

# Welcome to the Department of Mathematics

Dr. Jan Gutowski

Director of Learning and Teaching

Prof. Ian Roulstone

Head of Department



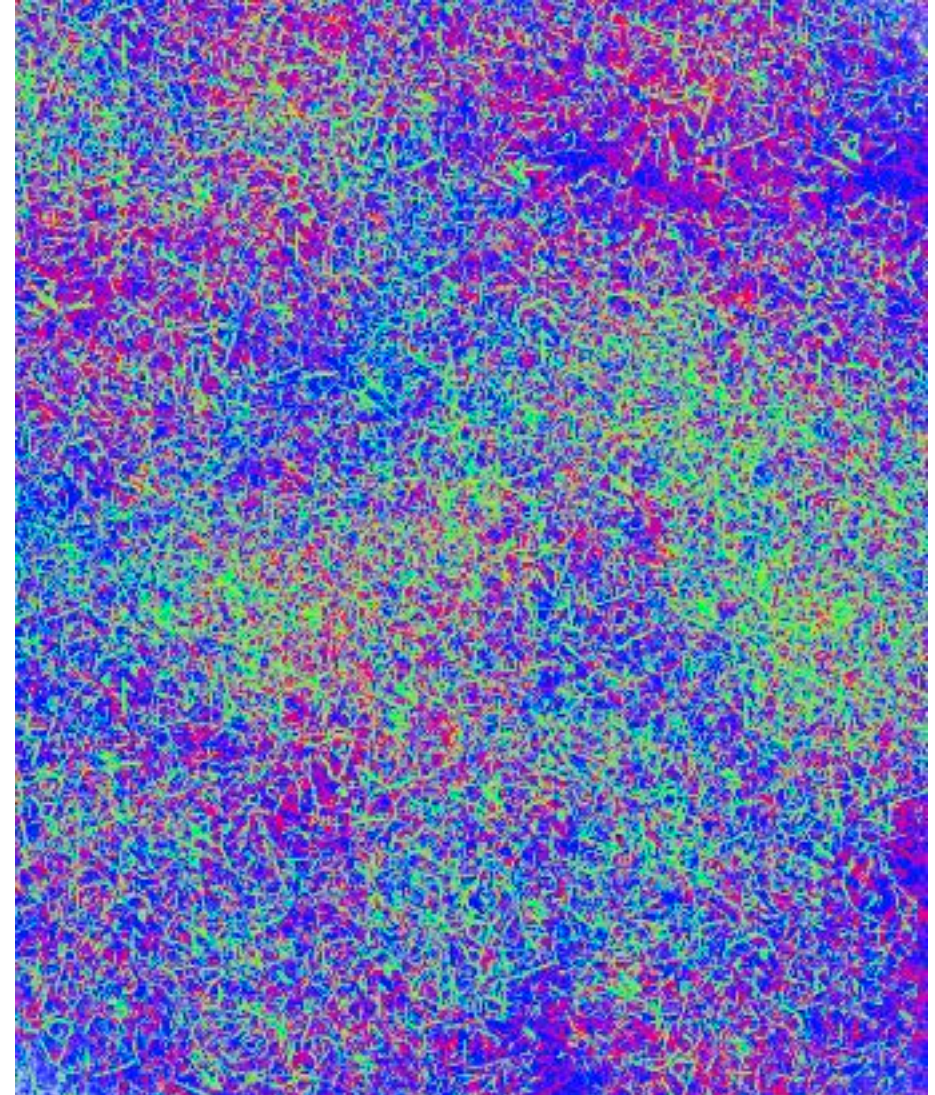
# A Mathematical Interlude

## Theorem

Consider the plane  $\mathbb{R}^2$ . Suppose that every point in  $\mathbb{R}^2$  is assigned one of three colours (e.g. **Red**, **Green** or **Blue**).

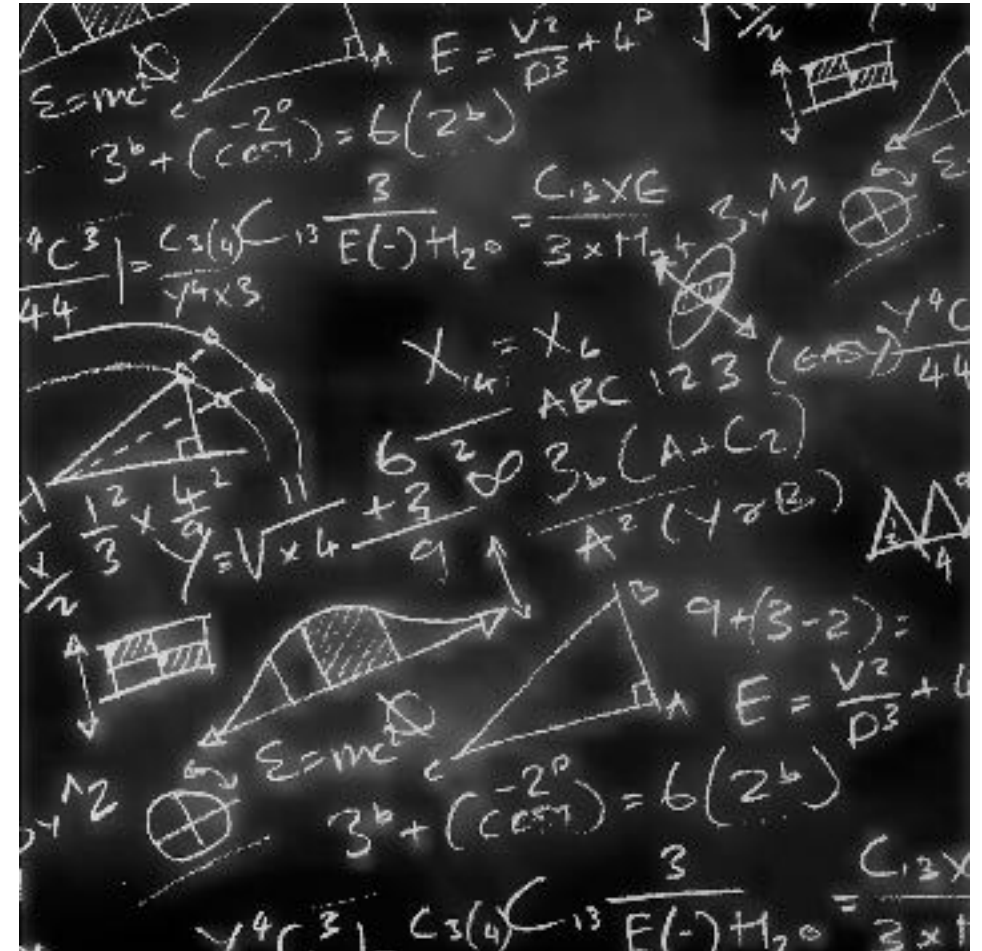
Then there exist at least two points on the plane, at distance 1 apart, which have the same colour.

*[Note: the colour assignment is completely arbitrary]*



Details from this  
presentation are available  
online:

[https://www.surrey.ac.uk/departments-  
mathematics/study/undergraduate](https://www.surrey.ac.uk/departments/mathematics/study/undergraduate)



# Think Ahead: Your Goals and Ambitions

- A good degree (especially in mathematics!) opens doors.
- Is a good degree sufficient to secure the career of your choice?
- At Surrey we offer not only the support required to help students achieve a good degree, we also offer many opportunities to enhance your CV.
- The combination of an excellent choice of modules, together with professional training, internships, project work, and language courses – all of which are optional – help to place our graduates at the front of the job market.

# Opportunities at Surrey

Motivation + Support = Success



# How do we study mathematics

## » Lectures

- *Large groups (120+)*
- *Note-taking*
- *50 minutes long*
- *About 12 hours per week*

## » Tutorials/seminars

- *Smaller groups (about 15)*
- *More discussion based*
- *2-3 hours per week*

## » Private study

- *At least 20 hours per week*
- *Biggest difference moving to university.*



# Mathematics Degree Programmes

## **MMath Degree Programmes (4 or 5\* Years)**

- MMath Mathematics (4 or 5\* years; G104/103/G100\*)
- MMath Mathematics with Statistics (4 or 5\* years; G104/103/G100\*)

## **BSc Degree Programmes (3 or 4\* Years)**

- BSc Mathematics (G101/G102\*)
- BSc Mathematics with Statistics (G1G3/G1GH\*)
- BSc Financial Mathematics (N300/N301\*)
- BSc Mathematics with Music (G1W3/G1WH\*)

\* Includes Professional Training Year

# Combined Degree Programmes

» BSc, MMath & MPhys in: Mathematics and Physics

- *50% Mathematics, 50% Physics*
- *All three also available with professional training*

» BSc in: Economics and Mathematics

- *50% Mathematics, 50% Economics*
- *also available with professional training*



# Entry requirements



## Mathematics BSc (Hons) or MMath – 2019 entry

[OVERVIEW](#)[PROGRAMME DETAILS](#)[ENTRY REQUIREMENTS](#)[FEES AND FUNDING](#)[APPLY](#)

What qualifications do you need?

A-level

A-level

Overall:

BSc (Hons) ABB. Applicants taking the Science Practical Endorsement are required to pass.

MMath (Hons) ABB. Applicants taking the Science Practical Endorsement are required to pass.

» Example grade offers:

*Mathematics BSc : AAB-ABB (Mathematics Grade A)*

*MMath Mathematics : AAA-AAB (Mathematics Grade A)*

- » **Headline:** We are looking for the best mathematicians who will profit from our degree.
- » **Please consult the University website** for full entry requirements for all Maths programmes

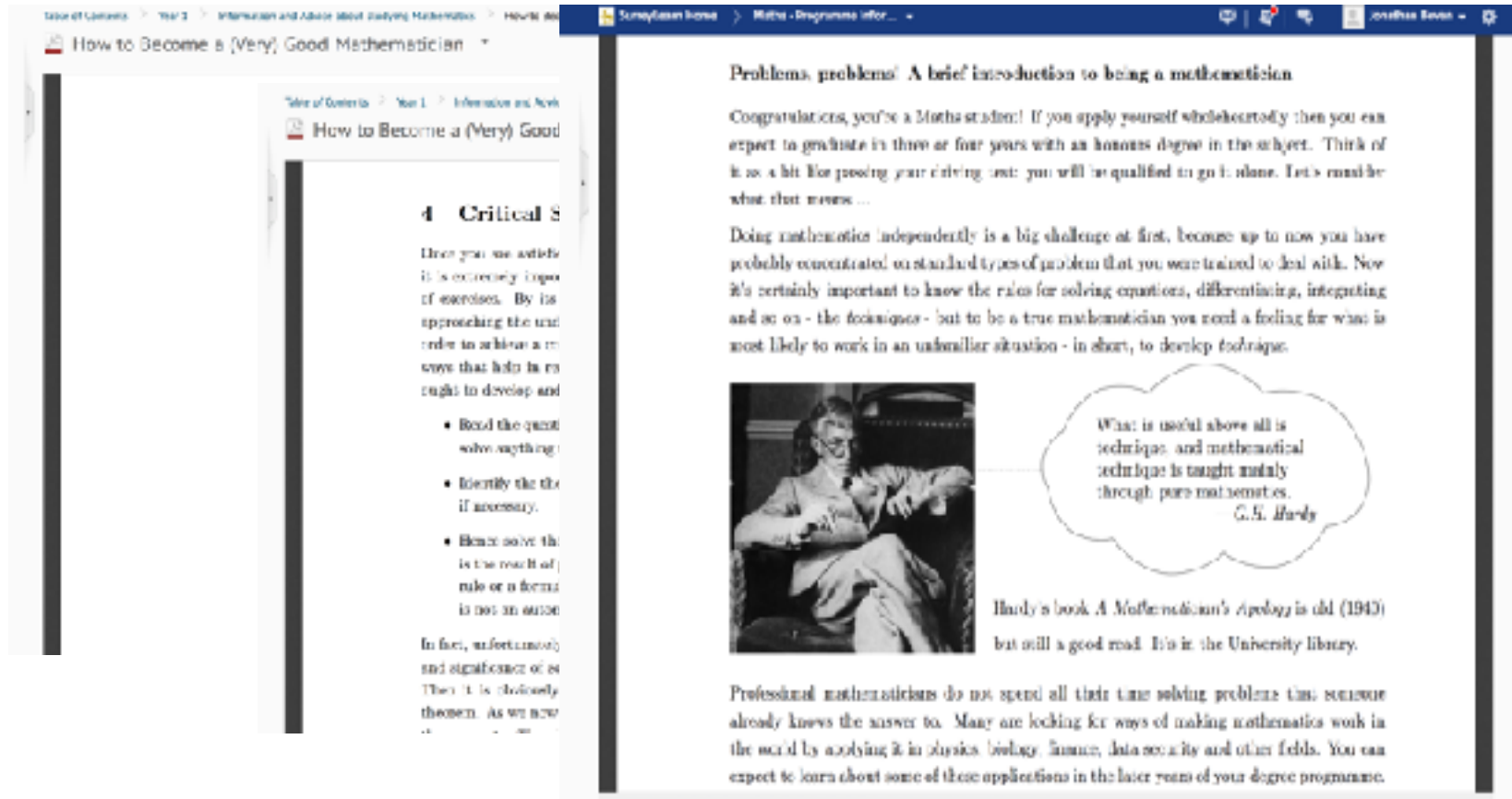
<https://www.surrey.ac.uk/subjects/mathematics>

# The Foundation Year

- » For students without an A in Mathematics A-level
- Entry grades CCD (with a minimum of C in A-level Mathematics).
- Students take 8 modules — 4 in Mathematics, 1 Computing, 2 Economics, and 1 Physics module.
- Integrated academic skills help equip students to study effectively and successfully in university.
- During the Foundation Year, students are fully integrated with the university community and environment.
- Accommodation is guaranteed for all students in the Foundation Year.

# Stepping up to University Mathematics

- » Supporting the transition from School/College to University is important, so the department has created some resources to help. These include:



The image displays two screenshots of web resources. The left screenshot shows a page titled 'How to Become a (Very) Good Mathematician' with a section on 'Critical Skills'. The right screenshot shows a page titled 'Problems, problems! A brief introduction to being a mathematician' with a quote from G.H. Hardy.

**Left Screenshot: How to Become a (Very) Good Mathematician**

Table of Contents > Year 1 > Information and Advice About Studying Mathematics > How to become a mathematician

## How to Become a (Very) Good Mathematician

### 4 Critical Skills

Once you are active in it, it is extremely important to approach the study of exercises. By its nature, mathematics is a subject where you need to develop and use techniques that help to solve problems.

- Read the question carefully and understand what is being asked.
- Identify the techniques that you need to use.
- Plan your solution: is the result of a rule or a formula, or is it a new idea?

In fact, unfortunately, the most important skill is the ability to think creatively and to come up with new ideas. This is obviously a skill that is not taught in a formal way.


**Right Screenshot: Problems, problems! A brief introduction to being a mathematician**

Surreyclassroom Home > Maths - Programme offer... > Problems, problems! A brief introduction to being a mathematician

## Problems, problems! A brief introduction to being a mathematician

Congratulations, you're a Maths student! If you apply yourself wholeheartedly then you can expect to graduate in three or four years with an honours degree in the subject. Think of it as a bit like passing your driving test: you will be qualified to go it alone. Let's consider what that means...

Doing mathematics independently is a big challenge at first, because up to now you have probably concentrated on standard types of problem that you were trained to deal with. Now it's certainly important to know the rules for solving equations, differentiating, integrating and so on - the techniques - but to be a true mathematician you need a feeling for what is most likely to work in an unfamiliar situation - in short, to develop *techniques*.



What is useful above all is technique, and mathematical technique is taught mainly through pure mathematics.

*G.H. Hardy*

Hardy's book *A Mathematician's Apology* is old (1940) but still a good read. It's in the University library.

Professional mathematicians do not spend all their time solving problems that someone already knows the answer to. Many are looking for ways of making mathematics work in the world by applying it in physics, biology, finance, data security and other fields. You can expect to learn about some of these applications in the later years of your degree programme.

# Year 1

» Provides a **broad base** covering:

- **Algebra** (Prime numbers, Complex numbers, Introduction to Groups).
- **Linear Algebra** (Solution of Linear Equations, Vectors and Vector Spaces, Matrices).
- **Calculus** (Functions, Curve sketching, techniques of differentiation and integration, First Order Ordinary Differential Equations).
- **Real Analysis** (Axioms of real numbers, Sets and sequences, Quantifiers, Convergence, Boundedness).
- **Mechanics** (Newton's Laws, Energy, Conservation laws).
- **Probability & Statistics** (Bayes' Theorem, Standard discrete distributions, Expectation and moments, Probability generating functions, Central limit theorem, Hypothesis testing).
- **Developing transferable skills** (Computing/Programming, Research skills, Communication skills)
- **Degree course specific modules**
  - *Introductory Economics*
  - *Oscillations and Waves*
  - *Instruments and Orchestration*

# Year 1: Overview

## » **Unassessed coursework**

- Designed to help you gain a deeper understanding of the lecture notes.
- Feedback given.
- Helps you prepare for.....

## » **Assessments**

- Class tests (typically 25% of overall mark).
- Exams at the end of each semester (typically 75% of overall mark).

.....and this pattern of assessment continues in subsequent years.

# Examples of coursework and seminar exercises include...

3. Find the following integrals:

SEMINAR SHEET 2: REAL ANALYSIS I (MAT1032), 2017.

(a)  $\int x^2 \ln x \, dx, \quad x > 0;$

(b)  $\int \frac{x^3 + 1}{x^2 + 1} \, dx;$

(c)  $\int_0^{\frac{\pi}{2}} \frac{1}{\sin x + 1} \, dx;$

(d)  $\int_{\frac{\pi}{3}}^{\frac{\pi}{2}} \sin x \cos x \ln(\sin x) \, dx.$

## Question 1:

- a) Prove by contradiction that any non-empty subset  $A \subset \mathbb{N}$  has a minimal element
- b) Prove that for any  $A \subset \mathbb{N}$  and any  $n \in \mathbb{N}$ , the set  $A \cap [1, n]$  is finite.
- c)\* Using a) and b) verify that any infinite subset of a countable set is countable.









## Seminar Problems 2

1. (a) Use the Euclidean algorithm to find the greatest common divisor of 27 and 22. Hence find integers  $m$  and  $n$  such that  $\gcd(27, 22) = 27m + 22n$ . Use this result to find an integer  $x \in \{0, 1, \dots, 26\}$  such that  $22x \equiv 1 \pmod{27}$ .
- (b) The diagram shows a 13-hour clock. If the hour hand is initially pointing to 13 as shown, where will it be pointing  $10^{14}$  hours later? (Assume the clock never stops.)





# SurreyLearn – the University's VLE: a screenshot

 ADVANCED ALGEBRA (MAT3032) Jonathan Bevan

Home Course Materials Panopto Communication ▾ Assessment ▾ Help Course Setup ▾

Announcements ▾

See below for Unassessed Coursework 2, which can be regarded as preparation for the test. Please ensure that you have read the test information at the bottom of this page.

At the end of Week 8 we have just started Section 2.6, as far as the statement of Proposition 2.27. The Chapter 3 notes have been added to the document linked below.

Lecture Times ▾

Monday 10:00 - 10:50 24AA04

Thursday 11:00 - 11:50 24AA04

Friday 11:00 - 11:50 24AA04

Office hours: I shall be available to help individuals and small groups in 41AA04 on Mondays at 13:00.

Calendar ▾

Assessment

The assessment components for this module are:

Test (Week 9) 20%, January exam 80%.

The test will cover sections 1.1 to 2.4 inclusive.

Assignments

[Unassessed Coursework 1 and answers](#)

[Unassessed Coursework 2](#), due by 3rd December, now with hints on Page 2. Work handed in

# Year 2: Overview

» Wide range of **compulsory** and optional modules building on foundation of Year 1 material

- **Ordinary Differential Equations**
- **Groups and Rings**
- Curves and Surfaces
- **Real Analysis** (M/MM, not FM)
- Numerical & Computational Methods (Not FM)
- General Linear Models
- Mathematical Statistics
- Stochastic Processes
- Inviscid Fluid Dynamics
- **Linear Partial Differential Equations**

together with course specific modules:

(Microeconomics, Musical Performance and so on.)

# Years 3 and M

» Wide range of modules specific to degree course, e.g.:

- Advanced Algebra
- Data Science
- Game Theory
- Quantum Mechanics
- Graphs and Networks
- Ecology & Epidemiology
- Special Relativity & Electrodynamics
- Statistical Methods with Financial Applications
- **Mathematics Education**
- Experimental Design
- Lagrangian Fluid Dynamics
- Theory of Derivatives Pricing

## Final year projects and Literature Reviews

- Optimising financial portfolios
- Simulation in the social sciences
- Analysis of bio-medical statistics
- Pharmaceutical drug modelling



# Department of Mathematics

- ~ 30 Academic and Research Staff
- ~ 20 Postgraduate Students
- ~ 350 Undergraduate Students



- Undergraduate Teaching
- PhD Training
- Research:
  - *Mathematics of Life and Social Sciences*
  - *Dynamical systems and PDEs*
  - *Fields, Strings and Geometry*
  - *Fluid Mechanics and Meteorology*



# Research

## Surrey Mathematics Research Blog

The latest research in mathematics from the University of Surrey

Home | About Us | Contact Us

Posted on January 14, 2018  
Posted by Tim Briggs

### Paper of James Grant on causality published in Letters in Mathematical Physics

The paper 'The nature of causality in quantum theory' by James Grant, published in Letters in Mathematical Physics, has been published online. The paper discusses the nature of causality in quantum theory, and the role of the observer in the process. It is a contribution to the ongoing debate about the foundations of quantum mechanics.

[Read more](#)

Posted on January 14, 2018  
Posted by Tim Briggs

### James Grant passes PhD confirmation examination

Congratulations to James Grant for passing his PhD confirmation examination. The exam was held on January 12, 2018, and James was one of the few students to pass. He is now a PhD student in the Department of Mathematics.

[Read more](#)

Posted on January 14, 2018  
Posted by Tim Briggs

### Martin Wolf visits and gives a talk at UMS in Edinburgh

Martin Wolf, a leading expert in the field of quantum entanglement, visited the University of Manchester in Edinburgh for a talk. He gave a talk on 'Quantum entanglement and the foundations of quantum mechanics'.

[Read more](#)

Posted on January 14, 2018  
Posted by Tim Briggs

### Paper of Sergey Zelik on Lieb-Thirring inequalities published in Mathematical Research

The paper 'On the Lieb-Thirring constants for the Schrödinger operator with a potential' by Sergey Zelik, published in Mathematical Research, has been published online. The paper discusses the nature of the Lieb-Thirring constants, and the role of the potential in the process.

[Read more](#)

Posted on January 14, 2018  
Posted by Tim Briggs

### Paper of Cleaver and Reulstone on data assimilation and paleoclimate published in JAMES

The paper 'The impact of data assimilation on the reconstruction of the 2000-2010 period' by Cleaver and Reulstone, published in JAMES, has been published online. The paper discusses the impact of data assimilation on the reconstruction of the 2000-2010 period.

[Read more](#)

Posted on January 14, 2018  
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### Paper of Nishi and Torricelli to appear in Journal of Physics A

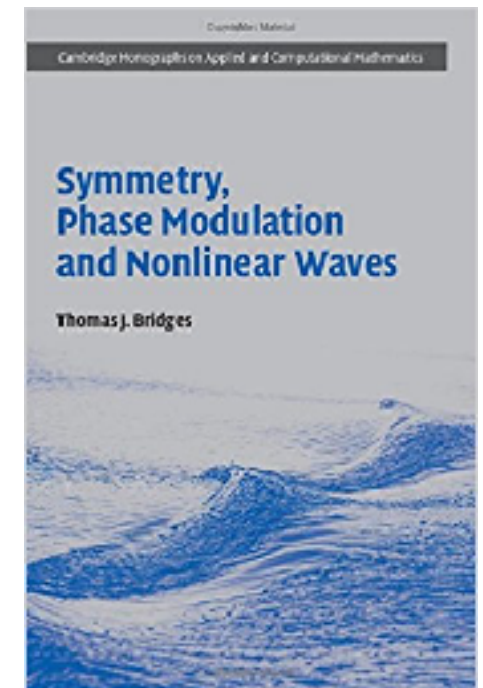
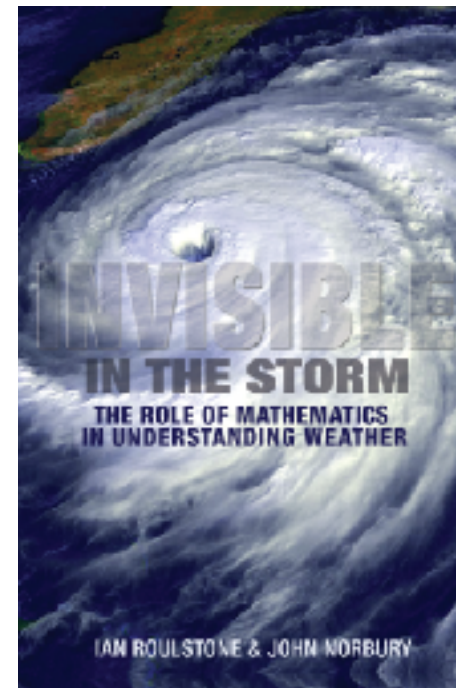
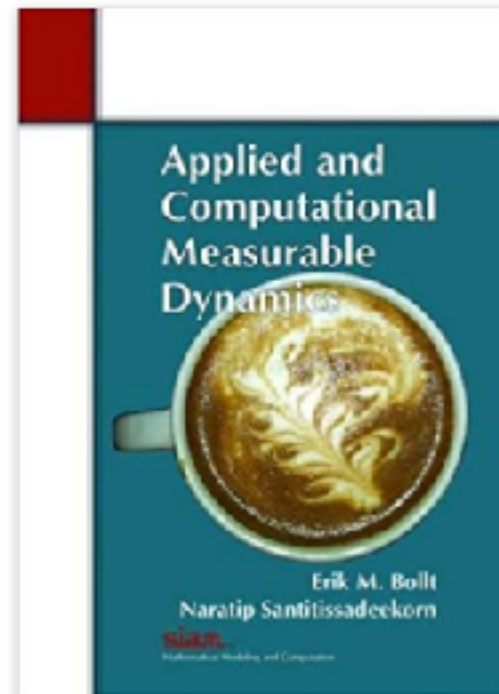
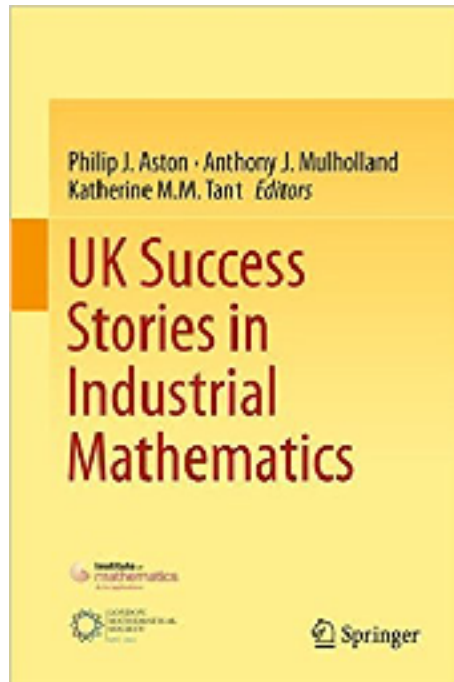
The paper 'The impact of data assimilation on the reconstruction of the 2000-2010 period' by Nishi and Torricelli, published in Journal of Physics A, has been published online. The paper discusses the impact of data assimilation on the reconstruction of the 2000-2010 period.

[Read more](#)

- We are an active research community and our research informs our teaching!
- See our blog [blogs.surrey.ac.uk/mathsresearch/](https://blogs.surrey.ac.uk/mathsresearch/)



# Books & Scientific Journals





# Department of Mathematics

*British Applied Maths Colloquium hosted here in 2017*



# Award winning facilities



# Accommodation at Surrey

- » More details can be found at <https://www.surrey.ac.uk/accommodation>
- » Descriptions of the different types of rooms can be found at <https://www.surrey.ac.uk/accommodation/our-accommodation>

# Optional Opportunities

- » Global Graduate Award in Languages
- » Global Graduate Award in Sustainability
- » Study Abroad
- » Summer Research Experience
- » Professional Training

**All excellent additions to your CV!**

# Global Graduate Award in Languages

- » To promote student mobility.
- » Arabic, Chinese, French, German, Italian, Japanese, Portuguese, Russian, Spanish.
- » Modules are assessed and results appear on transcript, but don't provide credit towards degree.



# Study Abroad - internationality



- » An option for Year 2 of study:
- » *One semester or a year at an 'approved' overseas university.*
- » *Modules taken provide credit towards final degree.*
- » *Currently agreements in place for universities in Canada, USA, Singapore and Australia.*



# Professional Training

- Optional, but many students take advantage of the opportunity.
- One year between years 2 and 3.
- Placements arranged from the end of the 1<sup>st</sup> year and throughout the 2<sup>nd</sup> year.
- Professional Training Coordinators assist in finding placements.
- Placements may be overseas.



# Professional Training

- A salary is paid by the employer.
- Regular visits are made during the year by academic staff (the University charges about 15% of the normal tuition fee during the placement).
- Written report and presentation at the end of the placement.
- Students frequently offered employment after degree.

# Some Recent Placements

- » **Pharmaceutical:** GSK, Pfizer, Quintiles, Roche
- » **Finance:** Bank of England, Lloyds TSB, HSBC, Goldman Sachs
- » **Actuarial:** Royal Sun Alliance, AXA, Mercer
- » **Computing:** Microsoft, IBM, Intel
- » **Education:** AQA, HEFCE
- » **Government:** Civil Service, HM Customs, DTI, ONS, NATS
- » **Car Industry:** Rolls-Royce, Bentley, Peugeot, Citroen
- » **Marketing:** Marks and Spencer, Reuters, Nestle

# MMath: Placement Options

- 4 Year Variant:

Placement is 8 months at end of year 3, start of year 4.

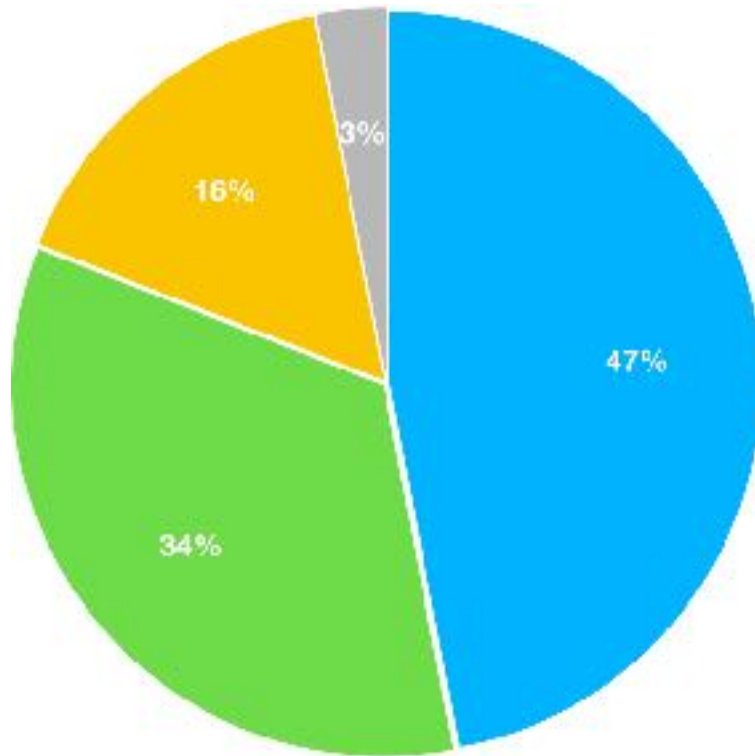
Placement consists of half of the assessment for the final year.

- 5 Year Variant has professional training year between years 2 and 3.
- Recent placements in actuarial, finance and pharmaceutical companies.

# Professional Training Year Results

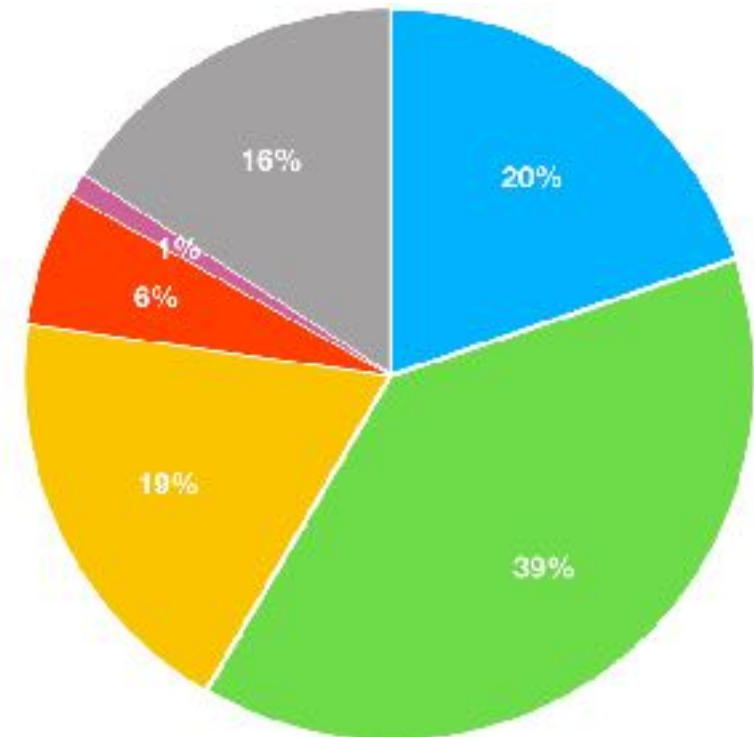
» Placement year vs. non-placement-year degree classes 2017

Placement student degree class percentages



● 1 ● 2:1 ● 2:2 ● Fail

Non-placement student degree class percentages



● 1 ● 2:1 ● 2:2 ● 3 ● Ordinary ● Fail

# Some Recent Graduate Destinations

- New Business Analyst (Barclays Bank, Canary Wharf)
- Pensions Administrator (Aon, Woking)
- Associate Software Engineer (Accenture, London)
- Statistical Programmer (Quintiles, Bracknell)
- Trainee Accountant (Crane, Ipswich)
- Analyst (HSBC, London)
- Graduate Implementation Consultant (Fidessa, London)
- PhD Mathematics
- MSc Mathematics, Medical Statistics, Astrophysics, Financial Maths
- Graduate Teacher Trainee
- PGCE Mathematics



# Summary

- Courses designed for flexibility with wide range of options.
- MMath prepares for study at higher level.
- Professional Training enhances CV and future job prospects.
- Overall: excellent preparation for successful entry to job market or post-graduate training.

# Mathematics at Surrey

For more information on our courses and modules, and application details, visit our website at:

<https://www.surrey.ac.uk/subjects/mathematics/>

This presentation can be downloaded from the link provided by the Surrey admissions team.

# The Solution to the 3-Colouring Problem

## PROOF

- » *Suppose [for a contradiction] that every pair of points distance 1 apart have different colours.*
- » Choose an arbitrary point on the plane P. P must be red, green, or blue. Suppose that P is red.
- » Construct the circle  $C_1$  of radius 1, centre P. All points on this circle must be either green or blue.
- » Choose an arbitrary point Q on the circle  $C_1$  — Q must be either green or blue. Suppose Q is blue.
- » Construct the circle  $C_2$  of radius 1, centre Q. As Q is blue, all points on this circle must be red or green.

# The Solution to the 3-Colouring Problem

- » Let  $R$  be a point at which the circles  $C_1$  and  $C_2$  intersect. There are two such points — for the purposes of this proof, either will do.
- » As  $R$  is at a distance 1 from  $P$ ,  $R$  cannot be red. As  $R$  is at a distance 1 from  $Q$ ,  $R$  cannot be blue.
- » So  $R$  must be green.
- » Construct the circle  $C_3$  of centre  $R$ , radius 1. Consider the intersection of the circles  $C_2$  and  $C_3$
- » There are two points at which  $C_2$  and  $C_3$  intersect. One of these is  $P$ . Let the other point be  $S$ .
- »  $S$  is distance 1 from  $Q$ , so  $S$  cannot be blue.  $S$  is distance 1 from  $R$  so  $S$  cannot be green. So  $S$  is red.

# The Solution to the 3-Colouring Problem

- » Let  $C$  be the circle of radius  $\sqrt{3}$  with centre P. This circle passes through the point S.
- » As the position of Q on the circle  $C_1$  is arbitrary, the whole of  $C$  must be red.
- » This means that there are two points on  $C$ , of distance 1 apart, which are both red, which contradicts the initial assumption.
- » Hence, the initial assumption must be false.
- » Hence, there must exist at least two points, distance 1 apart, with the same colour. ■

# The Solution to the 3-Colouring Problem

» Illustration of Proof

Points T and U are both red.

