DEPARTMENT OF MATHEMATICS
FOURTH YEAR COURSES 2021/2022

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.

APPLIED MATHEMATICS C, F10AC1 (Fluid Mechanics)
[Semester 1]
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, F10AM1
[Semester 1]
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, F10MF1
[Semester 1]
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.

OPTIMIZATION, F10MM1
[Semester 1]
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, F10NC1
[Semester 1]
Ordinary differential equations (ODEs) are central to mathematics and a multitude of different applications. In almost all cases, solutions to ODEs can only be approximated and usually this is done using methods from numerical analysis on a computer. This module provides an introduction to the derivation and analysis of techniques to do this both accurately and efficiently. The course includes the derivation and analysis of the properties of single-step and multi-step approximation methods for ODE initial value problems.

PURE MATHEMATICS C, F10PC1(Number Theory)
[Semester 1]
This course gives an introduction to some advanced topics in Number Theory such as quadratic reciprocity, Gaussian integers, the distribution of primes, sums of squares, the Riemann zeta function, and applications of number theory to cryptography.

MATHEMATICAL BIOLOGY B, F10AN2
[Semester 2]
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, F10MP2**  
[Semester 2]  
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 (PDEs), F10ND2**  
[Semester 2]  
PDEs are used as the basis for modelling many phenomena. In almost all real-world cases exact formulae for solutions to PDEs cannot be found, and approximations are used instead. This is done using methods from numerical analysis on a computer. This course provides an introduction to numerical techniques and analysis required to find the approximate solution of partial differential equations. The course covers approximation methods for parabolic (including the time dependent heat equation), hyperbolic (including time dependent wave equations) and elliptic equations (including steady state heat equations). The course mainly covers finite difference methods, but also introduces finite element methods for elliptic problems.

**PURE MATHEMATICS D, F10PD2 (Matrix Lie Groups and Lie Algebras)**  
[Semester 2]  
In this course, we will study Lie groups and their Lie algebras, two essential concepts in modern mathematics and theoretical physics. We will focus on the very concrete subset of matrix Lie groups and we will encounter many explicit examples. We will learn that matrix Lie groups form topological spaces called manifolds and that they can be differentiated to matrix Lie algebras which encode many of their properties. We will also focus on applications, both in the description of symmetries as well as in the solution of differential equations.

**GEOMETRY, F10PG2**  
[Semester 2]  
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.