DEPARTMENT OF MATHEMATICS - FIFTH-YEAR COURSES 2018/2019

Brief Descriptions: Please note that these courses run subject to demand and we might have to ask you to make an alternative selection at the start of the semester if the class is too small. You cannot take the courses with *'s if you took the equivalent course in year 4. You cannot take the course with a ** if you took F19NB.

Semester 1

MODELLING AND TOOLS, F11MT, [Semester 1, Malham/Schmuck]
The module aims to provide students with fundamental techniques of deterministic and probabilistic mathematical modelling. Model problems will be used to develop and illustrate these techniques. To investigate the problems, Matlab programs will be developed and implemented. The course will combine the presentation of theoretical material in lecture style and practical analytical and numerical studies of application problems.

APPLIED MATHEMATICS E, F11AE (Fluid Mechanics), [Semester 1, Schroers]
The goal of the course is to derive the mathematical models for fluid mechanics and use them to explain natural phenomena as well as outline important engineering applications. The course will include the continuum hypothesis, dynamics and properties of fluids, Euler and Navier-Stokes equations and vorticity with applications to Stokes flow, boundary layers, vortex sheets, compressible flows and shock waves.

MATHEMATICAL BIOLOGY A, F11AM*, [Semester 1, White]
The course aims to teach the application of ordinary differential equations and difference equations to problems in ecology. It will provide an understanding of the mathematical modelling methods that describe population dynamics, epidemiological (infectious disease) processes and evolutionary processes in ecological systems and instruction in the biological interpretation of mathematical results.

FUNCTIONAL ANALYSIS, F11FM*, [Semester 1, Youngson]
This course introduces measure theory and functional analysis. The course includes measure and integration, monotone and dominated convergence theorems, application to evaluation of integrals, normed and inner product spaces, operators and their adjoints and inverses.

OPTIMISATION, F11MM*, [Semester 1, Breit]
The main aim of this course is to present different methods of solving optimization problems in the three areas of linear programming, nonlinear programming, and classical calculus of variations. The course includes analytic techniques for analyzing functions, strong and classical Lagrangian classical techniques, linear programming and dynamic programming.

NUMERICAL ANALYSIS C, F11NC*, [Semester 1, Duncan]
Ordinary differential equations (ODEs) are central to mathematics and a multitude of different applications. Often solutions to ODEs can only be approximated numerically with a computer. This module provides an introduction to the derivation and analysis of techniques to do this both accurately and efficiently. The course includes approximation methods for initial value problems, single-step and multi-step methods, accuracy and stability, two-point boundary value problems, shooting techniques and finite difference methods.

PURE MATHEMATICS E, F11PE (Number Theory), [Semester 1, Ciobanu]
This course gives an introduction to some advanced topics in Number Theory such as quadratic reciprocity, Gaussian integers, the distribution of primes, the Riemann zeta function, elliptic curves and Fermat's last theorem.

MODELLING AND SIMULATION IN THE LIFE SCIENCES, F11MS, [Semester 1, Sherratt]
The aims of this course are to develop techniques of computational and differential equation modelling in biology, ecology and medicine. The course will introduce a number of modelling approaches that are widely used in applications to the life sciences, including reaction-diffusion equations, age-structured models, multi-scale modelling, and integral representations of dispersal. The course will teach practical implementation of these modelling approaches in the context of computer simulations, which will be illustrated by prototype applications from biology, ecology and medicine. This will be done by a mixture of lectures on basic methodology, computer labs, case studies, and group-based modelling exercises.

Semester 2

MATHEMATICAL BIOLOGY B, F11AN*, [Semester 2, Painter]
This course develops models of biological, medical and physiological processes including wound healing, cancer growth, heart disease, nerve impulses and disease spread. This course will teach the application of ordinary differential equations to simple biological and medical problems, the use of mathematical modelling in biochemical reactions, the application of partial differential equations in describing spatial processes such as cancer growth and pattern formation in embryonic development, and the use of delay-differential equations in physiological processes.

PARTIAL DIFFERENTIAL EQUATIONS, F11MP*, [Semester 2, Coutand]
The course aims to provide knowledge in the theory of partial differential equations. The course includes classification of linear second order equations, Cauchy problems, well posed problems for PDEs, the wave equation, the heat equation, Laplace's equation and Green's functions.

NUMERICAL ANALYSIS D, F11ND*, [Semester 2, Schmuck]
This course provides an introduction to the techniques and analysis required to find the numerical solution of partial differential equations. The course includes numerical solutions of PDE's, finite difference methods for elliptic boundary value problems, Dirichlet and Neumann boundary conditions, finite difference methods for parabolic and hyperbolic initial value problems, the heat equation and wave equations.

PURE MATHEMATICS F, F11PF (Hilbert Space Operators) ,**[Semester 2, Boulton]**
In this course we examine classical results about linear operators on Hilbert spaces. We begin by studying the concepts of projection and dimension on separable Hilbert spaces. We then study the concept of compact operators which is fundamental in functional analysis. We subsequently focus on the spectral theorem for compact selfadjoint operators. Then we study the solution of Fredholm and Volterra integral equations.

GEOMETRY, F11PG*,[Semester 2, Schroers]
This course develops methods of multidimensional calculus to investigate geometrical properties of smooth curves and surfaces. The topics covered include curves in Euclidean space, vector fields and differential forms, moving frames and structure equations, surfaces in Euclidean space, curvature and geodesics.

DYNAMICAL SYSTEMS, F11AS,[Semester 2, Rynne]
The course aims to provide postgraduate students with a knowledge and critical understanding of dynamical systems particularly as they arise from systems of ordinary differential equations as models in applied mathematics.

STOCHASTIC SIMULATION, F11SS,[Semester 2, Lord]
The inclusion of random effects in simulations is growing more and more important to try and quantify uncertainty in real world systems. The aims of this module are to develop understanding of continuous random variables and their practical numerical simulation. The course discusses simulation of random numbers and examines basic Monte-Carlo methods. We will look at Brownian motion its properties and simulation. We introduce stochastic integrals and stochastically forced ordinary differential equations. We show how to perform numerical simulations and analysis.

APPLIED LINEAR ALGEBRA, F11AL,[Semester 2, Loisel]**
This course aims to provide a toolkit of modern techniques in applied linear algebra. As well as introducing algorithms, it aims to provide ways to evaluate their accuracy and efficiency. It will consist of a combination of background theory, practical applications (using Matlab) and case studies.

DATA ASSIMILATION WITH APPLICATIONS TO CLIMATE CHANGE, F11DA ,[Semester 2, Malham]
The aims of this course are to develop techniques of data assimilation in numerical weather prediction and climate change modelling. We will introduce a number of data assimilation approaches that are widely used in applications to numerical weather prediction and climate change modelling, including basic regression analysis, variational approaches, Kalman filtering, extended and ensemble Kalman filtering and the Bayesian inference approach. The course will teach practical implementation of these data assimilation techniques in the context of computer simulations, which will be illustrated by prototype applications from geophysical fluid dynamics and climate change models. This will be taught using by a mixture of lectures on basic methodology, tutorial exercises, computer labs, case studies and a large group-based modelling, implementation and simulation project.