all eight 15-credit Year 2 modules: MATH210, MATH215, MATH220, MATH225, MATH230, MATH235, MATH240, MATH245; these are the only MATH2xx modules considered below. In subsequent years there are choices available.

The following are minimum requirements; the vast majority of Year 3 students choose 8 MATH3xx modules instead of just 6. Furthermore, a student may be able to substitute a MATH3xx module for a more advanced taught MATH4xx module, subject to approval by their Director of Studies.

**BSc Mathematics**

First Year: MATH100, MATH110
Second Year: All eight MATH2xx modules.
Third Year: At least 6 MATH3xx modules

**BSc Mathematics with Statistics**

First Year: MATH100, MATH110
Second Year: All eight MATH2xx modules.
Third year: At least 6 MATH3xx modules, 4 of which must be statistics modules.

**BSc Statistics**

First Year: MATH100, MATH110
Second Year: All eight MATH2xx modules
Third Year: At least 6 MATH3xx modules, 4 of which must be statistics modules.

**BSc (Placement Year)**

For each of the three BSc degrees above, we also offer the option of taking a placement year. To enrol on this degree scheme students must have taken the module FST150 in their first year.

First Year: MATH100, MATH110, FST150
Second Year: All eight MATH2xx modules, FST250
Third Year (Placement Year): FST350a
Fourth Year: FST350b, together with the same requirements for the corresponding Third Year of the non-placement year BSc degree scheme.
**MSci Mathematics**

First Year: MATH100, MATH110  
Second Year: All eight MATH2xx modules.  
Third Year: At least 6 MATH3xx modules  
Fourth Year: 6 taught MATH4xx modules, and MATH491 or MATH492

**MSci Mathematics with Statistics**

First Year: MATH100, MATH110  
Second Year: All eight MATH2xx modules.  
Third Year: At least 6 MATH3xx modules, 4 of which must be statistics modules.  
Fourth Year: 6 taught MATH4xx modules, 2 of which must be taught MATH4xx Statistics modules; compulsory 30 credit dissertation module could be either MATH491 or MATH492.

**MSci Statistics**

First Year: MATH100, MATH110  
Second Year: All eight MATH2xx modules.  
Third Year: At least 6 MATH3xx modules, 4 of which must be statistics modules.  
Fourth Year: At least 6 MATH4xx modules, 3 of which must be taught MATH4xx Statistics modules; the dissertation must be MATH492.

**MSci (Study Abroad)**

The regulations are the same as for the corresponding MSci degree, interpreted appropriately. The requirement "At least 4 MATH3xx Statistics modules" will be taken to mean that at least 50% of the modules taken for assessment while abroad should have a significant statistical component.

**Minor modules**

In Year 3 of a single-major BSc degree, up to two 15 credit MATH modules may be replaced by minor courses in other subjects in Year 3, but in practice the choice is usually limited by prerequisites; the vast majority of students choose 8 MATH3xx modules. The following are some modules that may be suitable, and have some mathematical content. Note that enrolment is subject to agreement from the administering department.

- MSCI222: Optimisation  
- ECON228: Game Theory  
- PPR305: Logic and Language
Combined-major degree schemes

Combined major schemes normally require 60 credits per year from each subject. The Mathematics/Statistics component of the various degrees is as follows.

**BSc Accounting, Finance and Mathematics**

**Year 1:** ACF100, ECON102, MATH100.
**Year 2:** MATH220, MATH230, MATH235, MATH245, ACF211, ACF212; one of ACF.F213M or ACF.F213L; one of ACF.F214M or ACF.F214L.
**Year 3:** 60 credits in modules offered by the Department of Accounting and Finance, including ACF301, ACF311, and ACF350. 60 credits in modules offered by the Department of Mathematics and Statistics. MATH330 is mandatory and 30 further credits must be in statistics modules.

**Excluded Modules:** MATH362, ACF220, ACF222, ACF261, ACF263M, ACF263L, ACF331, ACF332, ACF333, ACF334.

**BSc Accounting, Finance and Mathematics (Industry)**

**Year 1:** ACF100, ECON102, MATH100, MNGT150.
**Year 2:** OWT250a (Social Research Methods 7.5 credits), MATH220, MATH230, MATH235, MATH245, ACF211, ACF212; one of ACF.F213M and ACF.F213L; one of ACF.F214M and ACF.F214L.
**Year 3:** Industrial placement. Dissertation (AC.F340, 22.5 credits)
**Year 4:** 60 credits from the Department of Accounting and Finance, including ACF301, ACF311, and ACF350. 60 credits from the Department of Mathematics and Statistics, including MATH330 and 30 further credits in statistics modules.

**Excluded Modules:** MATH362, ACF220, ACF222, ACF261, ACF263M, ACF263L, ACF331, ACF332, ACF333, ACF334.

**BSc Computer Science and Mathematics**

**Year 1:** MATH100, MATH110, SCC110, SCC120.
**Year 2:** MATH220, SCC202, SCC204, SCC210. Three further MATH2xx modules. One further module must be chosen from SCC.201 and SCC.205.
**Year 3:** Four MATH3xx modules (excluding MATH362). Two of SCC.201, SCC.205, SCC.312, SCC.360, SCC.361 and SCC.363.

**Excluded modules:** MATH362.

**MSci Computer Science and Mathematics**

**Year 1:** MATH100, MATH110, SCC110, SCC120
**Year 2:** MATH220, SCC202, SCC204, SCC205, SCC210. Three further MATH2xx modules (must include MATH240 if taking MATH49x in year 4).
**Year 3:** SCC312, SCC360, SCC361, SCC363. Four MATH3xx modules (excluding MATH362)
**Year 4:** One of the following pathways. In all cases, the total number of credits must be 120. Mathematics pathway: (prerequisite MATH240 from year 2) One of MATH491, MATH492, or MATH493 (dissertation, 30 credits). Three or four MATH4xx modules and SCC.400 (15 credits each). One or two of SCC.401-3, SCC.411-3 (15 credits each).
Computer Science pathway: SCC.421 (dissertation, 30 credits). Two or three MATH4xx modules (15 credits each). SCC.400 and two or three of SCC.401-3, SCC.411-3 (15 credits each)
Computer Science with Placement pathway: SCC.421 (dissertation, 30 credits). SCC.419 (placement, 30 credits). Two MATH4xx modules (15 credits each). SCC.400 and one of SCC.401-3 (15 credits each)

**Excluded modules:** MATH362.
**BSc Economics and Mathematics**

**Year 1:** ECON101, ECON105, MATH100.

**Year 2:** MATH220, MATH230, MATH235, MATH245. Four of ECON207, ECON208, ECON211, ECON212, ECON220, ECON221, ECON222a, ECON222b, ECON223, ECON228, ECON229 and ECON230.

**Year 3:** MATH330 and three more MATH3xx modules (excluding MATH362) two of which must be in statistics. Four of ECON228, ECON229, ECON230, ECON321-9, ECON33x.

**Excluded Modules:** ECON103, ECON209, ECON213, ECON224, ECON225, MATH362.

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**BSc Economics and Mathematics (Industry)**

**Year 1:** ECON101, ECON105, MATH100.

**Year 2:** MATH220, MATH230, MATH235, MATH245. OWT.250 (Social Research Methods). Four of ECON207, ECON208, ECON211, ECON212, ECON220, ECON221, ECON222A, ECON222B, ECON223, ECON228, ECON229 and ECON230

**Year 3:** Industrial placement.

**Year 4:** MATH330 and three more MATH3xx modules (excluding MATH362) two of which must be in statistics. ECON350 (dissertation). Four of ECON228, ECON229, ECON230, ECON320-8.

**Excluded Modules:** ECON103, ECON209, ECON213, ECON224, ECON225, MATH362.

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**BSc Financial Mathematics**

**Year 1:** MATH100, MATH110, ACF100.

**Year 2:** MATH210, MATH230, MATH235 and one further MATH2xx module, ACF215, ECON224, ECON225; one of AC.F214M or AC.F214L.

**Year 3:** MATH313, MATH330, two more MATH3xx statistics modules (excluding MATH362). Four of AC.F302, AC.F304, AC.F305, AC.F321, AC.F324.

**Excluded modules:** MATH362.

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**BSc Financial Mathematics (Industry)**

**Year 1:** MATH100, MATH110, FST150, AC.F100, AC.F150.

**Year 2:** MATH210, MATH230, MATH235 and one further MATH2xx module. FST250, ACF215, ECON224, ECON225; one of AC.F214M or AC.F214L.

**Year 3:** Industrial placement and FST350a (10 credits).

**Year 4:** FST350b. MATH313, MATH330, two further MATH3xx statistics modules (excluding MATH362). Four of AC.F302, AC.F304, AC.F305, AC.F321, AC.F322, AC.F323, AC.F324, AC.F380.

**Excluded Modules:** MATH362.

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**MSci Financial Mathematics**

**Year 1:** MATH100, MATH110, ACF100

**Year 2:** MATH210, MATH230, MATH235 and one further MATH2xx module. ACF215, ECON224, ECON225; one of AC.F214M and AC.F214L.

**Year 3:** MATH313, MATH330 and two* further MATH3xx statistics modules. Four of AC.F302, AC.F304, AC.F305, AC.F321, AC.F324.

**Year 4:** ACF605, MSCI516, MSCI536. In addition, one of the following pathways.

- **Mathematics pathway:** (prerequisite MATH240 from year 2 or 3). One of MATH491, MATH492, MATH493 (dissertation, 30 credits). Four* MATH4xx statistics modules.

- **Management Science pathway:** QFIN400 (dissertation, 30 credits). Two* MATH4xx modules and three of AC.F629, ECON451, ECON452, ECON454, ECON456, MSCI513, MSCI523, MSCI526.

*For either pathway, students must have taken either MATH332 or MATH432 by the end of their degree.
Excluded Modules: MATH362 MATH453 may not be taken if MATH331 was taken in Year 3. MATH454 may only be taken if either MATH331 was taken in Year 3, or MATH453 is also taken. AC.F629 may not be taken if AC.F324 was taken in Year 3.

BA French/German/Italian/Spanish Studies and Mathematics

In what follows, LLLL stands for one of FREN, GERM, SPAN

Year 1: MATH100. Either LLLL100 or LLLL101.
Year 2: Four MATH2xx modules. DELC200, LLLL233. Students who took LLLL100 must take LLLL200i and LLLL201i. Students who took LLLL101 must take LLLL200 and LLLL201. One further 15 credit Part II module from the Department of European Languages and Cultures (note that DELC200 does not carry any credit).
Year 3: Year abroad. DELC310 (30 credit).
Year 4: Four MATH3xx modules. LLLL300, LLLL301. 30 credits from Part II modules offered by the Department of European Languages and Cultures.

Excluded Modules: MATH362.

BSc Mathematics, Operational Research, Statistics and Economics (MORSE)

Year 1: MATH100, ECON101, MSCI 101, MSCI 103.
Year 2: MSCI222, MSCI223, MATH 220, MATH230, MATH 235, ECON 207, ECON208. One additional module from any of MSCI, MATH, ECON for which you have the necessary prerequisites (except disallowed combinations).
Year 3: MATH330. Seven further modules. One module must be from ECON, one from MSCI. Three further from any of MSCI, MATH, ECON. Two remaining modules can be chosen freely from across the university.

BSc Mathematics, Operational Research, Statistics and Economics (MORSE) (Industry)

Year 1: MATH100, ECON101, MSCI 101, MSCI 103.
Year 2: MSCI222, MSCI223, MATH 220, MATH230, MATH 235, ECON 207, ECON208. One additional module from any of MSCI, MATH, ECON for which you have the necessary prerequisites (except disallowed combinations).
Year 3: Industrial placement.
Year 4: MATH330. Seven further modules. One module must be from ECON, one from MSCI. Three further from any of MSCI, MATH, ECON. Two remaining modules can be chosen freely from across the university.

BA Mathematics and Philosophy

Year 1: MATH100, MATH110, PHIL100.
Year 2: MATH210, MATH220, MATH215, MATH225. 60 credits from the Part II modules offered by the Department of Politics, Philosophy and Religion.
Year 3: Four MATH3xx modules. 60 credits from the Part II modules offered by the Department of Politics, Philosophy and Religion. This may include the 30 credit dissertation module PPR.399.

BSc Theoretical Physics with Mathematics

Year 1: MATH100, MATH110 (but with PHYS115 instead of MATH115), PHYS100.
Year 2: MATH210, MATH220, MATH215, MATH225, PHYS222, PHYS223, PHYS232, PHYS272.
Year 3: Two MATH3xx modules. PHYS311, PHYS313, PHYS321, PHYS322, PHYS378, PHYS379

Excluded Modules: MATH362

MSc Theoretical Physics with Mathematics

Year 1: MATH100, MATH110 (but with PHYS115 instead of MATH115), PHYS100.
Year 2: MATH210, MATH220, MATH215, MATH225, PHYS222, PHYS223, PHYS232, PHYS272.
Year 3: Two MATH3xx modules. PHYS311, PHYS313, PHYS321, PHYS322, PHYS378, PHYS379.
Year 4: PHYS451, PHYS452. Two modules from MATH4xx, excluding MATH491/2. 30 credits from amongst PHYS48x and PHYS411. 
**Excluded Modules:** MATH362.

**Natural Sciences**

The Natural Sciences programme offers a flexible degree scheme, which is suited for students who would like to take certain combinations of modules which aren't offered through any other degree scheme. Please contact the Natural Science Coordinator in our department for more information.
Module Descriptions

Below are all of our Year 2, 3, and 4 modules available to Mathematics and Statistics students. Some modules listed below have a Project component to their assessment. These are typically written reports, to be completed by students individually, and are assessed by the lecturer, who will give personalized feedback. Projects are an excellent opportunity to improve a wide range of your skills; the exam component in those modules is weighted less than non-project modules, which may reduce the amount of pressure on students during exam time.

More information about the modules can be found online at the Module Catalogue.

http://www.lusi.lancaster.ac.uk/CoursesHandbook/

MATH210: Real Analysis (15 cr.)
Prereq.: MATH101, MATH113, MATH114
Coursework: 15%, Exam: 85%
The course starts with a recap of limits of sequences and convergence of series. The notion of a limit is then extended to functions, which leads to the analysis of differentiation, including proper proofs of techniques learned at A-level and in MATH114. The Intermediate Value Theorem is now given the respect it deserves and proved from the definitions, and we discover that it has more applications than expected. We turn next to the Mean Value Theorem: earlier results ensure that its proof is now easy, and we show that it, too, has many applications of widely differing kinds. The next topic is new: sequences and series of functions (rather than just numbers); again it has many applications, and is central to more advanced analysis. The notion of integration is then put under the microscope; once it is properly defined (via limits) we show how to get from this definition to the familiar technique of evaluating integrals by reverse differentiation. We describe some applications of integration that are quite different from the ones in A-level before finally turning to Fourier series and some further applications.

MATH215: Complex Analysis (15 cr.)
Prereq.: MATH210
Coursework: 15%, Exam: 85%
Complex Analysis had its origins in differential calculus and the study of polynomial equations. In this course we consider the differential calculus of functions of a single complex variable and study power series and mappings by complex functions. The integral calculus of complex functions leads to some elegant and important results including the fundamental theorem of algebra. These classical theorems are also used to evaluate real integrals.

MATH220: Linear Algebra II (15 cr.)
Prereq.: MATH105
Coursework: 15%, Exam: 85%
The course is concerned with the study of vector spaces, together with their structure-preserving maps and their relationship to matrices. It considers the effect of changing bases on the matrix representing one of these maps, and examines how to choose bases so that this matrix is as simple as possible. It also studies vector spaces in which the concepts of length and angle can be introduced.

MATH225: Abstract Algebra (15 cr.)
Prereq.: MATH220
Coursework: 15%, Exam: 85%
From your previous mathematical studies, you will be aware of examples of different types of symmetries. As well as geometric symmetries (rotations, reflections, translations), you have also met permutations and linear transformations. The notion of a group is designed precisely to capture the common elements of all of these manifestations of symmetries. We take an abstract approach, where we can prove very general results that we will apply to lots of examples. We will begin the study of abstract groups, looking at their internal structure (subgroups) and how groups can be related by structure-preserving functions (homomorphisms). You have also encountered several different generalizations of "number systems" - the integers, the integers modulo n, polynomials and fields. Just as groups model symmetries, so rings are abstract models for number systems. They have an addition and a multiplication, satisfying most (but not all) of the familiar properties of the examples we have just mentioned. Again we will study the internal structure of rings, their structure-preserving maps and some basic results and fundamental theorems. The examples and results studied here are used and developed further throughout later pure mathematics modules in algebra, analysis, combinatorics and geometry."
MATH230: Probability II (15 cr.)  
Prereq.: MATH102, MATH103, MATH105  
Coursework: 15%, Exam: 85%  
Probability provides the theoretical basis for statistics and is of interest in its own right. Basic concepts covered in the first year probability module are recapped, with several important continuous probability distributions investigated in detail. We then consider transformations of random variables and groups of two or more random variables; this leads to two theoretical results about the behaviour of averages of large numbers of random variables, which have important practical consequences in statistics.

MATH235: Statistics II (15 cr.)  
Prereq.: MATH104, MATH230  
Coursework: 15%, Exam: 85%  
Statistics is the science of using observed data to help us understand patterns of population behaviour. Such data may be collected from samples, surveys or designed experiments. In this module we build on the concepts of statistical modelling, parameter estimation and testing introduced in Math105. The first half of the course introduces the linear regression model as a tool to model the relationships between observed variables. For this model we consider parameter estimation and interpretation, model fit and model selection. Next we consider the concept of likelihood-based inference which provides a general method by which the parameters in a statistical models can be estimated in order to draw conclusions from observed data.

MATH240: Project Skills (15 cr.)  
Prereq.: Student must be majoring in the department of Maths and Stats  
Various assessed components; no examination  
This module is required or recommended for all third and fourth year modules which have projects. This course aims to teach and enhance skills, including both subject-related and transferable skills, appropriate to Part II students in Mathematics and Statistics. These skills include the preparation of mathematical documents and presentation materials, scientific writing, oral presentations and group work. The module includes components on LaTeX, oral communication skills, scientific writing, a written short project, a written group project, and a group presentation.

MATH245: Computational Mathematics (15 cr.)  
Prereq.: MATH101; MATH102; MATH103; MATH104; MATH105  
Coursework: 30%, Exam: 70%  
Computers, and in particular, computational methods are playing an increasingly important role in mathematics and statistics. This module explores a range of computational and numerical methods for solving mathematical and statistical problems, focussing both on the theory underpinning the methods and the application of the methods to a variety of problems using R. The module starts by introducing programming within R. The module then moves through numerical solutions of equations, numerical and statistical (Monte Carlo) methods for evaluating integrals and finishes with the numerical solution of ODEs.

MATH313 Probability Theory (15 cr.)  
Prereq.: MATH210; MATH230; Excl MATH413  
Coursework: 10%, Exam: 90%  
The aim of this course is to develop an analytical and axiomatic approach to the theory of probabilities. The notion of a probability space is introduced and illustrated by simple examples featuring both discrete and continuous sample spaces. Random variables and the expectation are then used to develop a probability calculus, which is applied to achieve laws of large numbers for sums of independent random variables. Lindeberg's method is used to study the distributions of sums of independent variables. The results are illustrated in applications to random walks and statistical physics, in particular, the Poisson and central limit theorems are proven, with estimation of accuracy of both approximations.
MATH314 Lebesgue Integration (15 cr.)
Prereq.: MATH210; Excl. MATH414
Coursework: 10%, Exam: 90%
This course develops an advanced theory of integration, centered on the Lebesgue integral, which plays a foundational role in probability theory and mathematical analysis. We construct the Lebesgue measure and define the Lebesgue integral for functions on the real line, subsequently extending these ideas to the higher-dimensional setting. The material includes several cornerstone theorems of mathematical analysis, including the Monotone Convergence Theorem, the Dominated Convergence Theorem, and The Fubini-Tonelli Theorem. Advanced topics may include Lp spaces and/or some Fourier analysis.

MATH316: Metric Spaces (15 cr.)
Prereq.: MATH210, MATH220; Excl.: MATH416
Coursework: 10%, Exam: 90%
The course gives an introduction to the key concepts and methods of metric space theory, a core topic for pure mathematics and its applications. It offers a deeper understanding of continuity, leading to an introduction to abstract topology. The course provides firm foundations for further study of many topics including geometry, Lie groups and Hilbert space, and has applications in many others, including probability theory, differential equations, mathematical quantum theory and the theory of fractals.

MATH317 Hilbert Spaces (15 cr.)
Prereq.: MATH210, MATH220; (MATH316 recommended); Excl.: MATH417
Coursework: 10%, Exam: 90%
This course is a first introduction to the theory of Hilbert spaces, which is a powerful and elegant synthesis of techniques from linear algebra and analysis, and which provides a fundamental toolkit for many modern applications of analysis to engineering, physics and statistics. The fundamental notions are that of an inner product, which simultaneously generalizes the usual notions of angle and length in "usual" (Euclidean) 3-dimensional space; and the concept of completeness, which is needed to ensure good behaviour when trying to take limits. Questions about approximations of functions are thereby reduced to calculations with algebra that have geometrically intuitive meaning. The course also intends to give a flavour of ideas and arguments in abstract analysis, which may be pursued further in other courses. Examples and applications are chosen from a range of settings, including orthogonal polynomials, Fourier series, and reproducing kernels.

MATH318: Differential Equations (15 cr.)
Prereq.: MATH210
Coursework: 10%, Exam: 90%
This module considers questions relating to linear ordinary differential equations. While explicit solutions can only be found for special types of equations, some of the ideas of real analysis allow us to answer questions about the existence and uniqueness of solutions to more general equations, as well as study certain properties of these solutions.

MATH319: Linear Systems (15 cr.)
Prereq.: MATH215, MATH220
Coursework: 10%, Project: 20%, Exam: 70%
Linear systems is engineering mathematics. In the mid nineteenth century, the engineer Watt used a governor to control the amount of steam going into an engine, so that the input of steam reduced when the engine was going too quickly, and the input increased when the engine was going too slowly. Maxwell then developed a theory of controllers for various mechanical devices, and identified properties such as stability. The crucial idea of a controller is that the output can be fed back into the system to adjust the input. Many devices can be described by linear systems of differential and integral equations which can be reduced to a standard \((A,B,C,D)\) model. These include electrical appliances, heating systems and economic processes. The course shows how to reduce certain linear systems of differential equations to systems of matrix equations and thus solve them. Linear algebra enables us to classify \((A,B,C,D)\) models and describe their properties in terms of quantities which are relatively easy to compute. The course then describes feedback control for linear systems. The main result describes the linear controllers that stabilize an \((A,B,C,D)\) system. The course covers graphical methods such as Nyquist and Bode plots.
MATH321: Groups and Symmetry (15 cr.)
Prereq.: MATH225
Coursework: 10%, Exam: 90%
The study of groups is developed from Math225. `Direct products' are used to construct new groups, while any finite group is shown to `factor' into `simple' pieces. We also consider situations in which a group `acts' on a set by permuting its elements; this powerful idea is used to identify the symmetries of the Platonic solids, and help study the structure of groups themselves.

MATH322: Commutative Algebra (15 cr.)
Prereq.: MATH111, MATH225
Coursework: 10%, Exam: 90%
This is a theory-based course whose aim is to present some elementary concepts and results of commutative algebra. Students will investigate specific classes of commutative unital rings. The module builds upon the material encountered in the second-year course Abstract Algebra, and will provide the student with a foundation for further study in Galois theory or Algebraic geometry.

MATH323: Algebraic Curves (15 cr.) (10 week module in Lent)
Prereq.: MATH225, (MATH240 recommended)
Coursework: 10%, Project: 20%, Exam: 70%
The course is an introduction to elliptic curves, an important subject in algebraic geometry. In this module we will learn how curves can be described by algebraic equations, understand and use abstract groups in dealing with geometrical objects, learn some of the notions and the main results pertaining to elliptic curves.

MATH325: Representation Theory of Finite Groups (15 cr.)
Prereq.: MATH225, (MATH321 recommended)
Coursework: 10%, Exam: 90%
The course is an introduction to the ordinary representation theory of finite groups, including the first steps in character theory. Representation theory of finite groups is an important subject in algebra. The main results are presented together with examples and applications.

MATH326: Graph Theory (15 cr.)
Prereq.: MATH220
Coursework: 10%, Exam: 90%
Graph theory is a rapidly developing branch of mathematics that finds applications in other areas of mathematics as well as in other fields such as computer science, statistical physics, chemistry and data science. Graphs are mathematical structures used to model pairwise relations between objects. This course gives an introduction to three fundamental aspects of graph theory: structural graph theory (including graph minors and methods for counting trees), algebraic graph theory (using matrices to deduce properties of graphs) and topological graph theory (planar graphs and non-crossing embeddings on surfaces).

MATH327: Combinatorics (15 cr.)
Prereq.: MATH111, MATH112, MATH220
Coursework: 10%, Exam: 90%
Combinatorics is the core subject of discrete mathematics which refers to the study of mathematical structures that are discrete in nature rather than continuous (for example graphs, lattices, designs and codes). While combinatorics is a huge subject - with many important connections to other areas of modern mathematics - it is a very accessible one. This course gives an introduction to the fundamental topics of combinatorial enumeration (sophisticated counting methods), graph theory (graphs, networks and algorithms), and combinatorial design theory (Latin squares and block designs). Some important practical applications of the results and methods are also briefly discussed.
MATH328: Number Theory (15 cr.)
Prereq.: MATH111; (MATH225 recommended)
Coursework: 10%, Exam: 90%
Number theory is the study of the fascinating properties of the natural number system. How many primes leave remainder 1 when divided by 4, and how many leave remainder 3? Are there short cuts to factorizing large numbers or determining whether they are prime? (And why is this is important in cryptography?) Some equations have whole number solutions: how do we find them, count them or catalogue them? The number of divisors of an integer fluctuates wildly, but can we give a good estimation of the “average” number of divisors in some sense?
To answer such questions about natural numbers, one sometimes has to draw on ideas from algebra and analysis, including rational or complex numbers, groups, integration, infinite series and even infinite products. This course introduces some of the central ideas and problems of the subject, and some of the methods used to solve them, while keeping prerequisites to a minimum. The results are constantly illustrated by exercises and examples involving actual numbers.

MATH329: Geometry of Curves and Surfaces (15 cr.)
Prereq.: MATH115 or MATH220
Coursework: 10%, Exam: 90%
This module provides an introduction to the subject of differential geometry. Familiar tools from calculus and linear algebra are used to investigate curves and surfaces embedded in three-dimensional space. A number of well-known concepts will be encountered, such as length and area, and some new ideas will be introduced, including the curvature and torsion of a curve, and the first and second fundamental forms of a surface. Students will learn how to compute these quantities for a variety of examples, and in doing so will develop their geometric intuition and understanding.
In addition to the subject-specific aims, this module is intended to improve students' ability to understand and to develop mathematical arguments, and to present them in a clear and well-structured manner. The module also aims to enhance students' problem-solving abilities.

MATH330: Likelihood Inference (15 cr.)
Prereq.: MATH235; Excl.: MATH451
Coursework: 10%, Exam: 90%
Statistical inference is the theory of the extraction of information about the unknown parameters of an underlying probability distribution from observed data. Consequently, statistical inference underpins all practical statistical applications, such as those considered in all other third year statistics courses. This course reinforces the likelihood approach taken in MATH235, for single parameter statistical models, and extends this to problems where the probability for the data depends on more than one unknown parameter. The issue of model choice is also considered: in situations where there are multiple models under consideration for the same data, how do we make a justified choice of which model is the ‘best’? The approach taken in this course is just one approach to statistical inference: a contrasting approach, Bayesian Inference, is covered in MATH331.
MATH331: Bayesian Inference (15 cr.)
Prereq.: MATH235; Excl.: MATH453
Coursework: 10%, Exam: 90%
The Bayesian approach is arguably a simpler and more intuitive way of reasoning in statistics than that used in conventional classical statistics. Bayesians express their rational beliefs about a parameter by using probability density functions. Belief before the data is referred to as the prior distribution and that after the data has been looked at is called the posterior. The likelihood is central to the Bayesian approach but is used in a fundamentally different way than in classical statistics. Rather than maximising the likelihood, Bayesians’ update their belief by combining the information in the prior and in the data, through the likelihood, to obtain the posterior distribution. An important by-product of using Bayes rule is the denominator of Bayes rule which is referred to as the evidence. The evidence is used to compare different models for the same data-set.
We show that each of the familiar likelihoods (from the exponential family) have conjugate priors which mirror the mathematical form of the likelihood. Conjugacy ensures that the prior and posterior are from the same type of probability distribution. Updating the belief is achieved by merely updating the parameters of the prior. With conjugacy, the evidence in each case can also be derived and shown to be of known form.
For example the proportion parameter of the binomial likelihood can be given a conjugate beta prior. This ensures our posterior belief is also a Beta distribution but with different parameters. The evidence then can be shown to be a Beta-binomial distribution.
In this course we look at the difficulties involved when there is no prior information.
The final component of the Bayesian system thinking is a theory for making rational decisions. This is very simple to understand and apply to such an extent that it is useful for classical statisticians as well. It involves defining a utility function which is defined by quantifying the usefulness of a quantity specific to the individual. Bayesian decisions are then made by carrying out actions that maximise the expectation of the utility.

MATH332: Stochastic Processes (15 cr.)
Prereq.: MATH230; Excl.: MATH432
Coursework: 10%, Exam: 90%
This course covers important examples of stochastic processes, and how these processes can be analysed. As an introduction to stochastic processes we will look at the random walk process. Historically this is an important process, and was initially motivated as a model for how the wealth of a gambler varies over time (initial analyses focussed on whether there are betting strategies for a gambler that would ensure he won). We will then focus on the most important class of stochastic processes, Markov processes (of which the random walk is a simple example). Markov processes are defined by the property that the future of the process is independent of the past if we condition on the current state of the process. We will look at how to analyse Markov processes, and how Markov processes are used to model queues and populations.

MATH333: Statistical Models (15 cr.)
Prereq.: MATH330, (MATH240 recommended)
Coursework: 10%, Project: 20%, Exam: 70%
Generalized linear models (GLMs) may be used to relate a response variable to one or more explanatory variables. The response variable may be classified as quantitative (continuous or discrete, i.e. countable) or categorical (two categories, i.e. binary, or more than categories, i.e. ordinal or nominal). GLMs will be applied in a range of applications in the biomedical, natural and social sciences. R will be used in weekly workshops.

MATH334: Time series analysis (15 cr.)
Prereq.: MATH330, (MATH240 recommended)
Coursework: 10%, Project: 20%, Exam: 70%
A wide variety of sequences of observations arising in environmental, economic, engineering and scientific contexts come under the heading of time series data. Topics in Time Series and Volatility Modelling will discuss the techniques for the analysis of such data with emphasis on financial applications. In this module students will use R for exploratory data analysis.

MATH335: Medical Statistics (15 cr.)
Prereq.: MATH235, (MATH240 recommended)
Coursework: 10%, Project: 20%, Exam: 70%
This course aims to introduce students to the study designs and statistical methods commonly used in health investigations including measuring disease, study design, causality and confounding. Both observational and experimental designs feature and various health outcomes are considered. The course is built around a number of published articles and is structured to provide understanding of the problem being investigated and also the mathematical and statistical concepts underpinning inference.
MATH336: Multivariate Statistics in Machine Learning (15 cr.)
Prereq.: MATH220, MATH235, MATH245
Coursework: 10%, Project: 20%, Exam: 70%
The course will cover the mathematical foundations of multivariate statistics in machine learning. Mathematical representation and visualization of multivariate data, the motivation for multivariate analysis, the learning problem and types of learning with focus on supervised learning, feasibility of learning and the theory of generalization, probabilistic framework for learning, Bayes optimal predictor, empirical risk minimization, VC-dimension, generalization bound and bias-complexity trade-off, validation and model selection, and some supervised learning algorithms including kNNs, Perceptrons, Support Vector Machines and Artificial Neural Networks.
The students should be familiar with multivariate random variables (MATH230), statistics (MATH235), matrix algebra (MATH220), and computational mathematics in R (MATH245). Students without MATH245 may also be admitted, provided they can demonstrate they have sufficient programming experience (for example, SSC.110 and SSC.120)

MATH345: Financial Mathematics (15 cr.)
Prereq.: MATH230, MATH332
Coursework: 10%, Exam: 90%
We lay the mathematical foundations necessary to model certain transaction in the world of finance. Explicitly, we study some stochastic models for financial markets and investigate the pricing of European options and other financial products. We consider here two discrete models, the binomial model and finite market model, and one continuous model. In particular, we deduce the Black Scholes formula. To do this, we introduce some probabilistic terminology as sigma algebras and martingales, and some financial terminology as arbitrage opportunities and self financing trading strategies. Also, we will give a a brief overview over Brownian motion.

MATH361: Mathematical Education (15 cr.)
Prereq.: None
Coursework: 100% (2 written essays)
This course is designed to give you an opportunity to consider key issues in the teaching and learning of mathematics. Whilst it is an academic study of mathematics education and not a training course for teachers, it does provide an excellent foundation for a PGCE especially in preparing students to write academically. As a learner of mathematics of many years’ experience you are well-placed to reflect upon that experience and attempt to make sense of it in the light of theoretical frameworks developed by researchers in the field. Within this course we hope to help you with this process so that as a mathematics graduate you will be able to contribute knowledgeably to future debate about the ways in which your subject is treated within the education system

MATH362: Mathematical Education Placement (15 cr.)
Prereq.: MATH361
Coursework: 100% (Assignment 1 = 20%; Assignment 2 = 80%)
This module will be based on the Students’ Union’s Schools Partnership Scheme, which supports Lancaster students on 10-week placements in local primary and secondary schools. The module will involve classroom observation and assistance, the development of classroom resources, the provision of one-on-one or small group support and possibly the opportunity to teach sections of lessons to the class as a whole. Enrolment on this module is limited, and subject to departmental approval. Prior to enrolment, all students must pass an interview at the beginning of summer term in the previous academic year.

MATH411: Operator Theory (15 cr.)
Prereq.: MATH317 or MATH417
Coursework: 0% Exam: 100%
This module provides an introduction to an important topic in the field of modern analysis. A bounded operator is a generalisation of a matrix or linear transformation, where the underlying space is no longer required to be finite-dimensional. Fundamental ideas from analysis are used to extend well-known algebraic concepts, such as eigenvalues and the adjoint, to the infinite-dimensional setting. Students will encounter important families of operators, including unitary, self-adjoint and non-negative operators. The notion of a function of an operator will be extended from polynomial to continuous functions, provided that the operator is self adjoint. The course culminates in a generalisation of a familiar result from linear algebra, that any Hermitian matrix can be diagonalised. An appropriate version of this statement is shown to hold for any compact self-adjoint operator.
In addition to the subject-specific aims, successful completion of this module will improve students' abilities to analyse and construct complex mathematical arguments, and to express themselves clearly through written work.
MATH412: Topology and Fractals (15 cr.)
Prereq.: MATH210
Coursework: 10%, Exam: 90%
Fractals are fascinating objects whose study combines ideas from analysis and geometry. Such sets exhibit
properties such as self-similarity and non-integral dimension. The middle-thirds Cantor set is one example,
and another is the Sierpiński gasket; these arise by repeatedly deleting elements of the unit interval and a
solid equilateral triangle, respectively. The module discusses how to formalise such limit processes in a general
framework, and introduces key ideas from topology along the way. Thus concepts such as metric spaces,
compactness, connectedness and fractal dimension are explored. The discussion is kept relatively
straightforward, with the setting being the familiar one of real Euclidean space.

MATH413: Probability Theory (15 cr.)
Prereq.: MATH210; MATH230; Excl.: MATH313
Coursework: 10%, Exam: 90%
Description: See MATH313.

MATH414: Lebesgue Integration (15 cr.)
Prereq.: MATH210; excl MATH314
Coursework: 10%, Exam: 90%
Description: See MATH314.

MATH416: Metric Spaces (15 cr.)
Prereq.: MATH210, MATH220; Excl.: MATH316
Coursework: 10%, Exam: 90%
Description: See MATH316.

MATH417: Hilbert Spaces (15 cr.)
Prereq.: MATH210, MATH220; MATH230; Excl.: MATH317
Coursework: 10%, Exam: 90%
Description: See MATH317.

MATH423: Algebraic Curves (15 cr.)
Prereq.: MATH225, (MATH240 recommended) Excl.: MATH323
Coursework: 10%, Project: 20%, Exam: 70%
Description: See MATH323.

MATH424: Galois Theory (15 cr.)
Prereq.: MATH225, MATH322; (MATH321 recommended)
Coursework: 10%, Exam: 90%
Galois Theory is, in essence, the systematic study of properties of roots of polynomials. Starting with such a
polynomial \( f \) over a field \( k \) (e.g. the rational numbers), one associates a "smallest possible" field \( L \) containing
\( k \) and the roots of \( f \); and a finite group \( G \) which describes certain "allowed" permutations of the roots of \( f \). The
Fundamental Theorem of Galois Theory says that under the right conditions, the fields which
lie between \( k \) and \( L \) are in 1-to-1 correspondence with the subgroups of \( G \).
Towards the end of the course we will see two applications of the Fundamental Theorem. The first is the proof
that in general a polynomial of degree 5 or higher cannot be solved via a formula in the way that quadratic
polynomials can; the second is the fact that an angle cannot be trisected using only a ruler and compasses.
These two applications are among the most celebrated results in the history of mathematics.

MATH425: Representation Theory of Finite Groups (15 cr.)
Prereq.: MATH220, MATH225; (MATH321 recommended); Excl.: MATH325
Coursework: 10%, Exam: 90%
Description: See MATH325.
MATH426: Lie Groups and Lie Algebras (15 cr.)
Prereq.: MATH225, (MATH115 or MATH329 helpful, MATH321 or MATH325 helpful)
Coursework: 40%, Presentation: 30%; Essay: 30% (no examination)
The theory of Lie groups and Lie algebras permeates modern mathematics and theoretical physics and brings together the methods of algebra, geometry and analysis. The course will begin by introducing various classes of more or less familiar linear groups (i.e. groups of matrices). It will then define the concept of a Lie algebra and will study various classes of Lie algebras, analogous to the linear groups introduced earlier. This close parallel suggests that linear groups and Lie algebras can be tied together in a common framework; the rest of the course will be dedicated to developing this common framework. This will bring us to the concepts of a matrix Lie group; the exponential map on matrices; the tangent Lie algebra of a matrix Lie group. This course serves as a brief introduction to this vast topic; a range of further topics will be explored in the essays.

MATH432: Stochastic Processes (15 cr.)
Prereq.: MATH230; Excl.: MATH332
Coursework: 10%, Exam: 90%
Description: See MATH332.

MATH440: Stochastic Calculus for Finance (15 cr.)
Prereq.: MATH332 or MATH432, (MATH313/413 recommended)
Coursework: 10%, Project: 20%, Exam: 70%
Stochastic Calculus is a theory that enables the calculation of integrals with respect to stochastic processes. It has wide-ranging applications, which have been particularly fruitful in mathematical finance. This module begins with the study of continuous-time stochastic processes, focussing on Brownian motion. Along the way, key concepts such as martingales and stopping times are encountered. The module then explores how to construct an integral with respect to Brownian motion. This leads on to the derivation of Ito's formula, a stochastic analogue of the chain rule. This allows the definition and solution of stochastic differential equations (SDEs), the stochastic analogue to ordinary differential equations (ODEs). The theory is then used to derive the Black-Scholes Formula for pricing financial options.

MATH445: Financial Mathematics (15 cr.)
Prereq.: MATH230, MATH332 or MATH432 Excl: MATH345
Coursework: 10%, Exam: 90%
Description: See MATH345.

MATH451: Likelihood Inference (15 cr.)
Prereq.: MATH235; Excl.: MATH330
Coursework: 30%, Exam: 70%
The student will learn how information about the unknown parameters is obtained and summarized via the likelihood function; be able to calculate the likelihood function for some statistical models which do not assume independent identically distributed data; be able to evaluate point estimates and make statements about the variability of these estimates; understand about the inter-relationships between parameters, and the concept of orthogonality; be able to perform hypothesis tests using the generalised likelihood ratio statistic; use computational methods to calculate maximum likelihood estimates. Find maximum likelihood estimators using the statistical package R.

MATH452: Generalised Linear Models (15 cr.)
Prereq.: MATH330 or MATH451
Coursework: 50%, Exam: 50%
To learn techniques for formulating sensible models for set of data that enables to answer question such as how the probability of success of a particular treatment will depend on the patient's age, weight, blood pressure and so on. To introduce a large family of models, called the generalised linear models (GLMs), that includes the standard linear regression model as a special case and to discuss the theoretical properties of these models. To learn a common algorithm called iteratively reweighted least squares algorithm for the estimation of parameters. To fit and check these models with the statistical package R; produce confidence intervals and tests corresponding to questions of interest; and state conclusions in everyday language.
MATH453: Bayesian Inference (15 cr.)
Prereq.: MATH235; Excl.: MATH331
Coursework: 30%, Exam: 70%
Bayesian statistics is a framework for rational decision making using imperfect knowledge expressed through probability distributions. Bayesian principles are applied in the fields of navigation, control, automation and artificial intelligence. The aim of decision makers is to make rational decisions that maximise some personal utility function which may represent quantities such as money which are related to wealth of an individual. Within the Bayesian framework, knowledge of the world, (the prior) is updated as fresh observations arrive to yield a posterior distribution which shows the revised knowledge. The evidence for the model is expressed by calculating a marginal likelihood. Future behaviour and the fit of the model are assessed using a predictive distribution. This includes sampling uncertainty and uncertainty of our knowledge. We look at the posterior, the marginal and the predictive distributions for several one parameter conjugate models, and two families of multi-parameter fully conjugate models. We extend range of belief types that can be modelled by using mixtures of conjugate priors. We also explore the use of non-conjugate formulations of models and use Monte-Carlo integration, importance sampling and rejection sampling for calculating and simulating from these distributions.

MATH454: Computer Intensive Methods (15 cr.)
Prereq.: MATH330 or MATH451, MATH331 or MATH453, (MATH240 recommended)
Coursework: 50%, Exam: 50%
The first week of the course introduces students to the EM algorithm. The remainder of the course introduces the use of Markov chain Monte Carlo methods as a powerful technique for performing Bayesian inference on complex stochastic models. Weeks 2 and 3 will focus on the Gibbs sampler and the introduction of the Gibbs sampler will be closely integrated with Bayesian modelling techniques such as hierarchical modelling, random effects models, data augmentation and mixture modelling. Weeks 4 and 5 will focus on the generic Metropolis-Hastings algorithm and in particular the random walk Metropolis and independence sampler algorithms. Key MCMC issues such as burn-in, convergence and algorithmic performance will be discussed.

MATH463: Clinical Trials (15 cr.)
Prereq.: MATH235, MATH240
Coursework: 50%, Exam: 50%
Clinical trials are planned experiments on human beings designed to assess the relative benefits of one or more forms of treatment. For instance, we might be interested in studying whether aspirin reduces the incidence of pregnancy-induced hypertension; or we may wish to assess whether a new immunosuppressive drug improves the survival rate of transplant recipients. Note that treatments may be procedural, for example, surgery or methods of care. This course combines the study of technical methodology with discussion of more general research issues. The course begins with a discussion of the relative advantages and disadvantages of different types of medical studies. The basic aspects of clinical trials as experimental designs are then discussed. This includes a section on definition and estimation of treatment effects. Furthermore, cross-over trials, concepts of sample size determination, and equivalence trials are covered. The course also gives a brief introduction to sequential trial designs and meta-analysis.

MATH464: Principles of Epidemiology (15 cr.)
Prereq.: MATH333 or MATH452, MATH240
Coursework: 50%, Exam: 50%
This course introduces students to the basic principles of epidemiology, including its methodology and application to prevention and control of disease. Concepts and strategies used in epidemiologic studies are examined. At the conclusion of the course students should understand the role of epidemiology in preventive medicine and disease investigation, understand and be able to apply basic epidemiologic methods, and be able to assess the validity of epidemiologic studies with respect to their design and inferences.

CHIC465: Environmental Epidemiology (15 cr.)
Prereq.: MATH330 or MATH451
Coursework: 50%, Exam: 50%
This course aims to introduce students to the kinds of statistical methods commonly used by statisticians to investigate the relationship between risk of disease and environmental factors. Specifically, the course will cover methods for the analysis of spatial data, including spatial point-process models, spatial case-control methods, spatially aggregated data, point source problems and geostatistics. A number of published studies will be used to illustrate the methods described, and students will learn how to perform similar analyses using the statistical package R.
MATH466: Longitudinal Data Analysis (15 cr.)
Prereq.: MATH330 or MATH451, MATH333 or MATH452
Coursework: 50%, Exam: 50%
Longitudinal data arise when a time-sequence of measurements is made on a response variable for each of a number of subjects in an experiment or observational study. For example, a patient's blood pressure may be measured daily following administration of one of several medical treatments for hypertension. Typically, the practical objective of most longitudinal studies is to find out how the average value of the response varies over time, and how this average response profile is affected by different experimental treatments. This module presents an approach to the analysis of longitudinal data, based on statistical modelling and likelihood methods of parameter estimation and hypothesis testing.

MATH482: Assessing Financial Risk: Extreme Value Methods (15 cr.)
Prereq.: MATH451 or MATH330, MATH332 or MATH432
Coursework: 10%, Project: 20%, Exam: 70%
This module will cover topics related to the understanding of special models to describe the extreme values of a financial times series and fitting appropriate extreme value models to data which are maxima or threshold exceedance. The students will be able to use extreme value models to evaluate Value at Risk and understand the impact of heavy tailed data on standard statistical diagnostic tools.

MATH491, 492 Dissertation (30 cr.)
Prereq.: MATH240, MATH245 required for MATH492.
(No examination) Only available to Year 4 students on an MSci degree
At the end of Year 3 you will fill in a form stating your mathematical or statistical interests and based on that you will be assigned a dissertation supervisor (member of staff) and a topic. The dissertation may be in mathematics (MATH491), or statistics (MATH492). This depends on your degree scheme and your choice. During the first term you will meet your supervisor weekly and will be guided into your in-depth study of a specific topic. During the second term you will have to produce a written dissertation on what you have learnt and give an oral presentation. You will hand in your dissertation in the first week after the Easter recess. The grade is based 70% on your final written product, 10% on your oral presentation, and 20% on the initiative that you demonstrated during the entire two terms of the module. Further information is available from the Year 4 Director of Studies and will be communicated to every Year 4 student at the beginning of Term 1.
Module Combinations for Condonation Purposes

The available module combinations for the purposes of condonation listed below are applicable to the following programmes of study:

- BSc (Hons) Accounting, Finance and Mathematics
- BSc (Hons) Accounting, Finance and Mathematics (Industry)
- BSc (Hons) Computer Science and Mathematics
- BSc (Hons) Computer Science and Mathematics (Placement Year)
- MSci (Hons) Computer Science and Mathematics
- BSc (Hons) Economics and Mathematics
- BSc (Hons) Financial Mathematics
- BSc (Hons) Financial Mathematics (Industry)
- MSci (Hons) Financial Mathematics
- BA (Hons) French Studies and Mathematics
- BA (Hons) German Studies and Mathematics
- BA (Hons) Italian Studies and Mathematics
- BSc (Hons) Management Mathematics
- BSc (Hons) Management Mathematics (Industry)
- BSc (Hons) Mathematics
- BSc (Hons) Mathematics (Placement Year)
- MSci (Hons Mathematics
- MSci (Hons) Mathematics (Study Abroad)
- BA (Hons) Mathematics and Philosophy
- BSc (Hons) Mathematics with Statistics
- BSc (Hons) Mathematics with Statistics (Placement Year)
- MSci (Hons) Mathematics with Statistics
- MSci (Hons) Mathematics with Statistics (Study Abroad)
- BSc (Hons) Mathematics, Operational Research, Statistics and Economics (MORSE)
- BSc (Hons) Mathematics, Operational Research, Statistics and Economics (MORSE) (Industry)
- BSc (Hons) Natural Sciences
- BSc (Hons) Natural Sciences (Study Abroad)
- BSc (Hons) Natural Sciences
- BSc (Hons) Natural Sciences (Study Abroad)
- BSc (Hons) Theoretical Physics with Mathematics
- MSci (Hons) Theoretical Physics with Mathematics
- MSci (Hons) Theoretical Physics with Mathematics (Study Abroad)
- BA (Hons) Spanish Studies and Mathematics

Combinable Groups of Second Year Modules for the purpose of condonation

**Algebra**
MATH220 Linear Algebra II
MATH225 Abstract Algebra

**Analysis**
MATH210 Real Analysis
MATH215 Complex Analysis

**Statistics**
MATH230 Probability II
MATH235 Statistics II
Combinable Groups of Third Year Modules for the purpose of condonation

**Algebra and Geometry**
MATH321 Groups and Symmetry  
MATH322 Commutative Algebra  
MATH323 Algebraic Curves  
MATH325 Representation Theory of Finite Groups  
MATH326 Graph Theory  
MATH327 Combinatorics  
MATH328 Number Theory  
MATH329 Geometry of Curves and Surfaces

**Analysis**
MATH313 Probability Theory  
MATH314 Lebesgue Integration  
MATH316 Metric Spaces  
MATH317 Hilbert Spaces  
MATH318 Differential Equations  
MATH319 Linear Systems

**Probability**
MATH313 Probability Theory  
MATH314 Lebesgue Integration  
MATH332 Stochastic Processes  
MATH345 Financial Mathematics

**Statistics**
MATH330 Likelihood Inference  
MATH331 Bayesian Inference  
MATH332 Stochastic Processes  
MATH333 Statistical Models  
MATH334 Time Series Analysis  
MATH335 Medical Statistics  
MATH336 Multivariate Statistics in Machine Learning  
MATH345 Financial Mathematics

**Education**
MATH361 Mathematical Education  
MATH362 Mathematical Education Placement
Combinable Groups of Fourth Year Modules for the purpose of condonation

Algebra and Geometry
MATH412 Topology and Fractals
MATH423 Algebraic Curves
MATH424 Galois Theory
MATH425 Representation Theory of Finite Groups
MATH426 Lie Groups and Lie Algebras

Analysis
MATH411 Operator Theory
MATH413 Probability Theory
MATH414 Lebesgue Integration
MATH416 Metric Spaces
MATH417 Hilbert Spaces

Probability
MATH413 Probability Theory
MATH414 Lebesgue Integration
MATH432 Stochastic Processes
MATH445 Financial Mathematics
MATH440 Stochastic Calculus for Finance

Statistics
MATH432 Stochastic Processes
MATH440 Stochastic Calculus for Finance
MATH445 Financial Mathematics
MATH451 Likelihood Inference
MATH452 Generalised Linear Models
MATH453 Bayesian Inference
MATH454 Computationally Intensive Methods
MATH463 Clinical Trials
MATH464 Principles of Epidemiology
CHIC465 Environmental Epidemiology
MATH466 Longitudinal Data Analysis
MATH482 Assessing Financial Risk: Extreme Value Theory