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# University of Pretoria Yearbook 2022

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## BScHons *Mathematics* (02240182)

**Department** Mathematics and Applied Mathematics

**Minimum duration of study** 1 year

**Total credits** 135

**NQF level** 08

### Admission requirements

1. BSc (Mathematics) degree **or** BSc (Applied Mathematics) degree **or** relevant bachelor's degree
2. At least 60% for all mathematics and applied mathematics modules at final-year level
3. A minimum of 60% for each of the following subjects/modules (or equivalent) at final-year level:

- Real analysis
- Algebra

### Promotion to next study year

The progress of all honours candidates is monitored biannually by the postgraduate coordinator/head of department. A candidate's study may be terminated if the progress is unsatisfactory or if the candidate is unable to finish his/her studies during the prescribed period.



## Curriculum: Final year

**Minimum credits: 135**

### Stream 1: Applied analysis

Core credits: 75 credits

Elective credits: 60 credits

### Stream 2: Differential equations and modelling

Core credits: 135 credits

## Core modules

### Functional analysis 710 (WTW 710)

**Module credits** 15.00

**NQF Level** 08

**Prerequisites** Real analysis on third-year level

**Contact time** 2 lectures per week

**Language of tuition** Module is presented in English

**Department** Mathematics and Applied Mathematics

**Period of presentation** Semester 1

#### Module content

An introduction to the basic mathematical objects of linear functional analysis will be presented. These include metric spaces, Hilbert spaces and Banach spaces. Subspaces, linear operators and functionals will be discussed in detail. The fundamental theorems for normed spaces: The Hahn-Banach theorem, Banach-Steinhaus theorem, open mapping theorem and closed graph theorem. Hilbert space theory: Riesz' theorem, the basics of projections and orthonormal sets.

### Axiomatic set theory and mathematical logic 724 (WTW 724)

**Module credits** 15.00

**NQF Level** 08

**Contact time** 1 lecture per week

**Language of tuition** Module is presented in English

**Department** Mathematics and Applied Mathematics

**Period of presentation** Semester 1

#### Module content

Axiomatic set theory, ordinals, transfinite induction and recursion, ordinal arithmetic, the axiom of choice, cardinal arithmetic, the continuum hypothesis. Propositional and first order logic. The completeness and compactness theorems. Decidability, Gödel's incompleteness theorems.



## Algebra 731 (WTW 731)

<b>Module credits</b>	15.00
<b>NQF Level</b>	08
<b>Prerequisites</b>	Algebra on third-year level
<b>Contact time</b>	2 lectures per week
<b>Language of tuition</b>	Module is presented in English
<b>Department</b>	Mathematics and Applied Mathematics
<b>Period of presentation</b>	Semester 1

### Module content

The following topics will be covered: Galois theory and solving equations by radicals, introduction to the theory of R-modules, direct sums and products, projectivity and injectivity, finitely generated modules over Euclidean domains, primary factorisation, applications to Jordan and rational canonical forms of matrices.

## Measure theory and probability 734 (WTW 734)

<b>Module credits</b>	15.00
<b>NQF Level</b>	08
<b>Prerequisites</b>	Real analysis on third-year level
<b>Contact time</b>	2 lectures per week
<b>Language of tuition</b>	Module is presented in English
<b>Department</b>	Mathematics and Applied Mathematics
<b>Period of presentation</b>	Semester 1

### Module content

Measure and integration theory: The Caratheodory extension procedure for measures defined on a ring, measurable functions, integration with respect to a measure on a  $\sigma$ -ring, in particular the Lebesgue integral, convergence theorems and Fubini's theorem.

Probability theory: Measure theoretic modelling, random variables, expectation values and independence, the Borel-Cantelli lemmas, the law of large numbers.  $L^1$ -theory,  $L^2$ -theory and the geometry of Hilbert space, Fourier series and the Fourier transform as an operator on  $L^2$ , applications of Fourier analysis to random walks, the central limit theorem.

## Topology 790 (WTW 790)

<b>Module credits</b>	15.00
<b>NQF Level</b>	08
<b>Prerequisites</b>	Real analysis on third-year level
<b>Contact time</b>	2 lectures per week
<b>Language of tuition</b>	Module is presented in English
<b>Department</b>	Mathematics and Applied Mathematics



**Period of presentation** Semester 2

### Module content

General topology: Concepts such as convergence, compactness, connectedness, separation axioms and continuity are introduced in topological spaces. Their basic properties are treated. Important topologies like the product topology and the quotient topology are discussed.

Algebraic topology: Homotopy, the fundamental group, covering spaces, homotopy type.

## Project 795 (WTW 795)

**Module credits** 30.00

**NQF Level** 08

**Prerequisites** No prerequisites.

**Language of tuition** Module is presented in English

**Department** Mathematics and Applied Mathematics

**Period of presentation** Year

### Module content

Consult Department.

## Elective modules

### Special topics 727 (WTW 727)

**Module credits** 15.00

**NQF Level** 08

**Prerequisites** As required by specific topical content.

**Contact time** 1 lecture per week

**Language of tuition** Module is presented in English

**Department** Mathematics and Applied Mathematics

**Period of presentation** Semester 2

### Module content

A selection of special topics will be presented that reflects the expertise of researchers in the Department. The presentation of a specific topic is contingent on student numbers. Consult the website of the Department of Mathematics and Applied Mathematics for more details.

### Numerical analysis 733 (WTW 733)

**Module credits** 15.00

**NQF Level** 08

**Prerequisites** No prerequisites.

**Contact time** 2 lectures per week



**Language of tuition** Module is presented in English

**Department** Mathematics and Applied Mathematics

**Period of presentation** Semester 1

### Module content

An analysis as well as an implementation (including computer programs) of methods are covered. Numerical linear algebra: Direct and iterative methods for linear systems and matrix eigenvalue problems: Iterative methods for nonlinear systems of equations. Finite difference method for partial differential equations: Linear elliptic, parabolic, hyperbolic and eigenvalue problems. Introduction to nonlinear problems. Numerical stability, error estimates and convergence are dealt with.

## Finite element method 763 (WTW 763)

**Module credits** 15.00

**NQF Level** 08

**Prerequisites** WTW 733 is strongly recommended

**Contact time** 2 lectures per week

**Language of tuition** Module is presented in English

**Department** Mathematics and Applied Mathematics

**Period of presentation** Semester 2

### Module content

An analysis as well as an implementation (including computer programs) of methods is covered. Introduction to the theory of Sobolev spaces. Variational and weak formulation of elliptic, parabolic, hyperbolic and eigenvalue problems. Finite element approximation of problems in variational form, interpolation theory in Sobolev spaces, convergence and error estimates.

## Stochastic calculus 764 (WTW 764)

**Module credits** 15.00

**NQF Level** 08

**Prerequisites** WTW 734 or WTW 735

**Contact time** 2 lectures per week

**Language of tuition** Module is presented in English

**Department** Mathematics and Applied Mathematics

**Period of presentation** Semester 2

### Module content

Mathematical modelling of Random walk. Conditional expectation and Martingales. Brownian motion and other Lévy processes. Stochastic integration. Ito's Lemma. Stochastic differential equations. Application to finance.

## Mathematical methods and models 772 (WTW 772)



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<b>Module credits</b>	15.00
<b>NQF Level</b>	08
<b>Prerequisites</b>	No prerequisites.
<b>Contact time</b>	2 lectures per week
<b>Language of tuition</b>	Module is presented in English
<b>Department</b>	Mathematics and Applied Mathematics
<b>Period of presentation</b>	Semester 2

### Module content

This module aims at using advanced undergraduate mathematics and rigorously applying mathematical methods to concrete problems in various areas of natural science and engineering. The module will be taught by several lecturers from UP, industry and public sector. The content of the module may vary from year to year and is determined by relevant focus areas within the Department. The list of areas from which topics to be covered will be selected, includes: Systems of differential equations; dynamical systems; discrete structures; Fourier analysis; methods of optimisation; numerical methods; mathematical models in biology, finance, physics, etc.

## Partial differential equations of mathematical physics 776 (WTW 776)

<b>Module credits</b>	15.00
<b>NQF Level</b>	08
<b>Prerequisites</b>	WTW 710 or WTW 735
<b>Contact time</b>	2 lectures per week
<b>Language of tuition</b>	Module is presented in English
<b>Department</b>	Mathematics and Applied Mathematics
<b>Period of presentation</b>	Semester 2

### Module content

Field-theoretic and material models of mathematical physics. The Friedrichs-Sobolev spaces. Energy methods and Hilbert spaces, weak solutions - existence and uniqueness. Separation of variables, Laplace transform, eigenvalue problems and eigenfunction expansions. The regularity theorems for elliptic forms (without proofs) and their applications. Weak solutions for the heat/diffusion and related equations.

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The regulations and rules for the degrees published here are subject to change and may be amended after the publication of this information.

The [General Academic Regulations \(G Regulations\)](#) and [General Student Rules](#) apply to all faculties and registered students of the University, as well as all prospective students who have accepted an offer of a place at the University of Pretoria. On registering for a programme, the student bears the responsibility of ensuring that they familiarise themselves with the General Academic Regulations applicable to their registration, as well as the relevant faculty-specific and programme-specific regulations and information as stipulated in the relevant yearbook. Ignorance concerning these regulations will not



be accepted as an excuse for any transgression, or basis for an exception to any of the aforementioned regulations.