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 venue:

De Morgan House
57-58 Russell Square
London WC1B 4HS

Office address:
LTCC
Department of Mathematics
University College London
Gower Street
London WC1E 6BT

Phone: 020 7679 4309
E-mail: office@ltcc.ac.uk
www.ltcc.ac.uk

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

Basic Courses 2022 - 2023

LTCC

London Taught Course Centre

for PhD students in the mathematical sciences

3 October - 31 October 2022 (Block 1)

Stochastic Processes *Dr Terry Soo, UCL*
This course aims to introduce the main ideas and methods of simple applied probability, together with examples of a variety of applications. Main topics: Markov chains in discrete and continuous time, and Poisson-based processes.

Measure Theory *Dr Robert Simon, LSE*
We cover the basic structure of measures, starting with the algebra of sets on which a measure is defined. We explore the concept of outer measure and its most common application, the Lebesgue measure on Euclidean space. We end the course by applying measures to functions and their integration, including the monotone and dominated convergence theorems.

Pseudo-differential operators and applications to PDEs
Dr Claudia Garetto, QMUL
In this course we will study the theory of pseudo differential operators. These integral operators are a generalisation of differential operators. They have interesting algebraic properties, such as the existence of a symbolic calculus, which are very useful when studying PDEs (elliptic equations and higher order PDEs).

Applied Bayesian Methods *Prof. Petros Dellaportas, UCL*
This course introduces the Bayesian approach to statistical inference and relevant theories, methodologies and computational techniques for its implementation.

Symmetry Methods for Differential Equations
Prof. Peter Clarkson, Kent
This course is concerned with symmetry reductions of partial differential equations, which are obtained by seeking solutions in special forms or using group theoretical, highly algorithmic techniques. These symmetry reductions reduce the equation to a lower dimensional equation, often an ordinary differential equation.

7 November - 5 December 2022 (Block 2)

Morse theory, topology and robotics
Prof. Michael Farber, QMUL
The course will start with basic results of Morse theory which will be illustrated by applications in topology and robotics. We shall discuss solution of Smale's generalised Poincare Conjecture and his h-cobordism theorem. We shall apply the technique of Morse theory to study topology of configuration spaces of mechanical linkages and spaces of polygons achieving their full combinatorial classification.

Analytical Methods *Prof. Nick Ovenden, UCL*
We will study perturbation methods in the context of ordinary and partial differential equations. Topics covered will include matched asymptotics, steepest descents, conformal mappings, WKB expansions and multi-scale analysis.

Measure-theoretic Probability
Prof. Alexander Gnedin, QMUL
The course provides a measure-theoretic background for modern Probability Theory and introduces important stochastic processes. The selected topics include construction of measures, conditioning and martingales, types of convergence and limit theorems, construction and properties of Brownian motion, weak convergence of measures in application to Donsker's invariance principle. Each lecture is supplemented by a set of exercises of varying levels of difficulty.

Graph Theory
Prof. Jan van den Heuvel / Dr Yani Pehova, LSE
Our aims in this course are twofold. First, to discuss some of the major results of graph theory, and to provide an introduction to the language, methods and terminology of the subject. Second, to emphasise various approaches (algorithmic, probabilistic, etc.) that have proved fruitful in modern graph theory. These modes of thinking about the subject have also proved successful in other areas of mathematics, and the skills learnt in this course should be transferable to other areas of mathematics.

Models *Dr Oliver Kerr, City*
This course examines basic principles behind modeling, and looks at a variety of qualitative and quantitative models and their application.

9 January - 6 February 2023 (Block 3)

Theory of Linear Models *Dr Kalliopi Mylona, KCL*
This course covers the theory of linear models, with an emphasis on the most general results for estimation and inference in both small and large samples. Extensions to other classes of models will be discussed, especially where this builds on linear models theory.

Differential Geometry & Mathematical Physics
Dr Steffen Krusch / Prof Andrew Hone, Kent
We illustrate how concepts in differential geometry arise naturally in various areas of mathematical physics. We will describe manifolds, fibre bundles, (co)tangent bundles, metrics and symplectic structures, and their applications to Lagrangian mechanics, field theory and Hamiltonian systems, including various examples related to integrable systems and topological solitons.

Applications of Complex Analysis
Prof. Rod Halburd, UCL
After an introduction to elliptic functions we will study Abelian, Riemann theta and Baker-Akhiezer functions from the theory of Riemann surfaces. We will describe the solution of the Jacobi inversion problem and use it to find classes of solutions to some important nonlinear differential equations appearing in applications such as the motion of a rigid body and water waves.

Fundamental Theory of Statistical Inference
Prof. Alastair Young, Imperial
This course describes the key aspects of Bayesian, Fisherian and frequentist approaches to statistical inference. The module will cover: statistical inference from a decision-theoretic perspective; Bayesian methods; exponential and transformation families of models; principles of statistical inference and data reduction; key elements of frequentist theory of point estimation and hypothesis testing.

13 February - 13 March 2023 (Block 4)

Time Series Analysis *Dr Yining Chen, LSE*
The aim of this course is to introduce students to the statistical analysis of time series data and simple models, and showcase what time series analysis can be useful for. Topics include: autocorrelation, stationarity, trend removal and seasonal adjustment, basic time series models (e.g. ARMA) and their estimation, introduction to financial time series and the GARCH models. R demonstrations will also be included.

Mathematical Aspects of Quantum Computing
Prof. Shahn Majid, QMUL
We provide an introduction to the mathematics of quantum computing. After elementary notions such as qubits, entanglement, quantum gates and so-called quantum teleportation, the course focuses on algebraic and categorical structures, particularly Frobenius algebras, ZX-calculus based on interacting pairs of Hopf algebras, monoidal and braided monoidal categories. The course ends with an introduction to Kitaev surface code models for topologically fault-tolerant quantum computing.

Homological algebra *Prof. Markus Linckelmann, City*
The first half of this course will be a systematic introduction to the basic concepts and methods in homological algebra, such as chain complexes, cohomology, Ext and Tor, homotopy, long exact cohomology sequences, derived functors and categories.
The second half of the course will focus on applications in group cohomology, Hochschild cohomology of algebras, deformation theory, algebraic topology, and time permitting some basics on functor cohomology.