2019/0 - MTHA4003Y REAL ANALYSIS

Full Year, Level 4 module
(Maximum 150 Students)
UCU: 20 Organiser: Dr Jonathan Kirby
MODULE - 40% PASS ON AGGREGATE
Module Type: Examination with Coursework or Project
Timetable Slot:E
Exam Paper(hrs):2

You will explore the mathematical notion of a limit and see the precise definition of the limit of a sequence of real numbers and learn how to prove that a sequence converges to a limit. After studying limits of infinite sequences, you move on to series, which capture the notion of an infinite sum. You will then learn about limits of functions and continuity. Finally, you will learn precise definitions of differentiation and integration and see the Fundamental Theorem of Calculus.

2019/0 - MTHA4006Y ALGEBRA 1

Full Year, Level 4 module
(Maximum 120 Students)
UCU: 20 Organiser: Dr Sinead Lyle
MODULE - 40% PASS ON AGGREGATE
Module Type: Examination with Coursework or Project
Timetable Slot:H

Algebra plays a key role in pure mathematics and its applications. We will provide you with a thorough introduction and develop this theory from first principles. In the first semester, you consider linear algebra and in the second semester, you move on to group theory. In the first semester, you develop the theory of matrices, mainly (though not exclusively) over the real numbers. The material covers matrix operations, linear equations, determinants, eigenvalues and eigenvectors, diagonalization and geometric aspects. You conclude with the definition of abstract vector spaces. At the heart of group theory in Semester 2 is the study of symmetry and the axiomatic development of the theory. The basic concepts are subgroups, Lagrange's theorem, factor groups, group actions and the Isomorphism Theorem.

2019/0 - MTHA4007Y COMPUTATION AND MODELLING

Full Year, Level 4 module
(Maximum 120 Students)
UCU: 20 Organiser: Professor David Stevens
MODULE - 40% PASS ON AGGREGATE
Module Type: Examination with Coursework or Project
Timetable Slot:F

Computation and modelling are essential skills for the modern mathematician. While many applied problems are amenable to analytic methods, many require some numerical computation to complete the solution. The synthesis of these two approaches can provide deep insight into highly complex mathematical ideas. This module will introduce you to the art of mathematical modelling, and train you in the computer programming skills needed to perform numerical computations. A particular focus is classical mechanics, which describes the motion of solid bodies. Central to this is Newton's second law of motion, which states that a mass will accelerate at a rate proportional to the force imposed upon it. This leads to an ordinary differential equation to be solved for the velocity and position of the mass. In the simplest cases the solution can be constructed using analytical methods, but in more complex situations, for example motion under resistance, numerical methods may be required. Iterative methods for solving nonlinear algebraic equations are fundamental and will also be studied. Further examples drawn from pure mathematics and statistics demonstrate the power of modern computational techniques.

2019/0 - MTHA5001Y ANALYSIS

Full Year, Level 5 module
(Maximum 90 Students)
UCU: 20 Organiser: Dr David Aspero
MODULE - 40% PASS ON AGGREGATE
Module Type: Examination with Coursework or Project
Timetable Slot:D
Exam Paper(hrs):3

BEFORE TAKING THIS MODULE YOU MUST TAKE MTHA4003Y

This module covers the standard basic theory of the complex plane. The areas covered in the first semester, (a), and the second semester, (b), are roughly the following: (a) Continuity, power series and how they represent functions for both real and complex variables, differentiation, holomorphic functions, Cauchy-Riemann equations, Moebius transformations. (b) Topology of the complex plane, complex integration, Cauchy and Laurent theorems, residue calculus.

2019/0 - MTHA5002Y FLUID DYNAMICS - THEORY AND COMPUTATION

Full Year, Level 5 module
(Maximum 100 Students)
UCU: 20 Organiser: Dr Mark Blyth
MODULE - 40% PASS ON AGGREGATE
Module Type: Examination with Coursework or Project
Timetable Slot:A1
Exam Paper(hrs):3

BEFORE TAKING THIS MODULE YOU MUST TAKE MTHA4005Y OR TAKE MTHA4008Y
IN TAKING THIS MODULE YOU CANNOT TAKE MTHB5006A

This module introduces some of the fundamental physical concepts and mathematical theory

needed to analyse the motion of a fluid, with the focus predominantly on inviscid, incompressible motions. You will examine methods for visualising flow fields, including the use of particle paths and streamlines. You will study the dynamical theory of fluid flow, taking Newton's laws of motion as its point of departure, and will discuss the fundamental set of equations comprising conservation of mass and Euler's equations. The reduction to Laplace's equation for irrotational flow is demonstrated, and Bernoulli's equation is derived as a first integral of the equation of motion. Having established the basic theory, the way is set for a broader discussion of flow dynamics.

2019/0 - MTHA5003Y ALGEBRA

Full Year, Level 5 module
(Maximum 90 Students)
UCU: 20 Organiser: Dr Johannes Siemons
MODULE - 40% PASS ON AGGREGATE
Module Type: Examination with Coursework or Project
Timetable Slot:G
Exam Paper(hrs):3

BEFORE TAKING THIS MODULE YOU MUST TAKE MTHA4001Y AND TAKE MTHA4002Y

We introduce groups and rings. Together with vector spaces these are the most important structures in modern algebra. At the heart of group theory in Semester I is the study of symmetry and the axiomatic development of the theory. Groups appear in many parts of mathematics. The basic concepts are subgroups, Lagrange’s theorem, factor groups, group actions and the First Isomorphism Theorem. In Semester II we introduce rings, using the Integers as a model and develop the theory with many examples related to familiar concepts such as substitution and factorisation. Important examples of commutative rings are fields, domains, polynomial rings and their quotients.

2019/0 - MTHA5004Y DIFFERENTIAL EQUATIONS AND APPLIED METHODS

Full Year, Level 5 module
(Maximum 100 Students)
UCU: 20 Organiser: Dr Paul Hammerton
MODULE - 40% PASS ON AGGREGATE
Module Type: Examination with Coursework or Project
Timetable Slot:C
Exam Paper(hrs):3

BEFORE TAKING THIS MODULE YOU MUST TAKE MTHA4005Y
IN TAKING THIS MODULE YOU CANNOT TAKE MTHB5006A

(a) Ordinary Differential Equations: solution by reduction of order; variation of parameters for inhomogeneous problems; series solution and the method of Frobenius. Legendre's and Bessel's equations: Legendre polynomials, Bessel functions and their recurrence relations; Fourier series; Partial differential equations (PDEs): heat equation, wave equation, Laplace's equation; solution by separation of variables. (b) Method of characteristics for hyperbolic

equations; the characteristic equations; Fourier transform and its use in solving linear PDEs; (c) Dynamical Systems: equilibrium points and their stability; the phase plane; theory and applications.

2019/0 - MTHA6005Y MATHEMATICS PROJECT

Full Year, Level 6 module
(Maximum 120 Students)
UCU: 20 Organiser: Dr Sinead Lyle
MODULE - 40% PASS ON AGGREGATE
Module Type: Project
Timetable Slot:UNKNOWN

IN TAKING THIS MODULE YOU CANNOT TAKE MTHA5005Y

This module is reserved for third year students who have completed an appropriate number of mathematics modules at levels 4 and 5. It is a project on a mathematical topic supervised by a member of staff within the school, or in a closely related school. The focus of the project is on independent study; you will have the opportunity to undertake research in an area which is interesting to you. You will write an in-depth report on your chosen project, in the mathematical typesetting language LaTeX. There will also be a short oral presentation.

2019/0 - MTHF5029Y TOPOLOGY AND COMPUTABILITY

Full Year, Level 5 module
(Maximum 50 Students)
UCU: 20 Organiser: Dr Vanessa Miemietz
MODULE - 40% PASS ON AGGREGATE
Module Type: Examination with Coursework or Project
Timetable Slot:TBC
Exam Paper(hrs):2

This module provides an introduction to two self-contained topics which have not been seen before. Topology: This is an introduction to point-set topology, which studies spaces up to continuous deformations and thereby generalises analysis, using only basic set theory. You will begin by defining a topological space, and will then investigate notions like open and closed sets, limit points and closure, bases of a topology, continuous maps, homeomorphisms, and subspace and product topologies. Computability: This is an introduction to the theoretical foundation of computability theory. The main question we will focus on is “which functions can in principle (i.e., given unlimited resources of space and time) be computed?”. The main object of study will be certain devices known as unlimited register machines (URM’s). We will adopt the point of view that a function is computable, if and only if, I is computable by a URM. You will identify large families of computable functions and will prove that certain naturally occurring functions are not computable.

2019/0 - MTHF5030Y INTRODUCTION TO QUANTUM MECHANICS AND SPECIAL RELATIVITY

Full Year, Level 5 module
(Maximum 50 Students)

UCU: 20 Organiser: Dr Hayder Salman

MODULE - 40% PASS ON AGGREGATE
Module Type: Examination with Coursework or Project
Timetable Slot:F1\, F2
Exam Paper(hrs):2

This module introduces you to quantum mechanics and special relativity. In quantum mechanics focus will be on: 1. Studying systems involving very short length scales – eg structure of atoms. 2. Understanding why the ideas of classical mechanics fail to describe physical effects when sub-atomic particles are involved. 3. Deriving and solving the Schrodinger equation. 4. Understanding the probabilistic interpretation of the Schrodinger equation. 5. Understanding how this equation implies that certain physical quantities such as energy do not vary continuously, but can only take on discrete values. The energy levels are said to be quantized. For special relativity, the general concept of space and time drastically changes for an observer moving at speeds close to the speed of light: for example time undergoes a dilation and space a contraction. These counterintuitive phenomena are however direct consequences of physical laws. The module will also explain the basis of Special Relativity using simple mathematics and physical intuition. Important well-known topics like inertial and non-inertial frames, the Lorentz transformations, the concept of simultaneity, time dilation and Lorentz contraction, mass and energy relation will be explained. You will end with the implications of special relativity and quantum mechanics on a relativistic theory of quantum mechanics.