

# Welcome to SMSTC!

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# What is SMSTC?

SMSTC is the Scottish Mathematical Sciences Training Centre.

We provide graduate mathematics courses to all of Scotland.

There are nine member departments.



# Why do we exist?

UK higher education in mathematics is traditionally

- **short** (typically 3 years UG + 1 year Masters + 3 years PhD);
- **narrow** (graduate study was highly specialised).

The 2004 International Review of UK Mathematics concluded that PhD graduates were often strong in their narrow field, but lacked breadth.

As a result:

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As a result:

- the standard PhD programme was **lengthened** to 3.5 years,
- with the first 0.5 years to be spent on **broadening** training.

This training is (partly) provided by six 'taught course centres' across the UK.

## Who are we?

SMSTC is a community project. It includes:

- **Students:** mostly 1st year maths PhD, but also higher years, other subjects, other universities, postdocs, staff, . . .
- **Lecturers:** c. 50 per year, drawn from all nine universities.
- **Administrator:** Annabelle MacInnes
- **Director:** Fraser Daly (until December)
- **Deputy Director:** Ana Lecuona (until December, then Director).
- **Theme Heads:** Gabriel Barrenechea, Victor Elvira, Alessandro Sisto, Richard Scott.
- **Technical staff** at each university.
- **Postgraduate co-ordinators** at each university.
- **Tutors** at each university.
- **External advisers** from outwith Scotland.
- **Student reps** from each university (**volunteers needed!**)

## What courses do we offer?

We run **core modules** and **supplementary modules**.

### Core modules:

- run every year;
- are aimed mostly at first-year PhD students;
- consist of two-hour lectures once a week for ten weeks;
- have graded assignments.

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## Supplementary modules:

- are different every year;
- may be more advanced and taken by higher-year PhD students;
- may be shorter;
- don't always have graded assignments.

If you want a supplementary module to count towards your department's training requirements, talk to your supervisor or PG coordinator.

# Themes

You can take any combination of modules you want, as long as:

- you have suitable prior knowledge (see the Prospectus);
- your department agrees.

For convenience, we organize the core modules into four themes:

- Analysis
- Applications of Mathematics
- Probability & Statistics
- Structure & Symmetry



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## Analysis

Theme Head: Gabriel Barrenechea (Strathclyde)

Core modules:

- Dynamical Systems and Conservation Laws (Semester 1)
- Measure and Integration (Semester 1)
- Elliptic and Parabolic PDEs (Semester 2)
- Functional Analysis (Semester 2)

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## **Applications of Mathematics**

Theme Head: Richard Scott (St Andrews)

Core modules:

- Asymptotic and Analytical Methods (Semester 1)
- Continuum Mechanics (Semester 1)
- Numerical Methods (Semester 2)
- Mathematical Biology and Physiology (Semester 2)

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## **Probability and Statistics**

Theme Head: Victor Elvira (Edinburgh)

Core modules:

- Foundations of Probability (Semester 1)
- Regression and Simulation Methods (Semester 1)
- Stochastic Processes (Semester 2)
- Modern Regression and Bayesian Methods (Semester 2)

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## Structure and Symmetry

Theme Head: Alessandro Sisto (Heriot-Watt)

Core modules:

- Algebraic Geometry (Semester 1)
- Differential Topology (Semester 1)
- Representation Theory (Semester 2)
- Algebraic Topology (Semester 2)

# Supplementary modules 2024-25

## First semester:

- Conformal Field Theory and Vertex Operator Algebras
- Gradient Flows
- Riemann Surfaces and their Associated Moduli Spaces
- Topological Quantum Field Theory
- Quantum Computing

## Second semester:

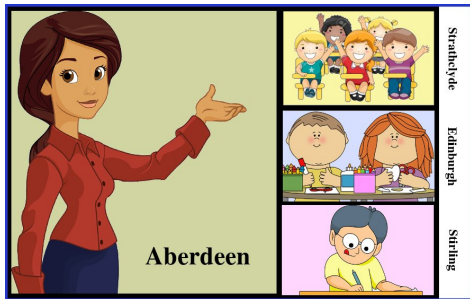
- Finite Element Methods for PDEs
- Gravity
- Holography
- Hopf Algebras

More may be added to the second semester: keep an eye on our website!

# How do lectures work?

Lectures are delivered by Zoom. Gather with other students at your local videoconferencing room.

**Example:** If you're in Dundee and the lecturer is in Aberdeen, you see this:



Screen 1

**The definition**

A metric space  $X$  is **positive definite** if for every finite  $A \subseteq X$ , the matrix  $Z_A$  is positive definite.

E.g.:  $\mathbb{R}^n$  with the Euclidean or taxicab metric, hyperbolic space, any ultrametric space.

**Theorem (Meckes)**

*All sensible ways of extending the definition of magnitude from finite metric spaces to compact positive definite spaces are equivalent.*

E.g.: For a compact positive definite space  $A$ , we can define

$$|A| = \sup\{|B| : \text{finite } B \subseteq A\}.$$

Or equivalently, we can choose a sequence  $(B_n)$  of finite subsets with  $B_n \rightarrow A$  in the Hausdorff metric, then define  $|A| = \lim_{n \rightarrow \infty} |B_n|$ .

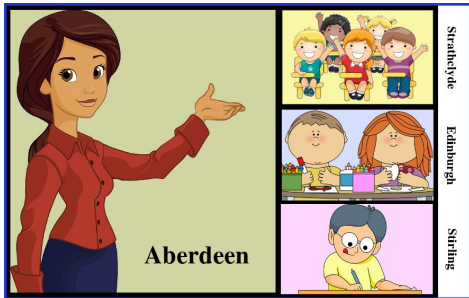
The definition can also be expressed directly, without using finite approximations.

Screen 2

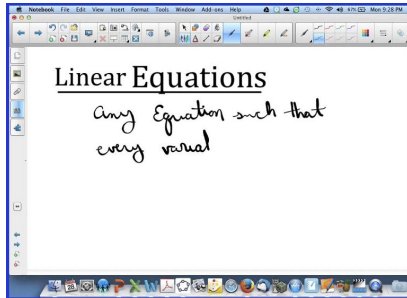
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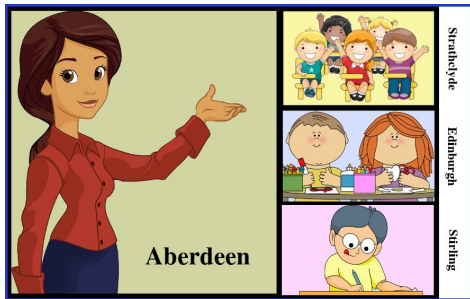


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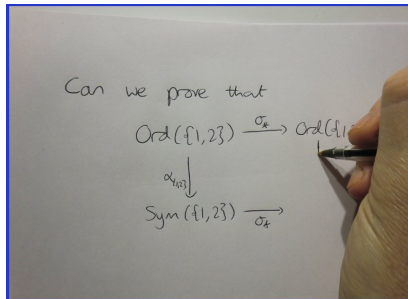
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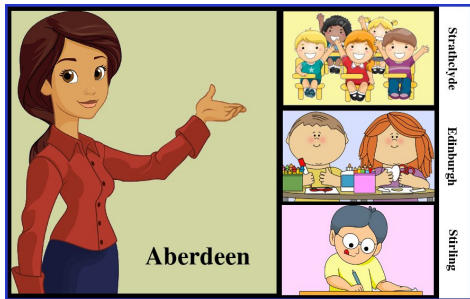
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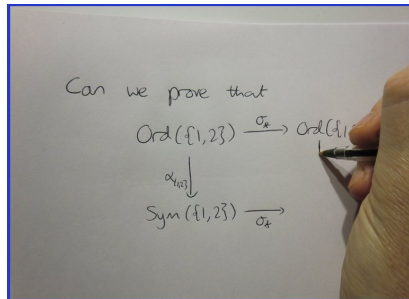
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Screen 1



Screen 2

It's interactive: you can ask and answer questions. (But please keep the microphone off otherwise!)

## How do lectures work?

Lectures will be delivered via Zoom.

- Joining details will be emailed to enrolled students. Please don't share them further.
- Lectures will not (and must not) be recorded — exceptions by request to the Director only.
- Full notes are available on the website.
- It's up to you if you want video on/off and if you want to participate — but if you can participate, this should benefit you.

## What happens outside lectures?

Material on the website: The website ([www.smstc.ac.uk](http://www.smstc.ac.uk)) is crucial!

Study the notes, do the exercises, follow up on suggested texts, etc.  
Some modules are 'flipped': you're expected to read in advance.

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**Assessment:** Each core module is assessed in either one or two assignments. You get written feedback, a grade for each assignment, and an overall grade for the module. All this is visible to your supervisor.

Assignments are **individual** pieces of work, not group efforts.

## How many modules should I do?

Your postgraduate director decides what's required (not us).

- A 'typical' load (original EPSRC expectation): 6 modules.
- We don't require you to take them all in the same year!
- Your choices should be to widen your knowledge, not to support your research directly.

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### Examples:

- Student A has started a PhD straight from UG. They take six core modules.
- Student B did a lot of high-level courses in their MSc, so only takes three modules: two core, one supplementary.
- Student C takes four core modules, but wants to learn some other subjects that SMSTC doesn't offer, so also takes a UG course and a reading course.

## How much time does all this take?

Typically, about **75% of your time for the first six months of your PhD** is intended to be spent on training.

**Make sure your supervisor doesn't overload you with other work.**

**Warning:** You are likely to have clusters of assignment deadlines around the middle and end of semesters.

**Plan ahead for this!**



## What doesn't SMSTC do?

SMSTC doesn't force you to do anything.

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SMSTC doesn't provide tutorials.

These are the responsibility of your department.

Lectures are done centrally by videoconference—organized by SMSTC.

Tutorials are done locally in person—organized by your department.

If you're not being offered tutorial support, *complain to your department!*

## Student reps

- **Volunteers needed:** one per university and CDT!
- Important avenue for feedback to lecturers, departments and SMSTC.
- One student rep attends our Academic Steering and Management Group meeting in May: it's crucial we have a student voice when reviewing the current academic year and planning for the next.

# Questions and feedback

Some mechanisms for asking questions or providing comments:

- **Local tutors:** e.g. specific mathematical points.
- **Lecturer:** e.g. points that your tutor can't answer.
- **Theme Head:** e.g. feedback on course provision.
- **PG coordinator and supervisor:** e.g. questions about your training.
- **SMSTC Administrator:** purely administrative questions.
- **SMSTC Director:** questions & comments about SMSTC overall.
- **Student reps:** anything you'd like to be passed on anonymously.
- **Formal feedback process:** in March and April.
- **Me, now:** ...?

# What now?

Today and tomorrow:

- Overviews of each **theme** and many of the **supplementary modules**, including content, prerequisites and assessment. These should help you
  - ▶ **make up (or change) your mind** on which modules to take;
  - ▶ **broaden your knowledge**, even if you've already chosen.
- Presentations on some **useful stuff for PhD students to know**, including on professional bodies you may wish to join.
- **Meeting students and staff** from universities across Scotland.
- Some **fun networking and team-building**, including curling and dinner.