

# Programme Specifications

## Modules offered on Mathematics programmes in 2023-24

Semester 1	Semester 2
<b>Level 1</b>	
MTH1011 Introduction to Algebra and Analysis (30 CATS) <sup>a</sup>	
MTH1021 Mathematical Methods 1 (30 CATS)	
MTH1015 Mathematical Reasoning (10 CATS)	MTH1025 Algorithmic Thinking (10 CATS)
SOR1020 Introduction to Probability and Statistics (30 CATS)	
	SOR1021 Introduction to SOR Methods (10CAT)
<b>Level 2</b>	
MTH2011 Linear Algebra	MTH2013 Metric Spaces
MTH2012 Analysis	MTH2014 Group Theory
MTH2031 Classical Mechanics	MTH2021 Mathematical Methods 2
SOR2003 Methods of Operational Research	SOR2002 Statistical Inference
<b>Level 3</b>	
MTH3011 Measure and Integration	MTH3021 Dynamical Systems
MTH3012 Rings and Modules	MTH3024 Modelling and Simulation
MTH4322 Top. Data Analysis/Geom.of Optim. <sup>b</sup>	MTH3025 Financial Mathematics
MTH3023 Numerical Analysis	MTH4311 Functional Analysis / FA & PDEs <sup>b</sup>
MTH3031 Classical Fields	MTH4332 Statistical Mechanics/Quant. Fields <sup>b</sup>
MTH3032 Quantum Theory	SOR3008 Stat. Data Mining & Machine Learn.
SOR3004 Linear Models	AMA3011 Applied Mathematics Project
SOR3012 Stochastic Processes and Risk	AMA3022 Team Project: Maths with Finance
AMA3011 Applied Mathematics Project	PMA3013/AMA3020 (Mathem.) Investigations
<b>Level 4</b>	
MTH4011 Topology	MTH4021 Applied Algebra and Cryptography
MTH4322 Top. Data Analysis/Geom.of Optim. <sup>b</sup>	MTH4311 Functional Analysis / FA & PDEs <sup>b</sup>
MTH4024 Practical Methods for PDEs	MTH4022 Information Theory
MTH4031 Advanced Quantum Theory	MTH4023 Mathematical Methods for QIP
	MTH4332 Statistical Mechanics/Quant. Fields <sup>b</sup>
SOR4007 Survival Analysis	SOR4008 Bayesian Statistics (from 2023-24)
AMA4005 / PMA4001 / SOR4001 Project (40 CATS)	

<sup>a</sup> All modules are 20 CATS unless indicated otherwise.

<sup>b</sup> Modules taught in alternate years that can be taken at Level 3 or Level 4.

<sup>c</sup> Level 2 Employability for Mathematics/Physics (0 CATS) must be taken to take a placement year.

## Degree Programmes

1. BSc Mathematics
2. BSc Mathematics and Statistics and Operational Research
3. BSc (Applied) Mathematics and Physics
4. BSc Theoretical Physics
5. BSc Mathematics and Computer Science
6. BSc Mathematics with Finance
7. BSc Mathematics with French/Spanish
8. MMath/MSci Mathematics\*
9. MMath/MSci Mathematics and Statistics and Operational Research
10. MSci Applied Mathematics and Physics
11. MPhys/MSci Theoretical Physics
12. MSci Mathematics and Computer Science

\* On the MMath/MSci Mathematics programme, students are expected to specialise in one of the four *streams*: Analysis/Differential Equations stream, Algebra stream, Quantum stream, Modelling stream. Each of these streams contains a number of compulsory modules, as well as some recommended (r) modules, *in addition to the modules that are compulsory for all MSci (MMath) students*, leading to a Level 4 project in the chosen area of specialisation.

Stream	Compulsory and recommended (r) modules		
	Level 2	Level 3	Level 4
Analysis/DEs		Dynamical Systems, Functional Analysis/Fourier Analysis & Application to PDEs	Topology, Functional Analysis/Fourier Analysis & Application to PDEs
Algebra	Group Theory	Rings and Modules	Topology, Applied Algebra and Cryptography
Quantum	Classical Mechanics	Quantum Theory, Functional Analysis/Fourier Analysis & Application to PDEs, Classical Fields (r), Quantum Fields / Statistical Mechanics (r), Numerical Analysis or Modelling & Simulation (r)	Advanced Quantum Theory, Functional Analysis/Fourier Analysis & Application to PDEs, Quantum Fields / Statistical Mechanics (r)
Modelling	Classical Mechanics (r)	Numerical Analysis, Dynamical Systems, Modelling & Simulation (r)	Functional Analysis/Fourier Analysis & Application to PDEs (r), Practical Methods for PDEs

# BSc Mathematics

Core module

Recommended module

Alternative core modules

Semester 1	Semester 2
<b>Level 1</b>	
Introduction to Algebra and Analysis (30 CATS)	
Mathematical Methods 1 (30 CATS)	
Mathematical Reasoning (10 CATS)	Algorithmic Thinking (10 CATS)
Introduction to Probability and Statistics (30 CATS)	
	Introduction to SOR Methods (10 CATS)
<b>Level 2</b>	
Analysis	Metric Spaces
Linear Algebra	Group Theory
Classical Mechanics	Mathematical Methods 2
Methods of Operational Research	Statistical Inference
<b>Level 3</b>	
Measure and Integration	Dynamical Systems
Rings and Modules	
Top. Data Analysis / Geometry of Optimisation	Financial Mathematics
Classical Fields	Functional Analysis / Fourier Analysis & PDEs
Quantum Theory	Statistical Mechanics / Quantum Fields
Linear Models	Statistical Data Mining & Machine Learning
Stochastic Processes and Risk	Mathematical Investigations
Numerical Analysis	Modelling and Simulation
Applied Mathematics Project	Applied Mathematics Project

At Stage 2, students should note the importance of taking Classical Mechanics or Group Theory, or Statistical Inference, as they are pre-requisites for a number of modules at Stage 3. At Stage 3, students must take Numerical Analysis or Modelling and Simulation, and take Applied Mathematics Project in semester 1 or semester 2, or Mathematical Investigations (but not both).

# BSc Mathematics and Statistics and Operational Research

Core module

Recommended module

Alternative core modules

Semester 1	Semester 2
<b>Level 1</b>	
Introduction to Algebra and Analysis (30 CATS)	
Mathematical Methods 1 (30 CATS)	
Mathematical Reasoning (10 CATS)	Algorithmic Thinking (10 CATS)
Introduction to Probability and Statistics (30 CATS)	
	Introduction to SOR Methods (10 CATS)
<b>Level 2</b>	
Analysis	Metric Spaces
Linear Algebra	Group Theory
Classical Mechanics	Mathematical Methods 2
Methods of Operational Research	Statistical Inference
<b>Level 3</b>	
Measure and Integration	Dynamical Systems
Rings and Modules	
Top. Data Analysis / Geometry of Optimisation	Financial Mathematics
Classical Fields	Functional Analysis / Fourier Analysis & PDEs
Quantum Theory	Statistical Mechanics / Quantum Fields
Linear Models	Statistical Data Mining & Machine Learning
Stochastic Processes and Risk	Mathematical Investigations
Numerical Analysis	Modelling and Simulation
Applied Mathematics Project	Applied Mathematics Project

Students must take at least 80 CATS of SOR modules across Levels 2 and 3. At Stage 3, students must take Applied Mathematics Project in semester 1 or semester 2, or Mathematical Investigations (but not both).

## BSc Applied Mathematics and Physics

Core module

Recommended module

Core external module

Semester 1	Semester 2
<b>Level 1</b>	
Introduction to Algebra and Analysis (30 CATS)	
Mathematical Methods 1 (30 CATS)	
PHY1001 Foundation Physics (40 CATS)	
PHY1004 Scientific Skills (20 CATS)	
<b>Level 2</b>	
Analysis	Metric Spaces
Linear Algebra	Group Theory
Classical Mechanics	Mathematical Methods 2
PHY2001 Quantum and Statistical Physics	PHY2004 Electricity, Magnetism and Optics
PHY2003 Astrophysics I	PHY2002 Physics of the Solid State
	PHY2005 Atomic and Nuclear Physics
<b>Level 3</b>	
Measure and Integration	Dynamical Systems
Rings and Modules	
Top. Data Analysis / Geometry of Optimisation	Financial Mathematics
Financial Mathematics	Functional Analysis / Fourier Analysis & PDEs
Classical Fields	Statistical Mechanics / Quantum Fields
Quantum Theory/PHY3001 Quant. Mech. & Rel.	PHY3002 Advanced Solid State Physics
PHY3004 Advanced Electromagnetism & Optics	PHY3003 Astrophysics II
PHY3006 Physics in Medicine	PHY3005 Nuclear & Particle Physics
Numerical Analysis / PHY3009 Comput. Proj.	Modelling and Simulation
Applied Maths Project / PHY3007 Project	Applied Maths Project / PHY3007 Project

At Stage 3, students take either Applied Mathematics Project or PHY3007 Project, in addition to at least 2 taught modules from Mathematics and 2 taught modules from Physics, including Quantum Theory or PHY3001, and Numerical Analysis or Modelling & Simulation, or PHY3009.

## BSc Theoretical Physics

Core module

Recommended module

Core external module

Semester 1	Semester 2
<b>Level 1</b>	
Introduction to Algebra and Analysis (30 CATS)	
Mathematical Methods 1 (30 CATS)	
PHY1001 Foundation Physics (40 CATS)	
PHY1004 Scientific Skills (20 CATS)	
<b>Level 2</b>	
Linear Algebra	PHY2002 Physics of the Solid State
Classical Mechanics	Mathematical Methods 2
PHY2001 Quantum and Statistical Physics	PHY2004 Electricity, Magnetism and Optics
<b>Level 3</b>	
Classical Fields	Statistical Mechanics / Quantum Fields
Quantum Theory	Modelling and Simulation
Numerical Analysis	Financial Mathematics
	PHY3002 Advanced Solid State Physics
	PHY3005 Nuclear & Particle Physics
Applied Mathematics Project	Applied Mathematics Project

At Stage 3, students must take 3 compulsory taught modules and the Applied Mathematics Project (in semester 1 or 2), and two optional modules from Mathematics or Physics.

## BSc Mathematics and Computer Science

Core module

Recommended module

Core external module

Semester 1	Semester 2
<b>Level 1</b>	
Introduction to Algebra and Analysis (30 CATS)	
Mathematical Methods 1 (30 CATS)	
Mathematical Reasoning (10 CATS)	Algorithmic Thinking (10 CATS)
CSC1025 Procedural Programming	CSC1029 Object Oriented Programming
<b>Level 2</b>	
Analysis	Metric Spaces
Linear Algebra	Group Theory
Classical Mechanics	Mathematical Methods 2
CSC2059 Data Structures and Algorithms	CSC2060 Theory of Computation
CSC2065 Professional and Transferrable Skills	CSC2062 Introduction to AI & Machine Learning
<b>Level 3</b>	
Measure and Integration	Dynamical Systems
Rings and Modules	
Top. Data Analysis / Geometry of Optimisation	Financial Mathematics
Classical Fields	Functional Analysis / Fourier Analysis & PDEs
Quantum Theory	Statistical Mechanics / Quantum Fields
Numerical Analysis	Modelling and Simulation
CSC3021 Concurrent Programming	CSC3001 Formal Methods
CSC3067 Video Analytics & Machine Learning	CSC3066 Deep Learning
	Mathematical Investigations
Applied Mathematics Project	Applied Mathematics Project

At Stage 2, students take at least 40 CATS from Mathematics and 40 CATS from Computer Science. At Stage 3, the choice must include either Applied Mathematics Project or Mathematical Investigations, in addition to at least 40 CATS from Mathematics and 40 CATS from Computer Science.

## BSc Mathematics with Finance

Core module

Recommended module

Core external module

Semester 1	Semester 2
<b>Level 1</b>	
Introduction to Algebra and Analysis (30 CATS)	
Mathematical Methods 1 (30 CATS)	
Introduction to Probability and Statistics (30 CATS)	
	Introduction to SOR Methods (10 CATS)
	FIN1001 Financial Institutions and Markets
<b>Level 2</b>	
Linear Algebra	Mathematical Methods 2
Methods of Operational Research	Statistical Inference
FIN2006 Financial Decision Making	FIN2008 Financial Market Theory
<b>Level 3</b>	
Linear Models	Financial Mathematics
Stochastic Processes and Risk	Statistical Data Mining & Machine Learning
Numerical Analysis	Team Project: Mathematics with Finance



## BSc Mathematics with French/Spanish

Core module

Recommended module

Core external module

Semester 1	Semester 2
<b>Level 1</b>	
Introduction to Algebra and Analysis (30 CATS)	
Mathematical Methods 1 (30 CATS)	
Mathematical Reasoning (10 CATS)	Algorithmic Thinking (10 CATS)
FRH1101 French 1 / SPA1101 Spanish 1 (40 CATS)	
<b>Level 2</b>	
Analysis	Metric Spaces
Linear Algebra	Group Theory
Classical Mechanics	Mathematical Methods 2
FRH2101 French 2 / SPA2101 Spanish 2 (40 CATS)	
<b>MTH3999 International Placement – Year Abroad</b>	
<b>Level 3</b>	
Measure and Integration	Dynamical Systems
Rings and Modules	Financial Mathematics
Top. Data Analysis / Geometry of Optimisation	Functional Analysis / Fourier Analysis & PDEs
Classical Fields	Statistical Mechanics / Quantum Fields
Quantum Theory	Mathematical Investigations
Numerical Analysis	Modelling and Simulation
Applied Mathematics Project	Applied Mathematics Project
FRH3101 French 3 / SPA3101 Spanish 3 (40 CATS)	

At Stage 3, students must take Numerical Analysis or Modelling and Simulation, and take Applied Mathematics Project in semester 1 or semester 2, or Mathematical Investigations (but not both).

# MMath/MSci Mathematics

Core module

Recommended module

Alternative core modules

Semester 1	Semester 2
<b>Level 1</b>	
Introduction to Algebra and Analysis (30 CATS)	
Mathematical Methods 1 (30 CATS)	
Mathematical Reasoning (10 CATS)	Algorithmic Thinking (10 CATS)
Introduction to Probability and Statistics (30 CATS)	
	Introduction to SOR Methods (10 CATS)
<b>Level 2</b>	
Analysis	Metric Spaces
Linear Algebra	Group Theory <sup>B</sup>
Classical Mechanics <sup>Q</sup>	Mathematical Methods 2
Methods of Operational Research	Statistical Inference
<b>Level 3</b>	
Measure and Integration	Dynamical Systems <sup>A,M</sup>
Rings and Modules <sup>B</sup>	
Top. Data Analysis / Geometry of Optimisation	Financial Mathematics
Classical Fields	Functional Analysis <sup>A,Q</sup> /Fourier Analysis & PDEs
Quantum Theory <sup>Q</sup>	Statistical Mechanics / Quantum Fields
Numerical Analysis <sup>M</sup>	Modelling and Simulation
Linear Models	Statistical Data Mining & Machine Learning
Stochastic Processes and Risk	Investigations <sup>Q,M</sup> /Mathematical Investigations <sup>A,B</sup>
<b>Level 4</b>	
Topology <sup>A,B</sup>	Applied Algebra and Cryptography <sup>B</sup>
Top. Data Analysis / Geometry of Optimisation	Functional Analysis <sup>A</sup> /Fourier Analysis & PDEs
Advanced Quantum Theory <sup>Q</sup>	Mathematical Methods for QIP
Practical Methods for PDEs <sup>M</sup>	Information Theory
	Statistical Mechanics / Quantum Fields
Survival Analysis	Bayesian Statistics
AMA4005 Project <sup>Q,M</sup> / PMA4001 Project <sup>A,B</sup> (40 CAT)	

<sup>A</sup> Modules that must be taken by students on the Analysis stream

<sup>B</sup> Modules that must be taken by students in the Algebra stream

<sup>Q</sup> Modules that must be taken by students in the Quantum stream

<sup>M</sup> Modules that must be taken by students in the Modelling stream

At Stage 2, students should note the importance of taking Classical Mechanics or Group Theory, or Statistical Inference, as they are pre-requisites for a number of modules at Stage 3.

# MMath/MSci Mathematics and Statistics and Operational Research

Core module

Recommended module

Alternative core modules

Semester 1	Semester 2
<b>Level 1</b>	
Introduction to Algebra and Analysis (30 CATS)	
Mathematical Methods 1 (30 CATS)	
Mathematical Reasoning (10 CATS)	Algorithmic Thinking (10 CATS)
Introduction to Probability and Statistics (30 CATS)	
	Introduction to SOR Methods (10 CATS)
<b>Level 2</b>	
Analysis	Metric Spaces
Linear Algebra	Group Theory
Classical Mechanics	Mathematical Methods 2
Methods of Operational Research	Statistical Inference
<b>Level 3</b>	
Measure and Integration	Dynamical Systems
Rings and Modules	
Top. Data Analysis / Geometry of Optimisation	Financial Mathematics
Classical Fields	Functional Analysis / Fourier Analysis & PDEs
Quantum Theory	Statistical Mechanics / Quantum Fields
Numerical Analysis	Modelling and Simulation
Linear Models	Statistical Data Mining & Machine Learning
Stochastic Processes and Risk	Investigations / Mathematical Investigations
<b>Level 4</b>	
Topology	Applied Algebra and Cryptography
Top. Data Analysis / Geometry of Optimisation	Functional Analysis / Fourier Analysis & PDEs
Advanced Quantum Theory	Mathematical Methods for QIP
Practical Methods for PDEs	Information Theory
	Statistical Mechanics / Quantum Fields
Survival Analysis	Bayesian Statistics
SOR4001 Project (40 CAT)	

Students must take at least 80 CATS of SOR modules across Levels 2 and 3.

## MSci Applied Mathematics and Physics

Core module	Recommended module	Core external module
Semester 1		Semester 2
Level 1		
Introduction to Algebra and Analysis (30 CATS)		
Mathematical Methods 1 (30 CATS)		
PHY1001 Foundation Physics (40 CATS)		
PHY1004 Scientific Skills (20 CATS)		
Level 2		
Analysis	Metric Spaces	
Linear Algebra	Group Theory	
Classical Mechanics	Mathematical Methods 2	
PHY2001 Quantum and Statistical Physics	PHY2004 Electricity, Magnetism and Optics	
PHY2003 Astrophysics I	PHY2002 Physics of the Solid State	
	PHY2005 Atomic and Nuclear Physics	
Level 3		
Measure and Intergation	Dynamical Systems	
Rings and Modules	Financial Mathematics	
Top. Data Analysis / Geometry of Optimisation	Functional Analysis / Fourier Analysis & PDEs	
Classical Fields	Statistical Mechanics / Quantum Fields	
Quantum Theory/PHY3001 Quant. Mech. & Rel.	PHY3002 Advanced Solid State Physics	
PHY3004 Advanced Electromagnetism & Optics	PHY3003 Astrophysics II	
PHY3006 Physics in Medicine	PHY3005 Nuclear & Particle Physics	
Numerical Analysis / PHY3009 Comput. Proj.	Modelling and Simulation	
PHY3008 Professional Skills	Investigations / PHY3008 Professional Skills	
Level 4		
Topology	Applied Algebra and Cryptography	
Top. Data Analysis / Geometry of Optimisation	Functional Analysis / Fourier Analysis & PDEs	
Advanced Quantum Theory	Mathematical Methods for QIP	
Practical Methods for PDEs	Information Theory	
	Statistical Mechanics / Quantum Fields	
PHY4001 Physics Research Project (60 CATS)	Physics modules (2×10 or 4×10 CATS)	
AMA4005 Project (40 CAT)		

At Stage 3, students take Investigations or PHY3008 and at least 2 taught modules from Mathematics and 2 from Physics, including, Quantum Theory or PHY3001, and NA or M&S, or PHY3009. At Stage 4, students take AMA4005 and 40 CATS from Physics, or PHY4001 and 40 CATS from Maths, with additional modules from Maths (1st case) or Physics (2nd case).

## MPhys/MSci Theoretical Physics

Core module

Recommended module

Core external module

Semester 1	Semester 2
<b>Level 1</b>	
Introduction to Algebra and Analysis (30 CATS)	
Mathematical Methods 1 (30 CATS)	
PHY1001 Foundation Physics (40 CATS)	
PHY1004 Scientific Skills (20 CATS)	
<b>Level 2</b>	
Linear Algebra	PHY2002 Physics of the Solid State
Classical Mechanics	Mathematical Methods 2
PHY2001 Quantum and Statistical Physics	PHY2004 Electricity, Magnetism and Optics
<b>Level 3</b>	
Classical Fields	Statistical Mechanics / Quantum Fields
Quantum Theory	Modelling and Simulation
Numerical Analysis	Financial Mathematics
	PHY3002 Advanced Solid State Physics
	PHY3005 Nuclear & Particle Physics
	Investigations
<b>Level 4</b>	
Advanced Quantum Theory	Statistical Mechanics / Quantum Fields
Practical Methods for PDEs	Information Theory
	Mathematical Methods for QIP
	Physics modules (2×10 CATS)
AMA4005 Project (40 CAT)	

At Stage 4 students can take two appropriate 10 CATS Physics modules: PHY4003 Ionising Radiation in Medicine, PHY4004 Medical Radiation Simulation, PHY4007 Laser Physics, PHY4008 Plasma Physics, PHY4009 Physics of Materials Characterisation, PHY4010 Physics of Nanomaterials, PHY4011 Ultrafast Science, PHY4016 Cosmology.

## MSci Mathematics and Computer Science

Core module

Recommended module

Core external module

Semester 1	Semester 2
<b>Level 1</b>	
Introduction to Algebra and Analysis (30 CATS)	
Mathematical Methods 1 (30 CATS)	
Mathematical Reasoning (10 CATS)	Algorithmic Thinking (10 CATS)
CSC1025 Procedural Programming	CSC1029 Object Oriented Programming
<b>Level 2</b>	
Analysis <sup>A</sup>	Metric Spaces <sup>A</sup>
Linear Algebra	Group Theory <sup>B</sup>
Classical Mechanics <sup>Q</sup>	Mathematical Methods 2 <sup>Q,M</sup>
CSC2059 Data Structures and Algorithms	CSC2060 Theory of Computation
CSC2065 Professional and Transferrable Skills	CSC2062 Introduction to AI & Machine Learning
<b>Level 3</b>	
Measure and Integration <sup>A</sup>	Dynamical Systems
Rings and Modules <sup>B</sup>	Financial Mathematics
Top. Data Analysis / Geometry of Optimisation	Functional Analysis / Fourier Analysis & PDEs
Classical Fields	Statistical Mechanics / Quantum Fields
Quantum Theory <sup>Q</sup>	Modelling and Simulation
Numerical Analysis <sup>M</sup>	
CSC3021 Concurrent Programming	CSC3001 Formal Methods
CSC3067 Video Analytics & Machine Learning	CSC3066 Deep Learning
	Investigations <sup>Q,M</sup> /Mathematical Investigations <sup>A,B</sup>
<b>Level 4</b>	
Topology <sup>A,B</sup>	Applied Algebra and Cryptography <sup>B</sup>
Top. Data Analysis / Geometry of Optimisation	Functional Analysis / Fourier Analysis & PDEs
Advanced Quantum Theory <sup>Q</sup>	Mathematical Methods for QIP
Practical Methods for PDEs <sup>M</sup>	Information Theory
	Statistical Mechanics / Quantum Fields
CSC4008 Digital Transformation: ...	CSC4003 Algorithms: Analysis and Application
AMA4005 Project <sup>Q,M</sup> / PMA4001 Project <sup>A,B</sup> (40 CAT)	

At Stages 2 and 3 students take at least 40 CATS from Mathematics and 40 CATS from Computer Science. Superscripts A, B, Q and M indicate modules recommended for students intending to pursue the Analysis, Algebra, Quantum or Modelling streams at Stages 2-4.