The LTCC

The LTCC fosters the training of doctoral research students in the Mathematical Sciences. Its courses cover the areas of Statistics, Applied Mathematics and Pure Mathematics, with the aim of providing students with an overview of these areas, and of acquiring a working knowledge of classical results and recent developments in their own broad research fields but outside the specialised domains of their individual research projects. There is a wide range of expertise among the staff of the institutions currently in the LTCC consortium:

- Departments of Mathematics and Statistical Science, UCL
- The School of Mathematical Sciences, Queen Mary University of London
- Department of Mathematics, Imperial College London
- Department of Mathematics, King's College London
- Departments of Mathematics and Statistics, LSE
- Departments of Mathematics, City, University of London
- SMSAS, University of Kent
- Department of Mathematics, Brunel University London
- Department of Mathematics, Royal Holloway University of London
- School of Mathematics and Statistics, Open University
- Department of Economics, Mathematics and Statistics, Birkbeck

The LTCC programme emphasises direct teaching and personal contact rather than distance learning, and includes modular lecture courses and short intensive courses.

Note: A fee is payable by students from non-LTCC departments.

Lecture venues will be on the UCL campus.

This course list is subject to change. Further information, venue details, full text syllabi, the registration form and timetable are available online at www.ltcc.ac.uk or contact us at office@ltcc.ac.uk.

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London Taught Course Centre

Advanced courses 2021-2022

for PhD students in the mathematical sciences

LTCC

London Taught Course Centre

Advanced Courses 2021-2022

4 October - 1 November 2021 (Block 1)

Galois Cohomology

Dr N. Dogra, KCL

Galois cohomology is a construction in arithmetic and algebraic geometry which lies at the intersection of two more general theories ("etale cohomology" and "group cohomology"), and is essential in carrying out computations in the former. We will introduce the notion of group cohomology, in its abelian and nonabelian incarnations, establish some foundational results on the cohomology of Galois groups, and discuss Brauer groups, class field theory, and applications to obstruction problems.

Principles and Design Patterns in Data Scientific Software Engineering

Dr F. Kiraly, UCL

AI software frameworks such as scikit-learn are workhorses of modern data scientific modelling practice. Designing such frameworks requires simultaneous consideration of best software engineering practice, mathematical formalism, and methodology. This course introduces these core topics, alongside exercises in collaborative coding practices, with opportunities for mentored contributions to open source tools. The course is suited for academics who would like to build their software skills, or programmers seeking an introduction to formal aspects of data science.

Semiclassical Analysis

Dr J. Galkowski, UCL

This course will provide an introduction to semiclassical analysis, a branch of microlocal analysis used to study problems with a small (or large) parameter. Motivated by the study of both elliptic and hyperbolic partial differential operators, this course will cover the background of semiclassical methods and some modern applications such as quantum ergodicity, eigenfunction estimates, or exponential decay for damped wave equations.

Hyperbolic Conversion Laws

Dr M. Schrecker, UCL

Hyperbolic conservation laws are a class of partial differential equations that occur throughout mathematical modelling but pose significant challenges to the analyst. In this course, I will provide the classical theory for scalar laws in many dimensions and systems in one dimension and highlight key open problems as well as recent progress.

Groups of Finite Cohomological Dimension

Prof F. Johnson, UCL

'Every countable group of finite cohomological dimension acts freely by diffeomorphisms on some Euclidean space'

We shall explain this statement via the finiteness conditions of Serre and Wall and illustrate it with a wide variety of examples, including discrete subgroups in Lie groups and examples of a more exotic type, namely the poly-Surface groups.

8 November - 6 December 2021 (Block 2)

An Introduction to Ergodic Theory and Topological Dynamics

Dr R. Yassawi, OU

This course introduces ergodic theory and topological dynamics, areas of mathematics which developed in the twentieth century, and which are currently active and vibrant areas of research. We will discuss the basic notions in this area, including those of ergodicity, mixing, entropy and complexity. Throughout we will illustrate with running examples from the family of Cantor dynamical systems to explain these concepts.

Orthogonal Polynomials

Dr A. Loureiro, Kent

This course will offer an overview of the modern theory of orthogonal polynomials and special functions, whilst discussing a vast plank of examples where they became instrumental.

10 January - 7 February 2022 (Block 3)

Riemannian Holonomy Groups

Dr L. Foscolo, UCL

The course is an introduction to the geometry of manifolds with special holonomy. After introducing Berger's classification, we will concentrate on the Ricci-flat holonomy groups and in particular on Calabi-Yau and hyperkähler metrics. The final part of the course will focus on constructions of compact and non-compact Ricci-flat manifolds with special holonomy.

An Introduction to Birational Geometry

Prof P. Cascini, Imperial

The course will introduce some of the main results in the field of birational geometry for complex algebraic vareities, starting from the case of surfaces and then focusing on the main achievements in the Minimal Model Program over the last few decades, such as the bend and break, the cone theorem, the base point free theorem and existence and termination of flips.

Reductive Groups

Prof N. Shepherd-Barron, KCL

We will start by constructing certain kinds of simple Lie algebras from positive even lattices and go on to construct the corresponding adjoint algebraic groups. We then construct their simply connected covers and explain how this leads to certain finite simple groups.

Mathematical Topics in General Relativity

Dr J. A. Valiente-Kroon, QMUL

This course will provide a general discussion of General Relativity as an initial value problem. In addition, it will serve as an introduction to applied methods of Differential Geometry and Partial Differential Equations.

14 February - 14 March 2022 (Block 4)

Asymptotic Methods and Statistical Applications

Dr H. Battey, Imperial

Many problems in statistics do not possess an exact analytic solution. While numerical evaluation is possible, greater insight is obtained through approximate analytic solutions. These, for instance, allow one to quantify the performance of statistical procedures in terms of intrinsic features or key tuning parameters.

Topics in the Design of Experiments

Dr S. Coad, QMUL

This course covers some of the topics which are essential background for much of the current research in design of experiments. It is in two parts: optimal design theory and sequential design.

Integrable Systems

Prof R. Halburd, UCL

We will study the inverse scattering transform for soliton equations as well as other solution-generating methods for integrable PDEs. The Painlevé equations and discrete integrable systems will also be discussed.

Elements of Functional Data Analysis

Dr A. Duncan, Imperial

The aim of this module is to broadly cover topics from the area of functional data analysis, exploring theory and applications. The approach this module will take is based on the Hilbert Space formalism and is concerned with statistical hypothesis tests in various functional data analytic settings. Theory will be motivated by examples from various areas of science including engineering, chemistry and finance.

Hyperkahler Manifolds

Dr N. Kurnosov, UCL

This course is an introduction to the theory of hyperkähler manifolds. We will give an overview theory of manifolds with special holonomy, and study basic examples with a lot of attention to their geometric construction, later we will focus on Torelli theorem and the geometry of hyperkähler manifolds.