Programme Information & PLOs

Title of the new programme – including any year abroad/ in industry variants

MMath Mathematics

Level of qualification

Please select:	Level 7

Please indicate if the programme is offered with any year abroad / in industry variants	**Year in Industry** Please select Y/N	Yes
	Year Abroad Please select Y/N	No

Department(s):
Where more than one department is involved, indicate the lead department

Lead Department	Mathematics
Other contributing Departments:	

Programme Leader

Dr Ian McIntosh

Purpose and learning outcomes of the programme

Statement of purpose for applicants to the programme

The MMath degree in Mathematics at York is designed to take students who are fascinated by mathematics on a journey which has the time to go more deeply into modern mathematics than the BSc. You will develop your mathematical skills to be able to understand the advanced techniques in mathematics which prepare you for postgraduate research. Throughout the degree your core mathematical skills (calculus, algebra, probability and statistics) will be developed to a high level of sophistication, and your reasoning skills will be sharpened, as you are guided to use mathematics in deeper and more interesting ways. You will develop other skills which will be valuable throughout your career, such as computer programming and the ability to write on technical subjects with clarity and precision. We pride ourselves
on being a friendly and inclusive department with high-quality teaching provided in a relaxed atmosphere. You will experience a variety of ways of learning and working, through lectures, small group seminars, group and individual projects,
under the careful guidance of our dedicated staff, all of whom are engaged in current research and many of whom are world leaders in their field.
In the final year you will use your knowledge, understanding and skills to write a dissertation on a topic of your own interest, under the supervision of an expert mathematician. By the end of the programme you will be ready to engage with research-level mathematics in some area of specialisation in pure or applied mathematics, and have one of the most sought-after qualifications by key employers.
If you choose to take the Year in Industry option, you will apply the knowledge and skills acquired in the first three years within an industrial setting. The department will negotiate with each placement provider to ensure that the nature of the training and project work provide an appropriate challenge. You will build on the key mathematical principles you have learnt and develop a range of skills, such as teamwork, communication, problem-solving and critical assessment.
The MMath programme is also accredited by the Institute of Mathematics and Its Applications (IMA) to the level of meeting the full educational requirement for Chartered Mathematician status.
With York's reputation as a top university, this makes an MMath degree in Mathematics at York an outstanding choice.

Programme Learning Outcomes

Please provide six to eight statements of what a graduate of the programme can be expected to do.
Taken together, these outcomes should capture the distinctive features of the programme. They should also be outcomes for which progressive achievement through the course of the programme can be articulated, and which will therefore be reflected in the design of the whole programme.

PLO	On successful completion of the programme, graduates will be able to:
1	use, with a high level of confidence and sophistication, the mathematical language and tools that underpin a wide range of research in, and applications to, science, technology and industry
2	recognise when an unfamiliar problem is open to mathematical investigation, and be able to formulate their own strategy for the process of such an investigation,
3	use logical reasoning as a basis for the critical analysis of ideas or statements which have a mathematical context, and develop independently their own ideas using well-founded reasoning,
4	conduct, both independently and as part of a group of peers, a study of a specialised area of mathematics which takes into account recent mathematical progress. They will be able to compare and synthesise multiple sources to produce this study, and be able to check or complete technical details from these sources independently,

5	communicate advanced mathematical ideas clearly, in writing and in a presentation, at a level appropriate for the intended audience,
6	create mathematical documents, presentations and computer programmes by accurately and efficiently using a range of digital technologies.

Programme Learning Outcome for year in industry (where applicable)

For programmes which lead to the title 'with a Year in Industry' – typically involving an additional year – please provide either a) amended versions of some (at least one, but not necessarily all) of the standard PLOs listed above, showing how these are changed and enhanced by the additional year in industry b) an additional PLO, if and only if it is not possible to capture a key ability developed by the year in industry by alteration of the standard PLOs.

Contribute mathematical and statistical skills to an industrial research problem and interact effectively in such an environment.

Programme Learning Outcome for year abroad programmes (where applicable)

For programmes which lead to the title 'with a Year Abroad' – typically involving an additional year – please provide either a) amended versions of some (at least one, but not necessarily all) of the standard PLOs listed above, showing how these are changed and enhanced by the additional year abroad or b) an additional PLO, if and only if it is not possible to capture a key ability developed by the year abroad by alteration of the standard PLOs.

n/a

Explanation of the choice of Programme Learning Outcomes

Please explain your rationale for choosing these PLOs in a statement that can be used for students (such as in a student handbook). Please include brief reference to:

i) Why the PLOs are considered ambitious or stretching?

Each PLO represents a challenge to the student to develop existing skills to a higher level. Through each stage the level of challenge is raised, as more depth or complexity is encountered. In studying mathematics each stage builds naturally on the attainments of the previous one, as foundational ideas are developed into fully fledged theories or methodologies. Those who fully rise to this challenge will be prepared to contribute to mathematics at the research frontier.

ii) The ways in which these outcomes are distinctive or particularly advantageous to the student:

The outcomes identify six basic areas, which can be summarised as:
technique, adaptability, critical thinking, scholarship, communication
and digital literacy. When possessed together they give each student the
abilities and understanding to function in any environment where the
precision and clarity of mathematical thinking are valuable. The Year in Industry offers students the opportunity to demonstrate their skills and abilities on a genuine research project, will provide the student with greater insight into their future career.

iii) How the programme learning outcomes develop students' digital literacy and will make appropriate use of technology-enhanced learning (such as lecture recordings, online resources, simulations, online assessment, 'flipped classrooms' etc)?

The communication elements require students to master digital literacy for visual presentations and for producing a dissertation. In addition, all students will learn some programming, and a number of modules include the opportunity to use mathematics software (such as R, Maple and MatLab).

iv) How the PLOs support and enhance the students' employability (for example, opportunities for students to apply their learning in a real world setting)?
The programme's employability objectives should be informed by the University's Employability Strategy:

http://www.york.ac.uk/about/departments/support-and-admin/careers/staff/

The PLOs cover a list of skills which are desired by employers: analytical reasoning, confidence with high level mathematics, clarity of communication, flexible thinking, the ability to learn complex ideas quickly and precisely, and digital literacy.

vi) How will students who need additional support for academic and transferable skills be identified and supported by the Department?

For first year students regular "drop-in" academic support sessions are scheduled into the timetable, as optional support for all first year students. The Mathematics Society runs weekly "Coffee and Calculus" sessions in the Department's social space (Topos) during Autumn and Spring term. These sessions are an opportunity for later year students to help first year students, but also a place where all years can come together to work in groups on weekly homework. Mathematical Skills 1 & 2 have optional timetabled drop-in sessions (fortnightly) during Spring term to help with the written assignments (particularly the use of LaTeX). Specific student needs related to disability are identified through statements of needs, with the oversight of the department's Disability Coordinator and each student's academic supervisor.

vii) How is teaching informed and led by research in the department/ centre/ University?

The vast majority of teaching staff are active in research, and through lectures, tutorials and seminars communicate the influence foundational ideas have on making progress in research. Students also explicitly connect with the principles of research through projects (in Math Skills 1 & 2, the MMath Group Project in 3rd year and the final year dissertation) as well as having the option to choose modules in the final year which reflect their preferred specialisation and, together with their choice of final year project, enable them to engage with mathematics at the research frontier. The research interests of staff and their industrial collaborations will be integrated into the programme via project work and placements.

Stage-level progression

Please complete the table below, to summarise students' progressive development towards the achievement of PLOs, in terms of the characteristics that you expect students to demonstrate at the end of each year. This summary may be particularly helpful to students and the programme team where there is a high proportion of option modules.

Note: it is not expected that a position statement is written for each PLO, but this can be done if preferred (please add information in the 'individual statement' boxes). For a statement that applies across all PLOs in the stage fill in the 'Global statement' box.

Stage 0 (if your programme has a Foundation year, use the toggles to the left to show the hidden rows)							
Stage 1							
On progression from the first year (Stage 1), students will be able to:			*Global statement*				
PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8

competently use foundational mathematical techniques	adapt foundational techniques to unfamiliar situations	create and critique elementary mathematical reasoning and understand the importance of sound reasoning	produce, in collaboration with others, a well-researched survey of some elementary idea or foundational tool in mathematics	communicate elementary mathematical ideas clearly and concisely	use computers for (a) elementary mathematical typesetting to produce a written report and slides for presentation (b) elementary statistical analysis		
Stage 2							
On progression from the second year (Stage 2), students will be able to:			*Global statement*				
PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
confidently perform calculations, or use methods, which require the combination of several foundational techniques, and identify which of those techniques is appropriate.	recognize when some foundational techniques can be applied outside the standard context, and put together two or more techniques to analyse a problem.	reproduce, with understanding and some insight, important examples of logical reasoning or mathematical argument, and create their own arguments for similar situations	independently perform a literature survey of a renowned or noteworthy mathematical idea, method or process.	write clearly and concisely, with an appropriate balance between mathematics and English, about well-understood mathematical ideas	write basic programmes in Java, typeset using LaTeX and understand how to search for technical information digitally		
Stage 3							
(For Integrated Masters) On progression from the third year (Stage 3), students will be able to:			*demonstrate the six PLO abilities in dealing with more sophisticated concepts than those studied in the third year, and work with a greater level of initiative. In particular, they will be prepared for a career in which the ability to work with high-level mathematical concepts, and possibly develop them, plays a significant role.*				
PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
confidently perform calculations using advanced methods and tools, and be able to select the appropriate method for the context	recognize when a method or tool developed in earlier years can be applied to an unfamiliar problem	reproduce or paraphrase a standard mathematical argument in the correct context, and be able to critically evaluate an argument or the application of a mathematical tool within a familiar context.	make an effective and scholarly contribution to a report on some sophisticated mathematical idea, method or process.	write clearly and concisely, with an appropriate balance between mathematics and English, about sophisticated mathematical ideas, both independently and as a contributor to a shared report. Also, to be able to provide a clear summary of such ideas for presentation.	confidently use computers for producing well-structured written reports and for effective literature research		
Programme Structure							

Module Structure and Summative Assessment Map

Please complete the summary table below which shows the module structure and the pattern of summative assessment through the programme.

'Option module' can be used in place of a specific named option. If the programme requires students to select option modules from specific lists these lists should be provided in the next section.

From the drop-down select 'S' to indicate the start of the module, 'A' to indicate the timing of each distinct summative assessment point (eg. essay submission/ exam), and 'E' to indicate the end of the module (if the end of the module coincides with the summative assessment select 'EA') . It is not expected that each summative task will be listed where an overall module might be assessed cumulatively (for example weekly problem sheets).

If summative assessment by exams will be scheduled in the summer Common Assessment period (weeks 5-7) a single 'A' can be used within the shaded cells as it is understood that you will not know in which week of the CAP the examination will take place.

Stage 0 (if you have modules for Stage 0, use the toggles to the left to show the hidden rows)

Stage 1

Credits	Module		Autumn Term										Spring Term										Summer Term									
	Code	Title	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
30	MAT00001C	Calculus	S										A													E	A					
20	MAT00010C	Algebra	S										A													E	A					
10	MAT00011C	Mathematical Skills 1: Reasoning and Communication	S										A									EA		A								
20	MAT00004C	Introduction to Probability and Statistics	S									EA	A																			
20	MAT00005C	Real Analysis												S												E	A					
20	MAT00003C	Introduction to Applied Mathematics												S												E	A					

Stage 2

Credits	Module		Autumn Term										Spring Term										Summer Term									
	Code	Title	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
40	MAT00034I	Applied Mathematics	S										A													E	A					

40	MAT00032I	Pure Mathematics	S									A												E	A						
40	MAT00035I	Probability & Statistics	S									A												E	A						
10	MAT00027I	Mathematical Skills 2	S								A										E	A									
10	MAT00026I	Linear Algebra	S								E	A																			
10	MAT00033I	Vector Calculus	S								E	A																			
10	MAT00024I	Functions of a Complex Variable											S								E				A						

Stage 3

Credits	Module		Autumn Term										Spring Term										Summer Term									
	Code	Title	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
10		Autumn - List A	S									E	A																			
10		Spring - List B												S								E					A					
20		Autumn/Spring - List C	S							A											A		EA					A					
40	MAT000043H	MMath Group Project	S																							EA				A		
10	MAT000058H	Option - Practical Data Science with R												S	A		A		A		A	EA										
10	MAT000057H	Option - Modelling with Matlab	S		A		A		A		A																					

Stage 4

Credits	Module		Autumn Term										Spring Term										Summer Term									
	Code	Title	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
10		Autumn - List D	S									E	A																			
20		Autumn - List E	S									E	A																			

10		Autumn/Spring - List F	S									A										EA					A					
10		Spring - List G												S								E					A					
20		Spring - List H												S								E					A					
10	MAT00060M	Option - Modelling with MATLAB	S									EA																				
40	MAT00006M	MMath Final Year Project	S									A														EA				A		
10	MAT00004M	Option - Directed Learning in Mathematics (Autumn)	S									EA																				
10	MAT00004M	Option - Directed Learning in Mathematics (Spring)												S								EA										
10	MAT00070M	Option - Soft Matter in Physics and Biology												S						A	A	EA					A					

Optional module lists

If the programme requires students to select option modules from specific lists these lists should be provided below. If you need more space, use the toggles on the left to reveal ten further hidden rows.

Option List A	Option List B	Option List C	Option List D	Option List E	Option List F	Option List G	Option List H
Bayesian Statistics MAT00003H	Formal Languages and Automata MAT00002H	Numerical Analysis MAT00041H	Algebraic Geometry MAT00001M	Mathematical Methods of Finance MAT00020M	C++ Programming with Applications in Finance MAT00021M	Algebraic Groups MAT00003M	Modelling of Bonds, Term Structure and Interest Rate Derivatives MAT00009M
Dynamical Systems MAT00011H	Differential Geometry MAT00006H		Quantum Mechanics III MAT00002M	Discrete Time Modelling and Derivative Securities MAT00023M	Computational Finance MAT00069M	Quantum Information MAT00007M	Stochastic Calculus and Black-Scholes Theory MAT00028M
Fundamentals of Fluid Dynamics MAT00012H	Mathematical Ecology & Epidemiology MAT00055H		Complex & Asymptotic Methods MAT00078M	Advanced Regression Analysis MAT00042M		Applications of Group Theory to Virology MAT00066M	Statistics for Insurance MAT00061M
Mathematical Finance I MAT00015H	Partial Differential Equations II MAT00054H		General Relativity MAT00046M	Portfolio Theory and Risk Management MAT00032M		Partial Differential Equations II MAT00079M	Credit Risk MAT00067M

Generalised Linear Models MAT00017H	Lebesgue Measure & Integration MAT00013H		Metric Number Theory MAT00049M	Survival Analysis (M Level) MAT00039M		Classical & Biological Fluid Dynamics (H Level) MAT00039H	Advanced Multivariate Analysis MAT00040M
Number Theory MAT00023H	Mathematical Finance II MAT00016H		Semigroup Theory MAT00050M			Advanced General Relativity MAT00077M	Financial Time Series MAT00041M
Quantum Mechanics I MAT00024H	Time Series MAT00045H		Partial Differential Equations I MAT00053M			Mathematical Ecology and Epidemiology MAT00080M	
Groups & Actions MAT00056H	Multivariate Analysis MAT00021H		Lie Algebras and Lie Groups MAT00065M			Functional Analysis MAT00045M	
Algebraic Number Theory MAT00029H	Quantum Mechanics II MAT00025H		Hilbert Spaces MAT00063M			Representation Theory of the Symmetric Group MAT00047M	
Stochastic Processes MAT00030H	Cryptography MAT00034H					Quantum Field Theory MAT00048M	
Statistical Pattern Recognition MAT00031H	Quantum Information MAT00053H					Analytic Number Theory MAT00051M	
Metric Spaces MAT00037H	Classical & Biological Fluid Dynamics (H Level) MAT00039H					Riemannian Geometry MAT00052M	
Partial Differential Equations (H Level) MAT00040H	Topology MAT00044H						
Complex & Asymptotic Methods MAT00048H							
Electromagnetism & Relativity MAT00007H							
Galois Theory MAT00008H							
Survival Analysis (H Level) MAT00018H							

Management and Admissions Information

This document applies to students who commenced the programme(s) in:	2017/18

Interim awards available Interim awards available on undergraduate programmes (subject to programme regulations) will normally be: Certificate of Higher Education (Level 4/Certificate), Diploma of Higher Education (Level 5/Intermediate), Ordinary Degree and in the case of Integrated Masters the Bachelors with honours. Please specify any proposed exceptions to this norm.

Certificate of Higher Education (Level 4/Certificate), Diploma of Higher Education (Level 5/Intermediate), Ordinary Degree; Bachelors with honours. Students who pass stage 3 of the MMath programmes, but subsequently do not pass stage 4, will be considered for the award of BSc Mathematical Sciences.

Admissions Criteria

TYPICAL OFFERS
A levels AAA/AAB
IB Diploma Programme 36/35 points including HL 6 in essential subjects
BTEC Extended Diploma DDD (may vary for combined programmes)

Length and status of the programme(s) and mode(s) of study

Programme	**Length (years)**	**Status (full-time/part-time)** Please select	**Start dates/months** (if applicable – for programmes that have multiple intakes or start dates that differ from the usual academic year)	**Mode**				
				Face-to-face, campus-based		**Distance learning**		**Other**
MMath Mathematics	4	Full-time	n/a	Please select Y/N	Yes	Please select Y/N	No	n/a
MMath Mathematics with a Year in Industry	5	Full-time	n/a	Please select Y/N	Yes	Please select Y/N	No	n/a

Language(s) of study

English.

Language(s) of assessment

English.

Programme accreditation by Professional, Statutory or Regulatory Bodies (PSRB)

Is the programme recognised or accredited by a PSRB

Please Select Y/N:	Yes	if No move to next Section if Yes complete the following questions

Name of PSRB

The programme is accredited by the Institute of Mathematics: it meets the educational requirements for Chartered Mathematician (CMath) designation. In addition, Level 6 mathematical finance modules carry the possibility of some exemption from Institute of Actuaries professional examinations, subject to performance at an appropriate level.

Are there any conditions on the approval/ accreditation of the programme(s)/ graduates (for example accreditation only for the full award and not any interim award)

Additional Professional or Vocational Standards

Are there any additional requirements of accrediting bodies or PSRB or pre-requisite professional experience needed to study this programme?

Please Select Y/N:	No	if Yes, provide details

(max 200 words)

University award regulations

The University's award and assessment regulations apply to all programmes: any exceptions that relate to this programme are approved by University Teaching Committee and are recorded at the end of this document.

Are students on the programme permitted to take elective modules?

(See: https://www.york.ac.uk/media/staffhome/learningandteaching/documents/policies/Framework%20for%20Programme%20Design%20-%20UG.pdf)

Please Select Y/N:	Yes	

Careers & Placements - 'With Placement Year' programmes

Students on all undergraduate and integrated masters programmes may apply to spend their third year on a work-based placement facilitated by Careers & Placements. Such students would return to their studies at Stage 3 in the following year, thus lengthening their programme by a year. Successful completion of the placement year and associated assessment allows this to be recognised in programme title, which is amended to include 'with Placement Year' (e.g. BA in XYZ with Placement Year'). The Placement Year also adds a Programme Learning Outcome, concerning employability. (See Careers & Placements for details).

In exceptional circumstances, UTC may approve an exemption from the 'Placement Year' initiative. This is usually granted only for compelling reasons concerning accreditation; if the Department already has a Year in Industry with criteria sufficiently generic so as to allow the same range of placements; or if the programme is less than three years in length.

Programme excluded from Placement Year?	No	If yes, what are the reasons for this exemption:

Study Abroad (including Year Abroad as an additional year and replacement year)

Students on all programmes may apply to spend Stage 2 on the University-wide North America/ Asia/ Australia student exchange programme. Acceptance onto the programme is on a competitive basis. Marks from modules taken on replacement years count toward progression and classification.

Does the programme include the opportunity to undertake other formally agreed study abroad activities? All such programmes must comply with the Policy on Study Abroad

https://www.york.ac.uk/staff/teaching/procedure/programmes/design/

Please Select Y/N:	No	

Additional information

Transfers out of or into the programme

ii) Transfers into the programme will be possible? (please select Y/N)	Yes	

Additional details:

Students on the MMath Mathematics programme may transfer to the BSc Mathematics programme at any time during Stages 1 and 2. Students on the BSc Mathematics programme may transfer to the MMath Mathematics programme at any time during Stages 1 and 2, subject to satisfactory academic progress and LEA agreement. Students may transfer to the MMath with a Year in Industry at the end of stage 2, subject to satisfactory academic progress. Students in stage 3 of the MMath with a Year in Industry may transfer to the MMath programme if they do not proceed with the Year in Industry. Students who fail the Year in Industry (which is assessed on a pass/fail basis by report) can either transfer to the standard MMath, or choose to graduate with a BSc Mathematical Sciences. Standard MMath students who do not pass stage 4 can also graduate with a BSc Mathematical Sciences.

ii) Transfers out of the programme will be possible? (please select Y/N)	Yes	

Additional details:

see above

Exceptions to University Award Regulations approved by University Teaching Committee

Exception Please detail any exceptions to University Award Regulations approved by UTC	**Date approved**

Date on which this programme information was updated:

19/07/18

Please note:

The information above provides a concise summary of the main features of the programme and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if they take full advantage of the learning opportunities that are provided.

Detailed information on the learning outcomes, content, delivery and assessment of modules can be found in the module descriptions.

The University reserves the right to modify this overview in unforeseen circumstances, or where the process of academic development, based on feedback from staff, students, external examiners or professional bodies, requires a change to be made. Students will be notified of any substantive changes at the first available opportunity.

Programme Map

Please note: the programme map below is in interim format pending the development of a University Programme Catalogue.

Programme Map: Module Contribution to Programme Learning Outcomes

This table maps the contribution to programme learning outcomes made by each module, in terms of the advance in understanding/ expertise acquired or reinforced in the module, the work by which students achieve this advance and the assessments that test it. This enables the programme rationale to be understood:

· Reading the table vertically illustrates how the programme has been designed to deepen knowledge, concepts and skills progressively. It shows how the progressive achievement of PLOs is supported by formative work and evaluated by summative assessment. In turn this should help students to understand and articulate their development of transferable skills and to relate this to other resources, such as the Employability Tutorial and York Award;

· Reading the table horizontally explains how the experience of a student at a particular time includes a balance of activities appropriate to that stage, through the design of modules.

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Stage	Module		Programme Learning Outcomes							
			PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
			use, with a high level of confidence and sophistication, the mathematical language and tools that underpin a wide range of research in, and applications to, science, technology and industry	**recognise when an unfamiliar problem is open to mathematical investigation, and be able to formulate their own strategy for the process of such an investigation,**	**use logical reasoning as a basis for the critical analysis of ideas or statements which have a mathematical context, and develop independently their own ideas using well-founded reasoning,**	**conduct, both independently and as part of a group of peers, a study of a specialised area of mathematics which takes into account recent mathematical progress. They will be able to compare and synthesise multiple sources to produce this study, and be able to check or complete technical details from these sources independently,**	**communicate advanced mathematical ideas clearly, in writing and in a presentation, at a level appropriate for the intended audience,**	**create mathematical documents, presentations and computer programmes by accurately and efficiently using a range of digital technologies.**	**#REF!**	**#REF!**
Stage 1	**Algebra MAT00010C**	Progress towards PLO	competently use the standard algebra of vectors, matrices and related objects	adapt the standard algebraic tools to problems slightly outside the standard format	justify the steps and methods used in algebraic arguments		present clear and concise solutions to exercises			

		By working on (and if applicable, assessed through)	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination	exercises and with formative feedback through marked work and the seminars, and assessed by examination	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 1	**Calculus MAT00001C**	Progress towards PLO	competently use the standard methods of differential and integral calculus	adapt standard calculus tools to problems slightly outside the standard format	justify the steps in the solution of calculus problems, or their application		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination	exercises and with formative feedback through marked work and the seminars, and assessed by examination	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 1	**Mathematical Skills 1 MAT00011C**	Progress towards PLO	achieve competence in working with sets, functions, logic and methods of proof	adapt the standard concepts of set theory and logic to problems slightly outside the standard format	practice different methods of mathematical reasoning	find relevant resources, understand their content and contribute towards the group report as a collaborative effort in exposition	practice and develop written and oral communication skills	use LaTeX to create a short written report, and prepare slides for a presentation.		

		By working on (and if applicable, assessed through)	lecture material and exercises, with feedback through marked work and the tutorials, and assessed by course work and examination	exercises and with feedback through marked work and the tutorials, and assessed by course work and examination	lecture material and exercises, with feedback through marked work and the tutorials, and assessed by course work and examination	their contribution to the group project (3-4 students per group), as assessed by the written project.	the production of the group project and group presentation talk, as assessed through the written project (8-10 pages) and the group talk (12-15 minutes).	the written report and the presentation slides for the group project in Spring term, with the support of lectures and drop-in support classes, and as assessed by the written project and the presentation slides.		
Stage 1	**Introduction to Probability and Statistics MAT00004C**	Progress towards PLO	understand and use standard probability theory and its relation to statistical analysis, and be able to do elementary statistical modelling and analysis	apply the standard methods from the module in unfamiliar situations	explain the reasoning behind the standard methods of statistical analysis using their theoretical foundations		present clear and concise solutions to exercises	confidently use the statistical package R for elementary data analysis		
		By working on (and if applicable, assessed through)	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination	exercises and with formative feedback through marked work and the seminars, and assessed by examination	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination		exercises, with the support of seminars and formative feedback through marked work	the data analysis examples with the support of the computer practicals		

Stage 1	**Introduction to Applied Mathematics MAT00003C**	Progress towards PLO	understand and practice the use of mathematical methods to formulate and solve standard problems in elementary applied mathematics	adapt a range of methods to create and investigate applied mathematical models beyond the standard examples	analyse the reasoning behind the core dynamics of a mathematical model		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination	exercises and with formative feedback through marked work and the seminars, and assessed by examination	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 1	**Real Analysis MAT00005C**	Progress towards PLO	competently use the standard methods of real analysis to work with sequences, series and functions	adapt the standard analytic tools to problems slightly outside the standard format	justify the logical steps in the proofs of analytic results		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination	exercises and with formative feedback through marked work and the seminars, and assessed by examination	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination.		exercises, with the support of seminars and formative feedback through marked work			

Stage 2	**Applied Mathematics MAT00034I**	Progress towards PLO	work confidently with the mathematical aspects and foundational ideas in the application of mathematics to modern physics: Newtonian gravity, special relativity, classical and quantum mechanics, waves and fluids	apply a variety of mathematical tools and physical principles to be able to model unfamiliar situations and analyse the consequences of such models	understand and be able to justify the thought processes behind the choice of one or other mathematical tool, or the reasoning and assumptions underlying a particular mathematical model		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination	exercises and with formative feedback through marked work and the seminars, and assessed by examination	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 2	**Pure Mathematics MAT00032I**	Progress towards PLO	understand the language of abstract mathematics and work confidently with the ideas which form the basis of abstract algebra, number theory and geometry	recognize and be able to put into practice the principles of abstract mathematics in unfamiliar settings	reproduce, with understanding, central arguments used in algebra, number theory and geometry, and be able to adapt these to similar situations		present coherent, clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination	exercises and with formative feedback through marked work and the seminars, and assessed by examination	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination		exercises, with the support of seminars and formative feedback through marked work			

Stage 2	**Probability & Statistics MAT00035I**	Progress towards PLO	work confidently with a range of statistical tools (both analytically and numerically), statistical inference concepts and techniques, and be able to use probability theory to model a variety of random processes	apply the statistical methods and the framework of applied probabilistic modelling to unfamiliar situations	understand and be able to explain when it is appropriate to use statistical methods or models amongst those covered in the syllabus		present clear and concise solutions to exercises	building on the skills developed in Introduction to Probability and Statistics, write code in the statistical package R for the statistical analysis of data sets		
		By working on (and if applicable, assessed through)	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination	exercises and with formative feedback through marked work and the seminars, and assessed by examination	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination		exercises, with the support of seminars and formative feedback through marked work	example data sets with the support of example classes		
Stage 2	**Mathematical Skills 2 MAT00027I**	Progress towards PLO	understand the basics of scientific computing and be able to write functional code for some standard algorithms	apply the methods of numerical analysis to unfamiliar problems	critically analyse their own computer code	investigate, independently after some initial guidance, the literature on a mathematical process or focussed area of research	write coherent documentation of their programming project, or write a report (8-10 pages) which gives a clear account of one of three optional topics in mathematics	write an elementary programme using Java, and, building on the skills developed in Mathematical Skills 1, typeset a written report which includes a short literature survey		

		By working on (and if applicable, assessed through)	lecture material and supported by laboratory practice sessions	practical exercises, with the support of laboratory classes and as assessed through the programming assignment	the programming exercises, supported by laboratory practice sessions	either the programming project or the mathematical topic project, as assessed by the submitted report.	either the programming project or the mathematical topic project, as assessed by the submitted report.	the coding exercises in Autumn term (and the Spring term for students of the programming pathway), and the written report in the Spring term.		
Stage 2	**Linear Algebra MAT00026I**	Progress towards PLO	use the standard methods of basic linear algebra and matrix theory, and their theoretical justification through abstract algebra	apply basic linear algebra and matrix theory to a range of unfamiliar situations	prove standard results in abstract linear algebra		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination	exercises and with formative feedback through marked work and the seminars, and assessed by examination	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 2	**Vector Calculus MAT00033I**	Progress towards PLO	use the standard methods of multi-variable differential and integral calculus to work with functions of many variables and vector fields	apply these standard methods to problems which require a level of interpretation to set up the application			present clear and concise solutions to exercises			

		By working on (and if applicable, assessed through)	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination	exercises and with formative feedback through marked work and the seminars, and assessed by examination			exercises, with the support of seminars and formative feedback through marked work			
Stage 2	**Functions of a Complex Variable MAT00024I**	Progress towards PLO	understand and use the standard methods of complex analysis for functions of one complex variable	apply complex analysis to solve problems in applied real analysis, where their use provides quick and powerful solutions	decide when certain methods from complex analysis can, or cannot, be applied and give a justification for this decision		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination	exercises and with formative feedback through marked work and the seminars, and assessed by examination	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination.		exercises, with the support of seminars and formative feedback through marked work			
Stage 3	**Differential Geometry MAT00006H**	Progress towards PLO	understand and be able to calculate the standard geometric properties of curves and surfaces	decide which geometric properties can be evaluated given different representations of a curve or surface	justify the steps made in differential geometric arguments		present clear and concise solutions to exercises			

		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 3	**Algebraic Number Theory MAT00029H**	Progress towards PLO	understand what is meant by "Algebraic Number Theory" and will be well-versed in many of the standard techniques	recognise various problems in algebraic number theory and apply the techniques they have learnt to solve them (e. g., factorisation of algebraic integers or ideals; identification of prime and irreducible elements in rings of integers)	justify the steps made in algebraic and number-theoretic arguments		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			

Stage 3	**Cryptography MAT00034H**	Progress towards PLO	understand and be able to work with some of the mathematical underpinnings of modern cryptography	apply their current mathematical knowledge to new areas (namely certain cryptographic systems)	follow the reasoning as to why a primality test or a factorisation algorithm works		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 3	**Formal Languages and Automata MAT00002H**	Progress towards PLO	understand the concept and be able to calculate the languages associated with finite state automata	decide which languages are of a nature that allows them to be described via automata, or other finitary processes	analyse the logic behind the Pumping Lemma, allowing them one way of determining when a language is not regular		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			

Stage 3	**Galois Theory MAT00008H**	Progress towards PLO	understand and be able use symmetry in the solution of polynomial equations and the correspondence that reconstructs fields and their subfields inside groups of symmetry	see how their algebraic foundations can be applied to solve specific problems (in particular, the algebraic solutions of equations and the construction using ruler and compass of specific objects)	follow the reasoning behind the construction of the Galois group of a field extension and the correspondence between its subgroups and intermediate fields		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 3	**Groups and Actions MAT00056H**	Progress towards PLO	understand and be able to work with the theory of groups and their actions	decide which approach is appropriate to problems in group theory	follow logical steps in arguments and justify those steps		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture note and exercise sheet material	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination	exercises from exercise sheets and and past exam papers		exercises, with the support of seminars and formative feedback through marked work			

Stage 3	**Lebesgue Measure and Integration MAT00013H**	Progress towards PLO	understand and be able to calculate the Lebesgue integral of simple functions	decide which properties define a null set and be able to compute the Lebesgue integral of a given function	justify the steps made in defining the Lebesgue integral of a measurable function		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 3	**Metric Spaces MAT00037H**	Progress towards PLO	understand the notion of an abstract metric space and have a collection of tools to study them	understand how and when the concept of metric can be used to examine unfamiliar problems	comprehend and produce mathematical arguments to support claims concerning properties of metric spaces		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			

Stage 3	**Number Theory MAT00023H**	Progress towards PLO	understand and be able to use a wide range of methods from analytic number theory, Diophantine equations and Diophantine approximation	apply their analytic/number theoretic foundations to solve specific problems (eg. counting primes, Waring's problem) and develop new areas (Diophantine approximation)	comprehend and produce mathematical arguments to support claims concerning fundamental properties of numbers. At the end of the module students will (i) understand and appreciate a variety of methods and results in the subject and (ii) be able to tackle a variety of problems competently.		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 3	**Topology MAT00044H**	Progress towards PLO	understand the notion of topological spaces, invariants and fundamental groups and be able to apply the ideas in an abstract setting.	determine when a given space is a topological space, be able to determine when two spaces are essentially the same and be able to determine what, if any, topological invariants the spaces possess	answer questions and solve problems about topological spaces that require reasoned, solid mathematical arguments		present clear and concise solutions to exercises			

		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 3	**Dynamical Systems MAT00011H**	Progress towards PLO	analyse the qualitative features of simple dynamical systems	adapt standard techniques to unfamiliar nonlinear dynamical systems	justify the conclusions of a qualitative analysis of a nonlinear system		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 3	**Complex and Asymptotic Methods MAT00048H**	Progress towards PLO	confidently apply tools and techniques of complex analysis in a variety of standard problems, including evaluation of contour integrals and the solution of differential equations	adapt the methods of complex analysis to unfamiliar problems	justify the steps made in application of complex analytic methods		present clear and concise solutions to exercises			

		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination.	lecture material and exercises, with the guidance and support of seminars		exercises, with the support of seminars and formative feedback through marked work			
Stage 3	**Classical & Biological Fluid Dynamics (H Level) MAT00039H**	Progress towards PLO	apply fluid dynamics techniques to a set of problems in biology	adapt standard applied mathematics techniques to unfamiliar fluid dynamics problems in biology	justify the conclusions of a qualitative analysis of a biological fluid dynamics problem	conduct, independently or in groups, studies on the context or analysis of biological fluid dynamics problems	present clear written or seminar presentations of worked exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback during short presentations in seminars	exercises, with the support of seminars and formative feedback on marked work and presentations			
Stage 3	**Electromagnetism &Relativity MAT00007H**	Progress towards PLO	students will be able to apply vector calculus techniques to Maxwell's equations across a range of standard electromagnetic phenomena	students will be able to apply their theoretical understanding of electromagnetism to a range of phenomena, selecting the appropriate technique and applying it to an unfamiliar problem	students will work through a range of intriguing electromagnetic phenomena, including apparent paradoxes which require clear argument and new theory for their resolution		present clear and concise solutions to exercises			

		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 3	**Fundamentals of Fluid Dynamics MAT00012H**	Progress towards PLO	students will be able to apply basic fluid dynamics techniques to unfamiliar fluid dynamical problems	students will be able to adapt standard techniques to unfamiliar fluid dynamical problems	students will be able to justify the conclusions of a qualitative analysis of a fluid dynamics problem		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			

Stage 3	**Mathematical Ecology and Epidemiology MAT00055H**	Progress towards PLO	evaluate ecological or epidemiological problems and construct appropriate models. Using these models, they should be to apply appropriate mathematical tools and techniques to determine solution behaviour.	adapt the techniques taught to unfamiliar problems in the modelling of ecological and epidemiological problems.	justify the conclusions of a qualitative analysis of a dynamical systems problem		present clear and concise solutions to exercises, including the results of mathematical reasoning and the qualitative discussion of the implications and validity of mathematical models			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars and examples classes, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 3	**Modelling with MATLAB MAT00057H**	Progress towards PLO	write computer code to enable the numerical investigation of mathematical models in the life sciences	interpret empirical data in the context of some appropriate mathematical models	justify the mathematical models being used on the grounds of sound scientific and mathematical principles	relate the techniques to up-to-date research papers	write independent reports summarising key outputs clearly and concisely	be competent with the fundamentals of programming in MATLAB (a mathematical programming language for computation and visualization).		

		By working on (and if applicable, assessed through)	lectures and practical sessions, with feedback on formative coursework, and as assessed by coursework.	coursework, with the support of practical sessions	lectures and formative coursework, and as assessed by summative coursework.	lectures and coursework	coursework, with the support of lectures and feedback from marked work	lectures and practical sessions, and as assessed through coursework		
Stage 3	**Partial Differential Equations I (H Level) MAT00040H Partial Differential Equations II (H Level) MAT00054H**	Progress towards PLO	students will be able to use various techniques for analysing and solving partial differential equations	students will be able to adapt standard techniques to unfamiliar partial differential equations	students will be able to justify the conclusions of a qualitative analysis of a partial differential equation		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 3	**Numerical Analysis MAT00041H**	Progress towards PLO	students will be able to apply numerical approximation techniques to a range of standard mathematical problems	students will be provided with a range of approximation techniques that can be used in unfamiliar application problems	students will be able to justify which particular numerical method is appropriate in a given context, and in which sense the approximation error is small		students will be able to communicate mathematical arguments in Numerical Analysis in writing	implement the numerical methods in practice by means of computer packages (such as Maple or Excel) and/or programming languages (such as Java).		

		By working on (and if applicable, assessed through)	lecture materials, computer practicals, assessed computer-based coursework, as well as being assessed in the examination	lecture materials, computer practicals	lecture materials, computer practicals, written coursework, and as assessed through examination		assessed written coursework	lecture material, computer practicals, coursework		
Stage 3	**Quantum Mechanics I MAT00024H Quantum Mechanics II MAT00025H**	Progress towards PLO	students will be able to understand how the language of mathematics and mathematical techniques are used to solve standard problems in quantum mechanics	students will be able to tackle unseen problems in quantum mechanics by various mathematical approaches	students will be able to examine critically some applications of quantum mechanical principles		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 3	**Quantum Information MAT00053H**	Progress towards PLO	understand and use the language of quantum information theory	recognise when an information-theoretic problem may have a quantum advantage and understand the techniques that may solve them	developing lines of reasoning using the principles of quantum theory		explain clearly key ideas of quantum information theory and advantages of quantum protocols over classical			

		By working on (and if applicable, assessed through)	exercises, reading course materials and discussions in lectures	exercises, reading course materials and discussions in lectures	presentation and communication of ideas in solutions to exercises		presentation and communication of ideas in solutions to exercises and answering questions in lectures			
Stage 3	**Bayesian Statistics MAT00003H**	Progress towards PLO	students will be able to perform a Bayesian analysis of simple statistical models with a conjugate prior distribution, including derivation of the posterior distribution and simulation from the posterior predictive distribution	students will be able to recognize statistical problems which require the application of the Bayes' rule; and to apply the Bayesian inferential approach to unfamiliar simple statistical models	students will be able to interpret numerical summaries of the posterior and predictive distributions, produced by simulation methods		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 3	**Generalised Linear Models MAT00017H**	Progress towards PLO	students will be able to correctly formulate a generalised linear model and use it appropriately in the context of data analysis	students will be able recognise when generalised linear models do not fit the available data and adapt their modelling strategy as appropriate	students will be able to conduct inference using the appropriate tools and be aware of the corresponding assumptions and their consequent limitations		present clear and concise solutions to exercises	students will be able to use the statistical programme R to perform data analysis in the GLM context.		

		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars and practical sessions, through feedback on marked work and as assessed through examination	theoretical and practical exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars and practical sessions, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work	example data sets in exercises with the support of computer practical classes		
Stage 3	**Mathematical Finance I MAT00015H**	Progress towards PLO	students will be able to analyse portfolio selection and simple investment strategies	students will be able adapt standard techniques to unfamiliar portfolio optimisation and also forward contracts and options	students will be able to justify the conclusions of a quantitative analysis of portfolio under risk restrictions and also obtain arbitrage constraints in investment strategies		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 3	**Mathematical Finance II MAT00016H**	Progress towards PLO	students will be able to analyse the quantitative features of pricing and hedging options	students will be able adapt standard techniques to unfamiliar option pricing and hedging problems	students will be able to justify the conclusions of a quantitative analysis of pricing and hedging options		present clear and concise solutions to exercises			

		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 3	**Multivariate Analysis MAT00021H**	Progress towards PLO	students will be able to analyse the quantitative features of multivariate data	students will be able adapt standard techniques to unfamiliar multivariate data	students will be able to justify the conclusions of a qualitative analysis of a multivariate data set		present clear and concise solutions to exercises	students will be able to use statistical package R to analyse multivariate data by various techniques		
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of practicals, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of practicals, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of practicals, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work	examples with the support of computer practical classes		
Stage 3	**Practical Data Science with R MAT00058H**	Progress towards PLO	apply statistical techniques to real world problems	adapt standard statistical techniques to specific problems	justify the conclusions of a data analysis problem		clear presentation of worked exercises	appropriate presentation of statistical analysis in a short report		

		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through coursework and examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and assessed through coursework and examination	lecture material and coursework, with the guidance and support of seminars, and assessed through coursework and examination		coursework with the support of seminars and feedback on marked work	assessed coursework with the support of seminars and lecture material		
Stage 3	**Statistical Pattern Recognition MAT00031H**	Progress towards PLO	students will acquire a range of pattern recognition techniques that can be applied to real world data analysis, particularly classification problems	students will be able to identify and apply the most appropriate techniques to particular problems	students will be able to justify the conclusions of a qualitative analysis of a multivariate data set		present clear and concise solutions to exercises	apply pattern recognition techniques using the statistical package R.		
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises in seminars and computer practicals	lecture material and exercises, with the guidance and support of practicals, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work	example data sets in exercises with the support of seminars and examples classes		

Stage 3	**Stochastic Processes MAT00030H**	Progress towards PLO	students will be able to formulate and analyse mathematical models that take account of the stochastic (random) fluctuations that are always present in the real world. They will acquire a range of mathematical techniques and approximations that can be used to make analytic predictions from stochastic models	students will be able adapt standard techniques to unfamiliar stochastic dynamical systems	students will be able to justify the arguments behind using stochastic models and recognize the difference with deterministic models of behaviour		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 3	**Survival Analysis (H Level) MAT00018H**	Progress towards PLO	understand and be able to use the standard statistical techniques of survival analysis	apply the methods of survival analysis to unfamiliar data sets	explain the criteria for using the statistical models which apply to survival analysis		present clear and concise solutions to exercises			

		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of practical sessions, and through feedback on marked work	exercises, with the guidance and support of practical sessions, and through feedback on marked work	lecture material and exercises, with the guidance and support of practical sessions, and through feedback on marked work, and as assessed in the examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 3	**Time Series MAT00045H**	Progress towards PLO	students will be able to analyse the quantitative feature of time series models	students will be able to adapt standard techniques to unfamiliar time series models	students will be able to justify the conclusions of a quantitative analysis of a time series model		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			

Stage 3	**MMath Group Project MAT00043H**	Progress towards PLO		apply methods from other modules, as appropriate, to the topic of the project	provide a clear critical analysis of the mathematical principles under investigation	make an individual contribution to the study of background material by the group and be able to properly reference sources of information for the written project	present a clear written account of the topic under investigation, as well as a concise summary in poster form	building on the skills developed in Mathematical Skills 1 & 2, prepare a well-structured, technical document involving mathematical typesetting (which may include figures), with proper use of a referencing protocol. They will also be able to prepare a digital master for a poster summarising their project.		
		By working on (and if applicable, assessed through)		the development of the project material, with the guidance of the project supervisor	the background material relevant to the project, with the support of peer discussion and with the guidance of the project supervision meetings	the background for the group project and the written report, with support on proper referencing from the lecture	the written report (approx 30 pages in total), in collaboration with the peer group, and the individually prepared poster. Formative assessment: two short individual assignments during term. Summative assessment: the group project and the poster presentation.	the written report and the poster, with the support of lectures and demonstration classes, and feedback on the two individual assignments during the term.		

Stage 4	**Algebraic Groups MAT00003M Algebraic Geometry MAT00001M**	Progress towards PLO	work with the agebraic methods which reflect the geometry of aglgebraic sets or groups	apply these ideas to the analysis of unfamiliar concrete examples	produce their own lines of reasoning to prove statements about algebraic sets or groups		present clear written or seminar presentations of worked exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination		exercises, with the support of seminars and formative feedback on marked work and presentations			
Stage 4	**Analytic Number Theory MAT00051M**	Progress towards PLO	use a wide range of methods from analytic number theory	apply these techniques and ideas to the analysis of unfamiliar concrete examples	comprehend and produce mathematical arguments to support claims concerning fundamental properties of numbers		present clear written or seminar presentations of worked exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination		exercises, with the support of seminars and formative feedback on marked work and presentations			

Stage 4	**Hilbert Space MAT00063M Functional Analysis MAT00045M**	Progress towards PLO	work with the standard tools and results concerning Hilbert spaces and operators between them	apply these methods to unfamiliar problems on abstract or concrete Hilbert spaces	produce their own lines of reasoning to prove statments aobut Hilbert spaces and their operators		present clear written or seminar presentations of worked exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination		exercises, with the support of seminars and formative feedback on marked work and presentations			
Stage 4	**Lie Algebras & Lie Groups MAT00065M**	Progress towards PLO	use the standard tools of Lie algebra and matrix Lie group theory, particularly those relevant to the classification of finite dimensional Lie algebras	apply these ideas to the analysis of unfamiliar concrete examples	produce their own lines of reasoning to prove statements about Lie algebras and matrix Lie groups		present clear written or seminar presentations of worked exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination		exercises, with the support of seminars and formative feedback on marked work and presentations			

Stage 4	**Representation Theory of the Symmetric Group MAT00047M**	Progress towards PLO	use the standard tools of representation theory of finite groups and the combinatorical methods which underpin its application to the symmetric group	apply these ideas to the analysis of unfamiliar concrete examples	produce their own lines of reasoning to prove statements in the context of the topic of the module		present clear written or seminar presentations of worked exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination		exercises, with the support of seminars and formative feedback on marked work and presentations			
Stage 4	**Metric Number Theory MAT00049M**	Progress towards PLO	use the algebraic and probabilistic ideas within metric number theory and understand the interplay between number theory and basic dynamical systems	apply these techniques and ideas to the analysis of unfamiliar concrete examples	produce their own lines of reasoning to prove statements concerning systems of Diophantine inequalities		present clear written or seminar presentations of worked exercises			

		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination		exercises, with the support of seminars and formative feedback on marked work and presentations			
Stage 4	**Riemannian Geometry MAT00052M**	Progress towards PLO	work with the standard tools required for understanding the geometry of Riemannian manifolds	apply these ideas to the analysis of unfamiliar concrete examples	produce their own lines of reasoning to prove statements, both general and specific, about the geometry of Riemannian manifolds		present clear written or seminar presentations of worked exercises, and group work within seminars			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination		exercises, with the support of seminars and formative feedback on marked work and presentations, and interaction with peers			
Stage 4	**Semigroup Theory MAT00050M**	Progress towards PLO	develop an understanding of the algebraic theory of semigroups; an example of a class of algebras where not every congruence is determined by a subalgebra	apply these ideas to the analysis of unfamiliar concrete examples	produce their own lines of reasoning to prove statements, both general and specific, about properties of semigroups		present clear written or seminar presentations of worked exercises			

		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination		exercises, with the support of seminars and formative feedback on marked work and presentations, and interaction with peers			
Stage 4	**Classical and Biological Fluid Dynamics MAT00054M**	Progress towards PLO	apply high level fluid dynamics techniques to a set of problems in biology	adapt standard applied mathematics techniques to unfamiliar fluid dynamics problems in biology	justify the conclusions of a qualitative analysis of a biological fluid dynamics problem	conduct, independently or in groups, studies on the context or analysis of biological fluid dynamics problems	present clear written or seminar presentations of worked exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback during short presentations in seminars	exercises, with the support of seminars and formative feedback on marked work and presentations			
Stage 4	**Complex and Asymptotic Methods MAT00048H**	Progress towards PLO	confidently apply tools and techniques of complex analysis, with a high level of sophistication, to a wide variety of problems including evaluation of contour integrals and the solution of differential equations	adapt the methods of complex analysis to unfamiliar problems	justify the steps made in application of complex analytic methods		present clear and concise solutions to exercises			

		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination.	lecture material and exercises, with the guidance and support of seminars		exercises, with the support of seminars and formative feedback through marked work			
Stage 4	**General Relativity MAT00046M Advanced General Relativity MAT00077M**	Progress towards PLO	perform calculations in Einstein's theory of gravity using the framework of curved space-time	solve unfamiliar problems in General Relativity using the mathematical formulation of Einstein's theory	justify on both mathematical and physical grounds the conceptual framework of General Relativity		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 4	**Partial Differential Equations I MAT00053M Partial Differential Equations II MAT00079M**	Progress towards PLO	use, with a high level of sophistication, a number of standard techniques for analysing and solving linear partial differential equations	adapt standard techniques to unfamiliar partial differential equations	justify the conclusions of a qualitative analysis of a partial differential equation		present clear and concise solutions to exercises			

		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and as assessed through examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 4	**Modelling with MATLAB MAT00060M**	Progress towards PLO	write computer code to enable the numerical investigation of mathematical models in the life sciences	interpret empirical data in the context of some appropriate mathematical models	justify the mathematical models being used on the grounds of sound scientific and mathematical principles	relate the techniques to up-to-date research papers	write independent reports summarising key outputs clearly and concisely	be competent with the fundamentals of programming in MATLAB (a mathematical programming language for computation and visualization).		
		By working on (and if applicable, assessed through)	lectures and practical sessions, with feedback on formative coursework, and as assessed by coursework.	coursework, with the support of practical sessions	lectures and formative coursework, and as assessed by summative coursework.	lectures and coursework	coursework, with the support of lectures and feedback from marked work	lectures and practical sessions, and as assessed through coursework		
Stage 4	**Quantum Information MAT00007M**	Progress towards PLO	understand and use, to a high level of sophistication, the language of quantum information theory	recognise when an information-theoretic problem may have a quantum advantage and understand the techniques that may solve them	developing lines of reasoning using the principles of quantum theory		explain clearly key ideas of quantum information theory and advantages of quantum protocols over classical			

		By working on (and if applicable, assessed through)	exercises, reading course materials and discussions in lectures	exercises, reading course materials and discussions in lectures	presentation and communication of ideas in solutions to exercises		presentation and communication of ideas in solutions to exercises and answering questions in lectures			
Stage 4	**Quantum Mechanics III MAT00002M Quantum Field Theory MAT00048M**	Progress towards PLO	apply, with a high level of competence, techniques of quantum theory to various systems originating in atomic or high energy physics	understand how general formalism of quantum theory can be adapted to physical systems and be able to solve unfamiliar problems	critically analyse the framework of quantum theory for consistency and analyse and justify one's own reasoning		present clear and concise solutions to exercises on advanced quantum theory			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	working through the module material and presentation and communication of ideas in solutions to exercises		exercises, with the support of seminars and formative feedback through marked work			
Stage 4	**Applications of Group Theory to Virology MAT00066M Mathematical Ecology and Epidemiology MAT00080M**	Progress towards PLO	use a range of mathematical techniques to mathematically model phenomena from the biological sciences	adapt and apply the methods discussed in lectures to other problems in biological or ecological modelling	justify the assumptions which underlie different models	contribute to a group discussion on the uses and meaning of the mathematical models presented in lectures	present clear written or seminar presentations of worked exercises			

	Soft Matter in Physics and Biology MAT00070M	By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	exercises and seminars	exercises, with the support of seminars and formative feedback on marked work and presentations			
Stage 4	**Advanced Regression Analysis MAT00042M**	Progress towards PLO	correctly formulate, and code using R, a regression model and use it appropriately in the context of data analysis	recognise when a regression model does fit the available data and adapt their modelling strategy as appropriate	conduct inference using the appropriate tools and be aware of the corresponding assumptions and their consequent limitations. Also to be able to critically analyse code in R for correctness		present clear and concise solutions to exercises	use the statistical software R in the context of regression analysis		
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of seminars and practical sessions, through feedback on marked work and as assessed through examination	theoretical and practical exercises, with the guidance and support of seminars, and through feedback on marked work, and as assessed through examination	lecture material and exercises, with the guidance and support of seminars and practical sessions, and as assessed through examination		practical exercises, with the support of seminars and formative feedback through marked work	practical exercises, with the support of computer practical sessions		

Stage 4	**Advanced Multivariate Analysis MAT00040M**	Progress towards PLO	analyse the quantitative features of multivariate data, by hand and using the statistical software R.	adapt standard techniques to unfamiliar multivariate data.	justify the conclusions of a qualitative analysis of a multivariate data set.		present clear and concise course work	use computers for graphical representation of data and the R program for matrix algebra and multivariate analysis.		
		By working on (and if applicable, assessed through)	Lecture material and exercises, with the guidance and support of practicals, and through feedback on marked work, and as assessed through coursework and examination.	Exercises, with the guidance and support of practicals, and through feedback on marked work, and as assessed through coursework and examination.	Lecture material and exercises, with the guidance and support of practicals, and as assessed through coursework and examination.		Course work, with the guidance of feedback on marked exercises	computer practical classes		
Stage 4	**C++ Programming with Applications in Finance MAT00021M**	Progress towards PLO	write C++ code which can be used for standard applications in mathematical finance	apply and adapt code to an unfamiliar practical problem in the setting of finance	critically analyse code for correctness and suitability for an application in finance		write clear and coherent C++ code and an accompanying report on its use and purpose	write and compile C++ code in the context of financial applications		
		By working on (and if applicable, assessed through)	lectures, practical classes, exercises and as assessed by coursework and class tests	exercises and coursework	practical classes, exercises and coursework, with feedback from marked work		exercises and coursework, with the support of practical classes and feedback from marked work	exercises and coursework, with the support of practical classes and feedback from marked work		
Stage 4	**Computational Finance MAT00069M**	Progress towards PLO	implement Matlab routines which can be used for standard applications in computational finance	apply and adapt these numerical methods to an unfamiliar practical problem in the setting of finance	critically analyse numerical methods and the accompanying code for correctness, efficiency and suitability for an application in finance		write clear code and an accompanying report on an application of numerical methods in quantitative finance	write functional code in MATLAB in the context of financial applications		

		By working on (and if applicable, assessed through)	lectures, practical classes, exercises and as assessed by coursework and practical examination	exercises and coursework	practical classes, exercises and coursework		coursework, with the support of practical classes.	exercises and coursework, with the support of practical classes and feedback from marked work		
Stage 4	**Credit Risk MAT00067M**	Progress towards PLO	master the mathematical tools which can be used for standard applications in credit risk	apply and adapt the mathematical tools to an unfamiliar practical problem in the setting of credit risk	critically analyse solutions to problems for correctness and suitability for an application in credit risk		write clear and concise solutions to problems from exercises			
		By working on (and if applicable, assessed through)	lecture notes, exercises and with the support of seminars, and as assessed by examination	examples, exercises and with the support of seminars, and as assessed by examination	examples, exercises and with the support of seminars, and as assessed by examination		exercises and with the support of seminars and feedback on formative work			
Stage 4	**Financial Time Series MAT00041M**	Progress towards PLO	be able to use the basic characteristics of financial data, and apply financial time series models to analyse financial time series.	be able to select the appropriate time series models for sets of financial time series data.	be able to derive theoretical results relating to some important financial time series models and thereby justify their application		write clear and concise solutions to problems from exercises	using appropriate computer software to fit time series models to financial time series data, and carry out related predictions		
		By working on (and if applicable, assessed through)	lecture notes, exercises and with the support of seminars, and as assessed by examination	examples, exercises and with the support of seminars, and as assessed by examination	lecture notes and exercises, and as assessed by examination		exercises and with the support of seminars and feedback on formative work	computer practical classes, with feedback on exercises		

Stage 4	**Mathematical Methods of Finance MAT00020M Discrete Time Modelling & Derivative Securities MAT00023M Stochastic Calculus & Black-Scholes Theory MAT00028M Modelling of Bonds Term**	Progress towards PLO	use the tools of probability theory and stochastic processes in the context of mathematical finance	adapt these methods to unfamiliar concrete problems	justify the use of these tools and critically choose the appropriate tool for each situation		write clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lectures, seminars and exercises	exercises , with the support of seminars and as assessed by examination	lectures and exercises, with the support of seminars		exercises, with the support of seminars and formative feedback through marked work			
Stage 4	**Portfolio Theory and Risk Management MAT00032M**	Progress towards PLO	understand and use standard statistical measures of risk and methods for risk minimisation in the context of a portfolio of stocks	adapt these risk-minimisation methods to unfamiliar problems in portfolio managemen	justify the choice of the principal risk measures and the appropriateness of the risk-minimisation methods		write clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lectures, seminars and exercise	exercises , with the support of seminars and as assessed by examination	lectures and exercises, with the support of seminars		exercises, with the support of seminars and formative feedback through marked work			
Stage 4	**Statistics for Insurance MAT00061M**	Progress towards PLO	Analyse data of the type which typically arises from insurance and actuarial science, both by hand and with the aid of the statistical software R,	Apply these methods to unfamiliar data sets	Justify the choice of statistical models which are used for this analysis		Present clear and concise solutions to exercises	use statistical software to analyse insurance data		

		By working on (and if applicable, assessed through)	Lectures, seminars and exercises	Exercises, with the support of seminars	Lectures, seminars and exercises		Exercises, with the support of seminars and feedback through marked work	lectures, with the support of seminars		
Stage 4	**Survival Analysis MAT00039M**	Progress towards PLO	understand and be able to use to a high level of competence the statistical techniques of survival analysis	confidently apply the methods of survival analysis to unfamiliar data sets	justify the criteria for using the statistical models which apply to survival analysis		present clear and concise solutions to exercises			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the guidance and support of practical sessions, and through feedback on marked work, and as assessed in the examination	exercises, with the guidance and support of practical sessions, and through feedback on marked work	lecture material and exercises, with the guidance and support of practical sessions, and through feedback on marked work, and as assessed in the examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 4	**Directed Learning in Mathematics MAT00004M**	Progress towards PLO	understand and be able to use methods relevant to the area of specialsim of the DLM		criticaly analyse the literature to obtain a clear understanding of the topic under discussion		write clear and concise work as required by the assessment of the DLM			
		By working on (and if applicable, assessed through)	recommend reading and seminars		recommend reading and seminars		coursework, with the support of the seminars			

Stage 4	**MMath Final Year Project MAT00006M**	Progress towards PLO		adapt and apply the mathematics learned during the degree to some challenging topic outside the MMath degree syllabus	justify the reasoning and/or choice of methods used in the mathematics relevant to the project topic	conduct an independent study into a specialised area of mathematics, by researching material from a variety of sources, and be able to verify independently some of the results desccribed in the literature	communicate advanced mathematical ideas clearly in writing at the final year BSc level, and also be able to present an effective summary of these ideas for non-experts in a presentation	building on the writing and typesetyting skills developed in earlier years, prepare a long, well-structured, technical document involving mathematical typesetting (which may include figures), with proper use of a referencing protocol. They will also be able to prepare slides for a short presentation.		
		By working on (and if applicable, assessed through)		material found in the literature, with the support of the project supervisor and as assessed by the dissertation	the project dissertation, with the support of the project supervisor and as assessed by the dissertation	the project dissertation, with the support of the project supervisor and as assessed by the dissertation	the project dissertation (30-40 pages) and the presentation talk (10 minutes), with the support of the project supervisor, lectures and demonstration on writing and presenting mathematics, as assessed by the writing assignments, the dissertation and the presentation talk.	preliminary assignments which develop an appreciation of layout for documents and slides, the use of structure, the inclusion of figures. This is supported by practical classes, with feedback on assignments, and assessed through assignments and the presentation.		