HERIOT WATT UNIVERSITY

The Maths Newsletter

Looking for Editors

See Page 5

Department News and Events

Volunteers Needed

Mark Lawson

Year 1, The Space Race and Frying Pans

A Guide to Choosing your Courses

By Nick Gilbert and Others

With Support from the Jack Carr Fund

Opening Lines

Robert Weston (HOD)

Welcome to the new academic year and welcome to Issue 1 of the Heriot Watt University Maths Newsletter. This newsletter is a fantastic initiative and I hope its content will show the breadth and enthusiasm of the Heriot Watt mathematical community. We come from widely different backgrounds and are at different stages of our mathematical journeys, but we are united by our interest in exploring the world using the precise and beautiful language of mathematics. As we venture back out into the lecture hall and seminar room after so much home time, I look forward to meeting as many of you as possible at the many activities listed here.

Department News and Events

Induction Week

This academic year begins again with the Induction Week, taking place 6th -10th September. All the information for both new and returning students can be found on the Canvas Induction site including the timetable of events and how-to-guides, e.g., introduction to Canvas, our new virtual, learning environment, how to access support, use the library, sports facilities, Maths-Gym etc. Please attend all the live events, whether online or in person, and continue using the information on the Induction site also once the semester has started.

Maths Café Talks

The Maths Café and the Maths Gym are very happy to introduce short talks on different mathematical topics aimed at an undergraduate audience. Recordings of previous talks can be found here https://mathsgym.hw.ac.uk/past-maths-cafe-talks/

Keep an eye out for more information for the first talk of the Semester in Week 2.

Kit Yates: The Maths of Life and Death: Understanding the maths behind epidemics - Public Lecture

This talk will take place on the 8th October via Zoom. For more information see www.icms.org.uk/events/event/?id=1169

Maths Society

Jaan Kalder

The Initiative for Mathematics Society is starting this year at Heriot-Watt. The idea is to have space for maths students and people interested in Maths, to discuss Maths, have socials and much more! We will hold first social in collaboration with the Maths Cafe on second week of the current semester. More info will be available closer to the second week.

School Officer

Lucy Welford

Hello! My name's Lucy, a third year Maths student and I am the new School Officer for Maths for this academic year. As School Officer, it's my job to represent all students within the Maths department to make sure student voices are heard as well as helping to make positive changes to student learning experiences. Not only will I be representing our department, but I'll also be working closely with a team of Class Reps who'll be representing the voice of your year group by gathering student feedback and attending regular meetings - keep an eye on your inbox in Welcome Week if you're interested in applying. If you ever want to chat, whether it be about academic worries, issues or just general feedback, my email is so.maths@hw.ac.uk, or feel free to say hi if you see me about on campus.

Maths Gym and Maths Café

Emma Coutts

The **Maths Gym** is a cross-campus initiative aimed at supporting all HW students, from **any** subject, to strengthen their mathematical or statistical skills and gain confidence in applying these skills. We provide support through a variety of activities including drop-in sessions, one-to-one appointments and workshops.

Whether you want to brush up on basic skills or need help to understand new material from your course, don't hesitate to get in touch! We can help you achieve your maths or stats based goals, whatever they are. For more details please visit our website www.mathsgym.hw.ac.uk

The **Maths Café** is a peer supported initiative that allows maths students at Heriot-Watt to seek help among each other, ask questions or just chat with their peers. We also organise the Maths Café Talks throughout the academic year. These are a series of talks given by Heriot-Watt lecturers on a topic of their research every second Wednesday at 1pm. You can join us on https://discord.gg/DmKjajZXPB or check out our website https://mathsgym.hw.ac.uk/maths-cafe/

Piscopia Initiative

Gemma Crowe

The Piscopia Society is a UK-wide initiative which aims to encourage women and non-binary students to pursue a PhD in Mathematics. At Heriot-Watt, we will be hosting a PhD Information Event in October (date tbc) if you'd like to find out more about PhD options in Maths. All are very welcome to attend.

To find out more about the society and other events, such as our monthly PiWORKS seminar, please visit https://piscopia.co.uk/ or contact your Heriot-Watt representative: ggc2000@hw.ac.uk

A Quite Painless Interview

Recently we sat down to have a chat with Mark Lawson. You can find the full video interview (with extra content) here: https://youtu.be/HotorYmoJQU

What is a good habit to start in first year?

I think the most important thing is: just be regular. Don't do too much, don't do too little. Allow yourself to be paced by the lecturers.

There is always a temptation, I think, when you first go to university, to try and do too much. That sounds obvious, don't do too much. But on the other hand, don't leave it. Don't think, "oh I can do it next week". Because work piles up very very quickly. So, what I would say the best habit is, do a little bit every day. Keep up to date. Don't go too fast, don't go too slow and let yourself be guided by the lecturers.

Have you used your degree outside of maths in any way?

I think when you do a degree, you have to do it because you find the subject interesting. Otherwise, you are not going to get up in the morning, it's as simple as that. You have got to find it interesting.

I think what you learn when doing something like mathematics is a logical approach to problem solving. So problem solving in general. But having said that, I don't think I am any more able to solve real-life problems than anybody else.

In my own research, it turned out that some of my research was connected with theoretical physics - and that did turn out to be very good - so that was unexpected. I think being well educated in mathematics meant that I didn't turn off that particular avenue of research.

But in general terms, I think you do a degree because you enjoy it and it means something to you. When you do a maths degree it's certainly true that you are very employable in the end and you will learn techniques to solving problems. But I think the most important thing is to do it because you enjoy it. That's the most important thing.

What is your favourite part about your current work?

Oh, to be honest I like all of it. Everything I do I find interesting, otherwise I wouldn't do it. I am very lucky in that I do what I find interesting. If I were being paid to do the job by a company, I would have to do what they wanted to do. And I would try to do it as best as I could - and a lot of people have to do that. The great virtue of research in a university is that you can think what you want and follow where you want to go - and that is wonderful.

So everything I do, I enjoy doing. The hardest part is proving theorems, but every mathematician finds proving theorems hard, and you just have to accept the fact that it may take you weeks to figure out how to do something. It's just the name of the game.

What should you take away after four years of studying?

Two things. First of all, I hope you make some great friends, which is what I did. You will make a lot of good friends here and that is very important for the rest of your life.

The other thing, I think, you will take away (particularly from a maths degree) is an attitude of mind to solving problems. And that will help you a lot when applying for jobs. Because you will be applying for jobs where they want you to think for yourself. It's not necessarily that you will have an answer, but that you won't run from the room screaming, when they give you a problem, saying "I can't solve it". You will sit down, and you will think your way through it. And you will look at the various options you have to try and solve the problem.

And that, I think, is one of the most important things you learn when studying mathematics at university.

How did you get interested in mathematics?

Well... I was very lucky because I grew up in the 60's. And the Americans were spending billions of Dollars, and the Soviets were spending billions of Rubles, and sending rockets up, just so I would get interested in space rockets. So that was very kind of them!

And it was through that interest in rocketry that I became interested in physics and then through physics into mathematics. And then I stopped at maths because it seemed to me that maths underpinned everything. If you could do maths, you could do anything.

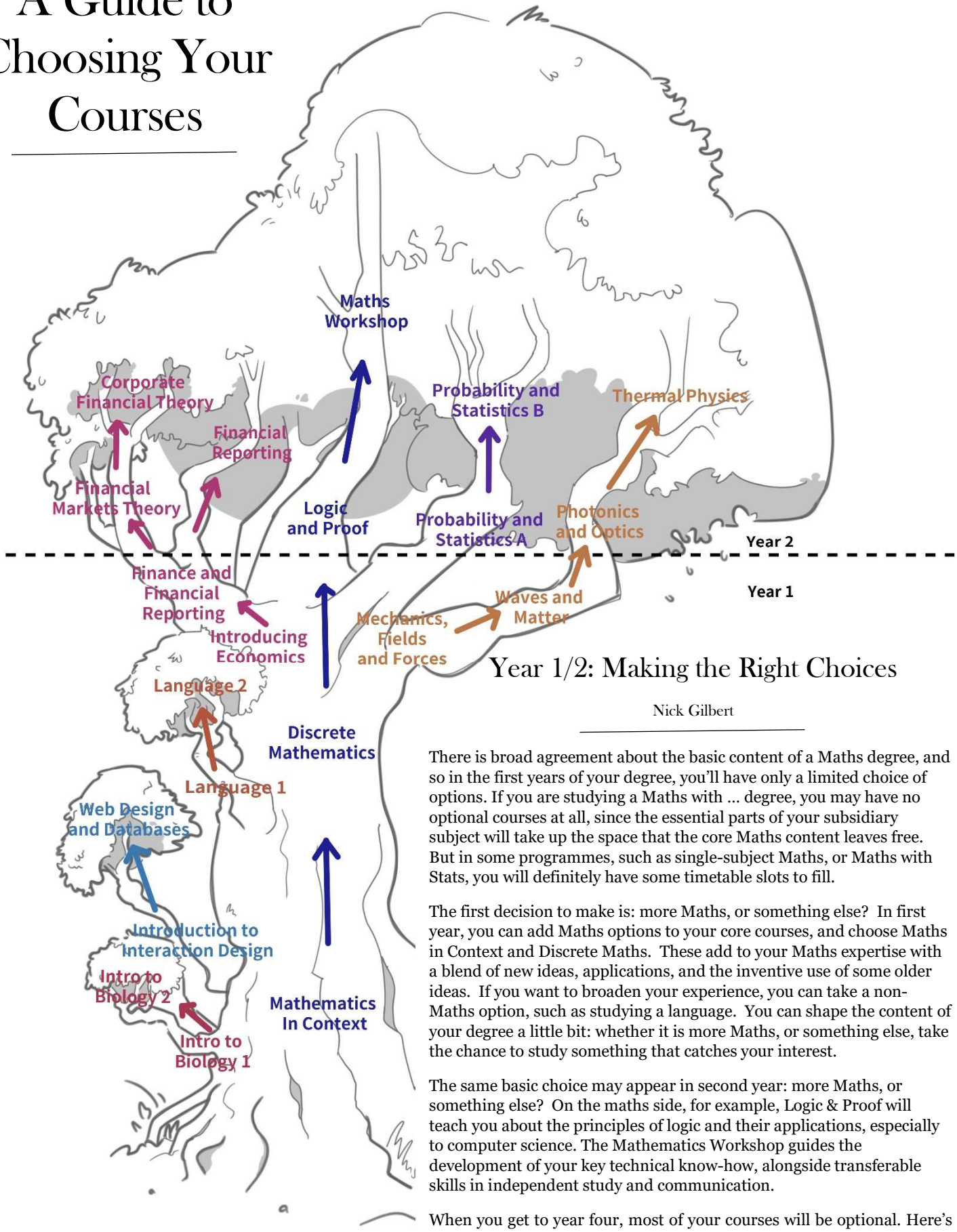
Whereas, if you could do physics you could be a very good physicist, but you wouldn't necessarily be a good mathematician. Whereas if you are a mathematician ... this was my idea anyways.

So it was through the space race how I got interested in mathematics and I suspect a lot of people in my generation became interested in the sciences - whether it is mathematics or physics or whatever - through watching these rockets going up every week and hearing people talk about the sciences and engineering of these rockets. And you couldn't help but get interested.

I was very lucky that these two great countries were willing to spend ALL that money, so 8-year-old-me could get interested in mathematics. I think it was money well spent!

So when people ask you what the space race gave to you, there are two things: the Teflon frying-pan and me doing mathematics. (grins)

A Guide to Choosing Your Courses



Year 1/2: Making the Right Choices

Nick Gilbert

There is broad agreement about the basic content of a Maths degree, and so in the first years of your degree, you'll have only a limited choice of options. If you are studying a Maths with … degree, you may have no optional courses at all, since the essential parts of your subsidiary subject will take up the space that the core Maths content leaves free. But in some programmes, such as single-subject Maths, or Maths with Stats, you will definitely have some timetable slots to fill.

The first decision to make is: more Maths, or something else? In first year, you can add Maths options to your core courses, and choose Maths in Context and Discrete Maths. These add to your Maths expertise with a blend of new ideas, applications, and the inventive use of some older ideas. If you want to broaden your experience, you can take a non-Maths option, such as studying a language. You can shape the content of your degree a little bit: whether it is more Maths, or something else, take the chance to study something that catches your interest.

The same basic choice may appear in second year: more Maths, or something else? On the maths side, for example, Logic & Proof will teach you about the principles of logic and their applications, especially to computer science. The Mathematics Workshop guides the development of your key technical know-how, alongside transferable skills in independent study and communication.

When you get to year four, most of your courses will be optional. Here's the chance to finally shape your degree, follow up on the ideas that you've liked the most this far, and to try out new options. Being good at Maths is not just excelling at the well-known and tried-and-tested: it is also being imaginative, creative and adventurous. You should choose your options in the same spirit!

For more information on optional/elective courses, talk to your personal tutor or year director.

Year 4/5 Courses

Here are some unofficial course descriptions from our lecturers to help you choose your year 4/5 courses.

Applied Maths C/E (Bernd Schroers)

After taking this course you'll be able to join a conversation about climate change and energy transition `without the hot air'!

In 2021/22, the Applied Maths C/E course will be about thermodynamics and statistical mechanics, and the application of both to understanding the Earth's atmosphere (the latter mostly in E). Thermodynamics is the science of heat, energy and work and in this course we will study a version of the theory which is geometrically very beautiful. Statistical mechanics provides an interpretation and understanding of thermodynamics in terms of the statistical properties of atoms and molecules. In particular, it provides a precise definition of entropy as a mathematical measure of disorder. That's probably my favourite concept in the course! The course only requires standard second year multivariable calculus and basics of probability. It's more enjoyable if you did not hate chemistry and physics at school, but no previous knowledge about either fields is assumed.

Maths Biology A/Maths Ecology (Andy White)

Mathematical Biology A develops mathematical models in continuous time (ODEs) and discrete time (difference equations) that represent a range of ecological systems. The analysis of the mathematical models can explain how species compete for resources, how predator-prey interactions can lead to population cycles and how vaccination can eradicate an infectious disease. You will learn general mathematical modelling skills and how to interpret modelling results. Towards the end of the course I'll show you how the mathematical skills you have learnt are being used to conserve the remaining populations of red squirrels in Scotland – which are threatened by competition and disease due to the invasive grey squirrel (and which is one of my favourite research topics).

Optimisation (Dominic Breit)

You will learn how to optimise your diet based on just frozen pizzas and frozen oven chips.

The first part of the course is centred at the celebrated simplex algorithm. There is a strong similarity to solving linear algebraic systems as in linear algebra. In the second part we focus on nonlinear optimisation, where tools from multidimensional calculus and ODEs will be applied.

Pure Maths C/E (Topology) (Laura Ciobanu)

(This course is only taught every other year and alternates with Number Theory)

Topology is my favourite course to teach: we will draw donuts, make Möbius bands out of paper, and get twisted in complicated knots. And you will see there is no difference between a coffee mug and a donut!

All this fun stuff applies to physics, robotics, DNA and more.

Numerical Analysis C (Dugald Duncan)

We often see descriptions in the news that include phrases like "computer modelling", "computer simulation" etc.

This numerical analysis of ordinary differential equations (ODEs) course explores the methods needed to take mathematical models based on ODEs (e.g epidemic models from the Math Bio course), "put them on a computer" and get quantitative answers. This almost always involves approximation, since most useful ODE models are too complicated to have exact solutions that can be written down in terms of standard functions. With no exact solution to compare with, then how do we know if the approximation is any good? The course aims to covers this and deal with the two sides of Numerical Analysis: computing approximate solutions (in Python); and analysing the properties (accuracy, cost etc.) of the approximation methods used.

Modelling & Simulation in Life Sciences (Jonathan Sherratt)

Take this course if you enjoy discussing how mathematical models relate to real-world biological systems.

This course concerns the various ways in which biological, ecological and medical systems can be represented using mathematical models. We will look entirely at problems involving both spatial and temporal components, since these are the most challenging to model. We will study a wide range of model types, discussing advantages and disadvantages. An important part of the course is a dissection of some relevant research papers, and part of the assessment will involve writing paper reviews. In the last three weeks of the course, students will work on a modelling problem in small groups. In 2021/22 this course will be taught entirely online.

Modelling and Tools (Mariya Ptashnyk)

If you are curious about different modelling and analysis techniques in Applied Mathematics, then Modelling & Tools course may be a good choice.

Modelling & Tools course covers a wide range of topic in Applied Mathematics and allows you to learn many different methods and techniques, including Markov chains, Chemical Master equations and Stochastic Simulation Algorithm, Qualitative analysis of ODEs and PDEs. Essential part of the course is devoted to programming using Python. In general, the emphasis is placed on the breadth of the material, whereas self-studies and discussion sessions will allow to cover topics most interesting to you in more details and depth. Important and interesting part of the course are two small projects on application of mathematics to different real-world problems.

Find the official course descriptions here:

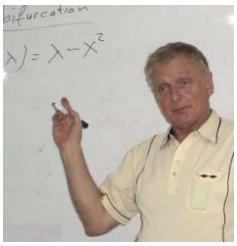
Year 4: http://www.macs.hw.ac.uk/students/wp-content/uploads/4thyear2021-2022.pdf

Year 5: http://www.macs.hw.ac.uk/students/wp-content/uploads/5thyear2021-2022.pdf

Jack Carr Fund Grants Scheme

Robin Knops

The Jack Carr Fund, established in memory of the late Professor Jack Carr, formerly Head of the University's Mathematics Department, invites applications for a limited number of small grants not expected to exceed £500. Larger grants may be awarded in special cases.



The scheme is open to Heriot-Watt University undergraduate and postgraduate students currently registered in Edinburgh for a degree normally in the mathematical sciences. Post-doctorates in MACS may also apply.

Applications should be submitted by email to June Maxwell *j.maxwell@hw.ac.uk* at any time before the closing dates of June 22, 2021, October 8 2021, and March 3 2022.

Examples of what might qualify for an award include:

- Academic study (excluding costs of student exchange visits and class trips.)
- Extra-curricular study in the mathematical sciences including participation in work-shops, and short study visits in the UK and elsewhere.
- Care and caring costs.
- Musical activity.

Further information and conditions may be obtained from: www.hw.ac.uk/uk/schools/mathematical-computer-sciences/departments/maths/jack-carr-scholarship-fund.htm

For informal enquiries and advice on applying please contact Professor Robin Knops, r.j.knops@hw.ac.uk, Convener of the JCF Board.

A Proof?

We present here a proof that everyone at Heriot-Watt has the same age. Can you spot the error?

"Proof" We proceed with induction. Clearly, everyone in a group of 1 person has the same age, so the statement is true for a group of 1 person.

Now, assume the statement is true for any group of k people. Now consider a group of k+1 people, and three people Angus, Bonnie and Callum in this group. If we remove Angus from this group, then we are left with a group of k people containing Bonnie and Callum, so Bonnie and Callum have the same age. Likewise, if we remove Bonnie, we are also left with a group of k people containing Angus and Callum, so Angus and Callum must also have the same age.

Thus, Angus, Bonnie and Callum all have the same age, so everyone in our group of k+1 must have the same age, so by induction any group of Heriot-Watt students must have the same age. $Q.E.D.?$

The Trefoil Knot

A mathematical knot can be obtained by taking a knot in a piece of string and connecting the ends together. The simplest thing to do would be nothing, and connecting the ends together would give you a loop (called the *unknot*).

To get a more interesting knot, you could take a piece of string and thread it through itself before connecting the ends. This knot is the simplest non-trivial knot, known as the *trefoil knot*.

Instead of showing an image here, we have hidden a trefoil somewhere in this newsletter. Good luck finding it (it may not look exactly as you'd expect!)

Maths Newsletter

Thank you for reading this far and for supporting our new project! We have had a blast this summer gathering information and putting this together, and we are very excited to have the first issue ready in time for the start of semester. We wanted this newsletter to be informative while keeping a bit of a light-hearted tone, so we hope that has come across.

We are always looking for interested undergraduate and postgraduate volunteers to help us with the editing and writing work! Get in touch through our email below.

We would like to give a huge thank you to everyone who made this project possible. A special mention to Heiko Gimperlein and Laura Ciobanu who have been tremendously helpful throughout this whole process, and to the Jack Carr Fund for supporting us in this endeavour. Thank you as well to all the people who took time out of their summer to contribute towards the newsletter and thank you to Michael Driscoll for the amazing artwork and Lewis Dukelow for the brilliant video editing.

We hope you are as happy with the final product as we are.

The *Maths Newsletter* team

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