University of Pretoria
Department of Mathematics and Applied Mathematics
Postgraduate Study Programme 2013

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1. General

Postgraduate study and research constitute one of the highest priorities in the Department. These activities are performed within the following highly relevant areas (which are further described in section 5).

Main research focus areas

- Partial differential equations, their numerical analysis and mathematical modelling
- Abstract analysis, topology and applications

Other research areas

- Discrete mathematics
- Undergraduate Mathematics teaching

1.1 Vision and mission

VISION

The Department of Mathematics and Applied Mathematics strives to be internationally recognised for academic excellence through the depth of its research and teaching, and to be locally relevant through its role in the development of the community it serves.

MISSION

The Department is an academic unit of the University of Pretoria, entrusted with the development of mathematical skills, knowledge and insights. Its mission is to

- be actively, visibly and notably involved in research at the forefront of the mathematical fields in which it has strength and expertise
- offer postgraduate training, up to doctoral and postdoctoral level, in its chosen fields of research expertise
- at undergraduate and honours level, engage in mathematical training in support of its own and other academic programmes of the University

Through its activities, the Department intends to

- contribute to the deep understanding of complex mathematical structures and their applications
- deliver graduates with considerable mathematical skills and the desire to be involved in problem solving
- intellectually and materially enhance the community and South African society by its relevant research outputs and involvement in projects that depend on its mathematical expertise

1.2 Seminars and Colloquia

All postgraduate students are encouraged to attend the ongoing research seminars and colloquia within the department. Schedules for these are found on the departmental as well as postgraduate notice boards.

1.3 Contact details

1.3.1 Department of Mathematics and Applied Mathematics

- Web address:
  http://www.up.ac.za/maths/postgrad click on "Postgraduate Brochure in PDF format" for the latest version of this postgraduate brochure as well as on the other links for information.

- Prof M Sango
  Coordinator: Postgraduate and Research Committee
  e-mail address: mamadou.sango@up.ac.za

- Mrs Y McDermot
  Head: Academic and Research Administration
  e-mail address: yvonne.mcdermot@up.ac.za

1.3.2 Faculty of Natural and Agricultural Sciences

- Contact person for Honours studies:

  Mrs Daleen Hartmann
  e-mail address: daleen.hartmann@up.ac.za

- Contact person for Master's and Doctoral studies:

  Mrs Cathy Barnard
  e-mail address: cathy.barnard@up.ac.za

Also refer to the Regulations and Syllabi (Postgraduate) of the Faculty of Natural and Agricultural Sciences, available on the University's homepage as well as from the Faculty Administration (contact persons as mentioned above).

2. Honours study

The Department of Mathematics and Applied Mathematics offers Honours degrees in the following four study fields: Mathematics, Applied Mathematics, Mathematics of Finance and Financial Engineering.

The Honours programme consists of a number of modules and an essay or project (see point 2.2).

2.1 Admission Criteria

2.1.1 General

An appropriate Bachelor's degree with a minimum of 60% for each Mathematics/Applied Mathematics module on third year level is required for admission to Honours study in Mathematics, Applied Mathematics and Mathematics of Finance. In the case of Honours study in Financial Engineering, an appropriate Bachelor's degree with a minimum of 60% for all modules on third year level is required for admission.

In all cases, the candidate's complete undergraduate academic record will be considered in the selection procedure. In particular, it is required that the candidate has a mark of **at least 60%** in each of the modules listed in point 2.1.2 for the specific programmes.

The progress of all Honours candidates is monitored biannually by the Postgraduate Coordinator. 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.

2.1.2 Specific admission requirements

Admission is subject to **specific requirements** for the respective programmes. A candidate should have done the listed subjects and obtained a mark of at least 60%:

1. **Mathematics** (degree code 02240181)
   Specific requirements: Real Analysis and Algebra on third year level.

2. **Applied Mathematics** (degree code 02240171)
   Specific requirements: Real Analysis on third year level and at least one of the subjects listed below on third year level:
   Partial differential equations, Ordinary differential equations or Numerical analysis.

3. **Mathematics of Finance** (degree code 02240272)
   Specific requirements: Real Analysis on third year level and Linear Algebra on second year level.

4. **Financial Engineering** (degree code 02240274)
   Specific requirements: Calculus, Differential Equations and Linear Algebra on second year level.

2.2 Composition of Honours Programmes

2.2.1 BSc Honours in Mathematics

Seven honours modules of 20 credits each (six compulsory and one elective) as well as the mandatory essay (20 credits).

Mathematics

Module	Code	Credits	Semester
Compulsory:			
Algebra	WTW 731	20	1
Functional Analysis	WTW 710	20	1
Measure Theory and Probability	WTW 734	20	1
Topology	WTW 790	20	2
Partial Differential Equations of Mathematical Physics	WTW 776	20	2
Mathematical Methods and Models	WTW 772	20	1
Essay	WTW 795	20	
Electives:			
Numerical Analysis	WTW 733	20	1
Finite Element Method	WTW 763	20	2
Stochastic Calculus	WTW 764	20	2
A **total** of at least **160 credits** is required.			

2.2.2 BSc Honours in Applied Mathematics

Seven honours modules of 20 credits each (six compulsory and one elective) as well as the mandatory essay (20 credits).

Applied Mathematics

Module	Code	Credits	Semester
Compulsory:			
Functional Analysis	WTW 710	20	1
Numerical Analysis	WTW 733	20	1
Measure Theory and Probability	WTW 734	20	1
Finite Element Method	WTW 763	20	2
Mathematical Methods and Models	WTW 772	20	1
Essay	WTW 795	20	
Electives:			
Continuum Mechanics	WTW 787	20	2
Stochastic Calculus	WTW 764	20	2
Mathematical Optimisation	WTW 750	20	1
Partial Differential Equations of Mathematical Physics	WTW 776	20	2
A **total** of at least **160 credits** is required.			

2.2.3 BSc Honours in Mathematics of Finance

Seven honours modules of 20 credits each (six compulsory and one elective) as well as the mandatory essay (20 credits).

Mathematics of Finance

Module	Code	Credits	Semester
Compulsory:			
Functional Analysis	WTW 710	20	1
Mathematical Models of Financial Engineering*	WTW 732*	20	1
Mathematical Models of Financial Engineering*	WTW 762	20	2
Measure Theory and Probability	WTW 734	20	1
Numerical Analysis	WTW 733	20	1
Stochastic Calculus	WTW 764	20	2
Essay **or** Project	WTW 795 **or** WTW 792	20	
Electives:			
Partial Differential Equations of Mathematical Physics	WTW 776	20	2
Mathematical Methods and Models	WTW 772	20	1
Finite Element Method	WTW 763	20	2
Mathematical Optimisation	WTW 750	20	1
Linear Models	LMO 710	20	1
Linear Models	LMO 720	20	2
Multivariate Analysis	MVA 710	20	1
Multivariate Analysis	MVA 720	20	2
A **total** of at least **160 credits** is required.			

*: Please note that WTW 732 and WTW 762 are compulsory modules for this study programme and that the lectures will be presented as follows:

> Weekly lectures as well as some extra “block” lectures, as will be arranged by the lecturer – also see the timetables provided at the first meeting (11 February 2013) for particulars.

2.2.4 BSc Honours in Financial Engineering

A number of compulsory and elective modules of 16 – 20 credits each of the Mathematics Department, the Engineering Faculty, etc. are offered as well as the mandatory project (20 credits).

Financial Engineering

Module	Code	Credits	Semester
***Compulsory**:*			
Industrial Analysis[1,2]	BAN 780	16	1
Operations Research[2]	BOZ 780	16	2
Mathematical Optimisation	WTW 750	20	1
Mathematical models of financial engineering*	WTW 732	20	1
Mathematical models of financial engineering*	WTW 762	20	2
Project	WTW 792	20	
Electives:			
Investment Management	BLB 780	20	1
Systems Engineering[2]	ISE 780	16	1
Modern Portfolio Theory	WTW 712	20	year
Numerical Analysis	WTW 733	20	1
Finite Element Method	WTW 763	20	2
Linear Models	LMO 710	20	1
Linear Models	LMO 720	20	2
Multivariate Analysis	MVA 710	20	1
Multivariate Analysis	MVA 720	20	2
Any postgraduate module from this or any other department ***as approved*** *by the Postgraduate Coordinator*			
A **total** of at least **160 credits** is required.			

The Postgraduate Coordinator has to approve the final programme composition for this programme.

[1] Students who have included Statistics, Mathematical Statistics or Industrial Engineering in their undergraduate degree programme, will not be allowed to take this module. Additional modules from the list of electives should be included in the programme composition.

[2] Lectures for these modules are scheduled in "blocks" – consult the relevant departments at the Faculty of Engineering, Built Environment and Information Technology as well as the timetables provided at the first meeting of honours students on 11 February 2013.

*: Please note that WTW 732 and WTW 762 are compulsory modules for this study programme and that the lectures will be presented as follows:

> Weekly lectures as well as some extra "block" lectures, as will be arranged by the lecturer – also see the timetables provided at the first meeting (11 February 2013) for particulars.

2.3 First Meeting and Module Schedules

The schedule for the first semester will be finalised during a meeting of honours students and their lecturers on the date indicated below. Lectures for honours modules in the department will normally be scheduled to begin at 17:00 or 17:30 during the week.

FIRST SEMESTER:
Monday, 11 February 2013 at 17:30 in room 2-1, Mathematics Building
SECOND SEMESTER:
Lectures will start on Monday, 22 July 2013 and registered honours students will be notified by e-mail about the timetable arrangements.

2.4 Examination Schedules

First semester examinations will take place in June and second semester examinations in November/December of each year.

2.5 Period of Study

A period of two years is allowed from the first examination to the final examination. Exceptions to this rule are only allowed following permission by the Dean of the Faculty via the Head of Department (see regulations G18, G22 and Sc 12). The duration of the studies for all the BSc (Honours) degrees in this Department is normally one year for full-time, and two years for part-time students.

2.6 Essay and Project

A candidate must finalise the arrangements for his/her essay/project with the postgraduate programme coordinator and submit a proposal in the format and on a date that will be given on the UP student portal (on ClickUP) for all candidates registered for the honours essay WTW 795 and the honours project WTW 792.

Candidates are advised to start on the essay/project as soon as possible. This essay/project must be completed during the study period and submitted in original typed form. A candidate must give a departmental talk on his/her essay/project and satisfactorily answer questions on the contents.

The essay/project must be submitted in typed form before or on the following dates:

For the autumn graduation ceremony:	30 November
For the spring graduation ceremony:	31 May

A departmental seminar on the essay/project must be presented before or on the following dates:

For the autumn graduation ceremony:	6 December
For the spring graduation ceremony:	30 June

Since the essay/project will be evaluated by an external examiner, the candidate must

adhere strictly to the above-mentioned dates.
After the departmental seminar the candidate must supply the department with an electronic copy of the essay/project, i.e. on a CD or by e-mail.

2.6.1 Aims of the Honours Essay

1. The candidate should be able to master a part of Mathematics on his/her own.
2. The candidate should be able to write a rigorous report on some aspect of Mathematics.
3. The candidate should expand his/her knowledge of the subject.
4. The candidate must show that he/she is able to present a talk on Mathematics by presenting a departmental seminar on the contents of his/her essay.

2.6.2 Evaluation of the Essay

1. Proofs must be complete.

   The candidate must show that he/she has mastered the field of his/her essay and that results have not merely been copied from the literature.
2. The results must be presented rigorously. Notation must be uniform and language usage must be of a high standard.

2.6.3 Aims of the Honours Project

1. The candidate should be able to investigate a problem from the financial industry and apply the necessary mathematics to analyse and/or solve the problem.
2. The candidate should be able to write a rigorous report on the project.
3. The candidate should expand his/her knowledge of the subject.
4. The candidate must show that he/she is able to present a talk on Mathematics in the financial world by presenting a departmental seminar on the contents of his/her project.

2.6.4 Evaluation of the Project

1. The candidate must show that he/she can apply mathematics to financial problems and interpret the results.
2. The results and proofs (where relevant) must be presented rigorously. Notation must be uniform and language usage must be of a high standard.

2.7 Modules presented by the Department of Mathematics and Applied Mathematics

2.7.1 Prerequisites

Module	Code	Credits	Semester	Prerequisites
Functional Analysis	WTW 710	20	1	Analysis WTW 310
Modern Portfolio Theory	WTW 712	20	year	Admissions test could be required / enrolment for WTW 732 required
Algebra	WTW 731	20	1	Algebra WTW 381
Mathematical Models of Financial Engineering	WTW 732	20	1	
Numerical Analysis	WTW 733	20	1	
Measure Theory and Probability	WTW 734	20	1	Analysis WTW 310
Mathematical Models of Financial Engineering	WTW 762	20	2	WTW 732 or Financial Engineering WTW 364
Finite Element Method	WTW 763	20	2	WTW 733 is strongly recommended
Stochastic Calculus	WTW 764	20	2	WTW 734
Mathematical Methods and Models	WTW 772	20	1	Analysis WTW 310
Partial Differential Equations of Mathematical Physics	WTW 776	20	2	WTW 710 and WTW 734
Continuum Mechanics	WTW 787	20	2	
Topology	WTW 790	20	2	Analysis WTW 310
Mathematical Optimisation	WTW 750	20	1	Multivariate Calculus and Linear Algebra; both on 2nd year level

2.7.2 Module descriptions

(WTW 710) Functional Analysis 710 (20 credits)
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.

Textbook:
(Prescribed) Erwin Kreyszig: Introductory Functional Analysis with Applications (Wiley, 1989)

(WTW 712) Modern Portfolio Theory 712 (20 credits)
Introduction to Markowitz portfolio theory and the capital asset pricing model. Analysis of the deficiencies in these methods. Sensitivity based risk management. Standard methods

for Value-at-Risk calculations. RiskMetrics, delta-normal methods, Monte Carlo simulations, back and stress testing**.**

Textbook:
(Recommended) JC Hull: Options, Futures, and other Derivatives, 8th ed. (Pearson Education, 2012)

(WTW 731) Algebra 731 (20 credits)
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 Euclidian domains, primary factorization, applications to Jordan and rational canonical forms of matrices.

(WTW 732) Mathematical Models of Financial Engineering 732 (20 credits)
Introduction to markets and instruments, Futures and options trading strategies, exotic options, arbitrage relationships, binomial option pricing method, mean variance hedging, volatility and the Greeks, volatility smiles, Black-Scholes PDE and solutions, derivative disasters.

Textbook:
(Recommended) JC Hull: Options, Futures, and other Derivatives, 8th ed. (Pearson Education, 2012)

(WTW 733) Numerical Analysis 733 (20 credits)
An analysis as well as an implementation (including computer programmes) 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.

Textbooks:
(Recommended) JC Strikwerda: Finite Difference Schemes and Partial Differential Equations, 2nd ed. (SIAM, 2004)
(Recommended) RL Burden & JD Faires: Numerical Analysis, 9th ed. (ISE) (Cengage Learning, 2011)

(WTW 734) Measure Theory and Probability 734 (20 credits)
Measure and integration theory:
The Caratheodory extension procedure for measures defined on a ring, measurable functions, integration with respect to a measure on a σ-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.

Textbooks:

(Prescribed) G de Barra: Measure Theory and Integration, 2nd ed. (Woodhead Publishing, 2003)
(Recommended) M Capinsky & PE Kopp: Measure, Integral and Probability, 2nd ed. (Springer - SUMS, 2004)

(WTW 750) Mathematical Optimisation 750 (20 credits)

Classical optimisation: Necessary and sufficient conditions for local minima. Equality constraints and Lagrange multipliers. Inequality constraints and the Kuhn-Tucker conditions. Application of saddle point theorems to the solutions of the dual problem. One dimensional search techniques. Gradient methods for unconstrained optimisation. Quadratically terminating search algorithms. The conjugate gradient method. Fletcher-Reeves. Second order variable metric methods: DFP and BFGS. Boundary following and penalty function methods for constrained problems. Modern multiplier methods and sequential quadratic programming (SQP) methods. Practical design optimisation project.

Textbook:
(Prescribed) W Frost & D Hoffmann: Optimization – Theory and Practice (Springer, 2010)

(WTW 762) Mathematical Models of Financial Engineering 762 (20 credits)

Exotic options, arbitrage relationships, Black-Scholes PDE and solutions, hedging and the Miller-Modigliani theory, static hedging, numerical methods, interest rate derivatives, BDT model, Vasicek and Hull-White models, complete markets, stochastic differential equations, equivalent Martingale measures.

Textbooks:
(Recommended) JC Hull: Options, Futures, and other Derivatives, 8th ed. (Pearson Education, 2012)
(Recommended) T Björk: Arbitrage theory in continuous time, 2nd ed. (Oxford Univ Press, 2004)

(WTW 763) Finite Element Method 763 (20 credits)

An analysis as well as an implementation (including computer programmes) 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.

(WTW 764) Stochastic Calculus 764 (20 credits)

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.

Textbook:
(Prescribed) Z Brzeźniak & T Zastawniak: Basic Stochastic Processes (Springer, 1999)

(WTW 772) Mathematical Methods and Models 772 (20 credits)

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. 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 optimization; numerical methods; mathematical models in biology, finance, physics, etc.

(WTW 776) Partial Differential Equations of Mathematical Physics 776 (20 credits)

Field-theoretic and material models of mathematical physics. Distributions and the Friedrichs-Sobolev spaces. Energy methods and Hilbert spaces, weak solutions – existence and uniqueness. 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. Weak solutions for wave propagation problems written as symmetric-hyperbolic systems.

(WTW 787) Continuum Mechanics 787 (20 credits)

Analysis of spatial versus material description of motion. Conservation laws. Derivation of stress tensors. Analysis of finite strain and rate of deformation tensors. Stress and strain invariants. Energy. Linear and nonlinear constitutive equations. Applications to boundary value problems in elasticity and fluid mechanics.

(WTW 790) Topology 790 (20 credits)

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.

Textbook:
(Prescribed) JR Munkres: Topology, 2nd ed. (Prentice Hall, 2000)

2.8 Modules presented by other Departments

(BAN 780) Industrial Analysis 780 (16 credits)
Department of Industrial & Systems Engineering

To introduce the student to the problem-solving cycle as supported by mathematical statistics, simulation modelling and operations research.
It is an introduction to: Simulation Modelling; Operations Research.

Prerequisites: Not for Industrial Engineering students

(BLB 780) Investment Management 780 (20 credits)
Department of Financial Management

Portfolio theory, equilibrium in capital markets, fixed income securities, security analysis, active portfolio management.

(BOZ 780) Operations Research 780 (16 credits)
Department of Industrial & Systems Engineering

Applied mathematical programming and optimisation. Special topics such as: Expert systems, Decision analysis, Forecasting, Genetic algorithms, ARIMA-modelling.

(ISE 780) Systems Engineering 780 (16 credits)
Department of Engineering & Technology Management

Management of the engineering effort required to bring new products and systems into being. Top-down approach:
Needs analysis to synthesis and design specification. Conceptualisation to detail design. Total system to component requirements. Prototype to production. The holistic approach considers design for aspects such as reliability, serviceability, user friendliness, producibility and affordability.

(LMO 710) Linear Models 710 (20 credits)
Department of Statistics

Projection matrices and sums of squares of linear sets. Estimation and the Gauss-Markov theorem. Generalised t- and F-tests.

Prerequisites: WST 311, WST 312, WST 321, WST 322

(LMO 720) Linear Models 720 (20 credits)
Department of Statistics

The singular normal distribution. Distributions of quadratic forms. The general linear model. Multiple comparison. Analysis of covariance. Generalized linear models. Analysis of categorical data.

Prerequisite: LMO 710 GS

(MVA 710) Multivariate Analysis 710 (20 credits)
Department of Statistics

Matrix algebra. Multivariate distributions. Samples from multivariate normal populations. The Wishart distribution. Hotelling's T^2 statistic. Inferences about mean vectors.

Prerequisites: WST 311, WST 312, WST 321, WST 322

(MVA 720) Multivariate Analysis 720 (20 credits)
Department of Statistics

The matrix normal distribution, correlation structures and inference of covariance matrices. Principal component analysis, factor analysis, discriminant analysis.

Prerequisites: MVA 710 GS

Abbreviation: GS - a final mark of at least 40%

3. Master’s study

The Department of Mathematics and Applied Mathematics offers MSc degrees in the following five study fields: Mathematics, Applied Mathematics, Mathematics of Finance, Financial Engineering, Mathematics Education.

The Master’s study consists of course work and a dissertation (see point 3.2).

The dissertation should demonstrate to an examination panel that the student has the ability to plan, initiate, carry out and report on a scientific investigation. A draft article for a reputable journal or conference should also be prepared towards the end of the research period. The main research focus areas in which a Master’s degree can be obtained, are described in the Section “Research Areas”.

3.1 Admission Criteria

3.1.1 General

An appropriate Honours degree is required for admission to Master’s study with at least 60% in each paper of the Honours examination. In the selection procedure the candidate’s complete undergraduate and Honours academic records will be considered.

In particular, admission is subject to **further requirements** for the specific programmes as listed in point 3.1.2 for the specific programmes.

Furthermore, the availability of a **suitable supervisor** for the study is essential for admission.

The Supervisor and Postgraduate Coordinator monitor the progress of each Master’s candidate. They may suspend the studies if the student does not progress satisfactorily or if the candidate is unable to finish his/her studies during the prescribed period.

3.1.2 Further admission requirements

Admission is subject to **further requirements** for the specific programmes. A candidate should have a mark of at least 60% in each of the listed honours modules:

1. **Mathematics** (degree code 02250181)
   Specific requirements: The following modules on Honours level should be included: Measure and Integration Theory, Functional Analysis, Topology and Algebra.

2. **Applied Mathematics** (degree code 02250171)
   Specific requirements: The following modules on Honours level should be included: Measure and Integration Theory, Functional Analysis, Partial Differential Equations and Numerical Analysis.

3. **Mathematics of Finance** (degree code 02250182)
   Specific requirements: The following modules on Honours level should be included: Measure and Integration Theory, Functional Analysis and Financial Mathematics / Financial Engineering.

4. **Financial Engineering** (degree code 02250184)
   Specific requirements: A BSc (Hons) degree in Financial Engineering (or an equivalent qualification), with a minimum of 60% for all modules on Honours level.

5. **Mathematics Education** (degree code 02250183)
   Specific requirements: An appropriate Honours degree with at least 60% in each paper of the Honours examination is required.

3.2 Composition of Master's Programmes

3.2.1 General composition

MSc in Mathematics, Applied Mathematics, Mathematics of Finance or Financial Engineering

The programme compilation of each of these four degrees consists of three Master's modules of 40 credits each (as approved by the Postgraduate Coordinator) as well as a dissertation (120 credits).

Thus these four Master's degrees each consists of

- 50% of research work, i.e. dissertation

  and

- 50% of course work, i.e. three Master's modules

MSc in Mathematics Education

The programme compilation consists of three Master's modules from the Education Faculty (totalling 43 credits), two Master's modules from the Department of Mathematics and Applied Mathematics (totalling 80 credits) as well as a dissertation (120 credits). The compilation of the modules should be approved by the Supervisor and the Postgraduate Coordinator.

Thus this Master's degree consists of:

- 50% of research work, i.e. dissertation

  and

- 50% of course work, i.e. two Master's modules (totalling 80 credits) from the Mathematics Department and three modules (totalling 43 credits) from the Education Faculty.

3.2.2 MSc in Mathematics or in Applied Mathematics

Course work entails three modules chosen in consultation with the Head of the Department and/or the Postgraduate Committee and subject to the approval of the Supervisor (120 credits).

See point 3.4. for the list of modules

Dissertation (120 credits):

- WIS 890 (Dissertation Mathematics) /
- TWS 890 (Dissertation Applied Mathematics)

A total of at least 240 credits is required.

3.2.3 MSc in Mathematics of Finance

Course work entails three modules (40 credits each, totalling 120 credits):

- WTW 831 (Mathematical and Computational Finance) (compulsory)

Two other Master's modules chosen in consultation with the Head of the Department and/or the Postgraduate Committee and subject to the approval of the Supervisor:

- WTW 881 (Abstract Analysis) (preferably)
- WTW 884 (Advanced Measure Theory) (preferably)

Dissertation (120 credits):

- WTW 892 (Dissertation Mathematics of Finance)

A total of at least 240 credits is required.

3.2.4 MSc in Financial Engineering

Course work entails the following three compulsory modules (40 credits each, totalling 120 credits):

- WTW 831 (Mathematical and Computational Finance)
- WTW 832 (Advanced Methods of Financial Engineering)
- WTW 833 (Quantitative Risk Management)

Dissertation (120 credits):

- WTW 894 (Dissertation Financial Engineering)

A total of at least 240 credits is required.

3.2.5 MSc in Mathematics Education

Course work entails the following (120 credits):

- Two Mathematics modules on Master's level, as approved by the supervisor (see point 3.4) (total 80 credits)
- Three modules from the Centre for Mathematics, Science and Technology Education of the Faculty of Education (confirm semester indication with them) (total 43 credits):
    - NMQ 810 (Research Methodology) (15 credits)
    - NMQ 725 (Introduction to Quantitative Research) (12 credits)
    - MCE 730 (Mathematics Education) (16 credits)

Dissertation (120 credits):

- WTW 893 (Dissertation Mathematics Education)

A total of at least 240 credits is required.

3.3 Module Schedules

The schedule for each semester will be finalised in the beginning of each semester. Please contact the department (see point 1.3) or consult the postgraduate homepage about the availability of these master's modules in a particular year as well as the semester indication of the presentation.

3.4 Master's Modules

Please note: Modules presented in a particular year are only known at the beginning of each semester of a particular year. Please consult the postgraduate webpage of the Department. Not all modules are presented every year. Please make sure that you meet the prerequisites.

Module	Code	Credits	Semester	Prerequisites
Abstract Analysis	WTW 881	40	1	Measure Theory and Functional Analysis on honours level
Advanced Measure Theory	WTW 884	40	2	Measure Theory and Functional Analysis on honours level
Sobolev Spaces	WTW 880	40	1	Measure Theory, Differential Equations and Functional Analysis on honours level
Mathematical and Computational Finance	WTW 831	40	1+2	Financial Engineering on honours level
Advanced Methods of Financial Engineering	WTW 832	40	1+2	Financial Engineering on honours level
Quantitative Risk Management	WTW 833	40	1+2	Financial Engineering on honours level
Convergence Spaces	WTW 812	40		Topology, Functional Analysis and Measure Theory on honours level
Homogenisation of Partial Differential Equations	WTW 836	40		Functional Analysis, Measure Theory and Partial Differential Equations on honours level
Special Functions and Approximation Theory	WTW 840	40		Complex Analysis at 3rd year level; Advanced Calculus and Ordinary Differential Equations
Stochastic Partial Differential Equations	WTW 846	40		Functional Analysis, Measure Theory and Partial Differential

				Equations on honours level. Knowledge of Probability Theory is advised but not required
Mathematical Epidemiology	WTW 850	40		Dynamical Systems and Ordinary Differential Equations (ODEs)
Introduction to Categories and Sheaves	WTW 851	40		Algebra at 3rd year and honours levels
Lattice Theory	WTW 855	40		Algebra on 3rd year level
Finite Element Analysis	WTW 863	40	2	Finite Element Method and Functional Analysis on honours level
Graph Theory	WTW 865	40		Discrete Structures on 3rd year level
Hyperbolic Systems of Partial Differential Equations	WTW 866	40		Partial Differential Equations at 3rd year and honours levels; Advanced Calculus and Linear Algebra
Differential Geometry	WTW 869	40		Linear Algebra, Differential and Integral Calculus and Partial Differential Equations on honours level
Dynamical Systems	WTW 887	40	1	Functional Analysis, Partial Differential Equations and Finite Element Method on honours level
Special Topics in Mathematics	WTW 888	40		Supervisor will determine

3.5 Module Descriptions

(WTW 881) Abstract Analysis 881 (40 credits)
Capita selecta from the following: Duality theory. Weak and Weak* topologies. The Krein-Milman theorem. The Stone-Weierstrass theorem. Fixed point theorems. Banach Algebras and the Gelfand transform. C*-algebras and their representations. Semigroups of operators. Functional analysis applied to probability theory and stochastics.

Textbook: JB Conway: A course in functional analysis - Graduate texts in Mathematics: 96 (Springer, 1985)

Prerequisites: Measure Theory and Functional Analysis on honours level.

(WTW 884) Advanced Measure Theory 884 (40 credits)
Lebesgue integral in a general measure space: Basic properties, convergence theorems, convergence in measure. L^p spaces: Completeness, approximation by continuous functions. Complex measures: Absolute continuity, Random-Nikodym Theorem,

representation of bounded linear functionals on L^p, Riesz Representation Theorem for bounded linear functionals on $C_0(X)$, where X is a locally compact Hausdorff space. Applications to probability.

Textbook: W Rudin: Real and complex analysis, 2nd ed. (McGraw-Hill, 1974)

Prerequisites: Measure Theory and Functional Analysis on honours level.

(WTW 880) Sobolev Spaces 880 (40 credits)

The module focuses on the Hilbertion Sobolev spaces as well as to their applications to elliptic boundary value problems. Topics to be discussed include: Distributions; The Sobolev space $H^m(\Omega)$; Duality: The Sobolev space $H^{-m}(\Omega)$; Traces: The Sobolev spaces $H^{m-½}(\Gamma)$ and $H^{-½}(\Gamma)$; Embeddings of $H^m(\Omega)$; Boundary value problems.

Prerequisites: Measure Theory, Differential Equations and Functional Analysis on honours level.

(WTW 831) Mathematical and Computational Finance 831 (40 credits)

Stochastic Calculus: Multidimensional Itô formula, correlated Wiener processes, the infinitesimal operator, SDE's, PDE's, the Kolmogorov equations, martingales, stochastic integral representations and Gisanov's theorem. The martingale approach to arbitrage theory. Bonds and interest rates: Martingale models, standard models, the Heath-Jarrow-Morton framework. Monte Carlo methods. Finite difference methods.

Textbook: T Björk: Arbitrage theory in continuous time, 2nd ed. (Oxford Univ Press, 2004)

(WTW 832) Advanced Methods of Financial Engineering 832 (40 credits)

Interest rate derivatives. Stochastic volatility models. Models to improve on the flaws in the Black-Scholes model. Principles of deal structuring. Principles of mathematical models. Specialized methods for interest rate and exotic derivatives. Application of numerical methods to relevant practical problems.

(WTW 833) Quantitative Risk Management 833 (40 credits)

Risk in perspective. Traditional RiskMetrics. Methods to calculate VaR. Designing scenario analysis and stress analysis. Risk measures based on loss distributions. Aggregate risk measures which include coherent risk measures. Extreme value theory. Correlation, copulas and dependence. Credit risk management.

(WTW 812) Convergence spaces 812 (40 credits)

Filters. Convergence of filters, sequences and nets in a topological space. Convergence structures, basic properties and constructs. Continuous convergence, c-embedded convergence spaces. Order convergence on lattices and posets. Convergence vector spaces and completions. Continuous convergence and duality on locally convex spaces. The Hahn-Banach theorem in convergence spaces.

Textbook: R Beatie & H-P Butzmann: Convergence Structures and Applications to Functional Analysis (Kluwer, 2002)

Prerequisites: Topology, Functional Analysis and Measure Theory on honours level.

(WTW 836) Homogenization of partial differential equations 836 (40

credits)
Review of functional analysis, Sobolev spaces and variational problems; rapidly oscillating functions; periodic composite materials; homogenization of elliptic problems; multiple scale method; two-scale convergence and applications.

Prerequisites: Functional Analysis, Measure Theory and Partial Differential Equations on honours level.

(WTW 840) Special functions and approximation theory 840 (40 credits)
The Gamma and Beta functions, the hypergeometric function, orthogonal polynomials and their properties, classical orthogonal polynomials such as Chebychev, Hermite, Laguerre, Ultraspherical and Jacobi polynomials, Padé approximation, applications of zeros of orthogonal polynomials to convergence of Padé approximants.

Prerequisites: Complex Analysis at 3rd year level; Advanced Calculus and Ordinary Differential Equations (ODEs).

(WTW 846) Stochastic partial differential equations 846 (40 credits)
Generalities on probability theory (random variables, conditional expectations); Martingales; stochastic integrals; Markov processes; existence and uniqueness results for ordinary stochastic differential equations; Sobolev spaces, Aubin-Dubinsky-Simon compactness theorem; convergence of probability measures: Prokhorov and Skorokhod theorems; existence and uniqueness of solutions of stochastic parabolic equations in divergence form: The Galerkin scheme; idea of renormalization group theory in turbulent flows modelled by Navier-Stokes equations with random forcing.

Prerequisites: Functional Analysis, Measure Theory and Partial Differential Equations on honours level. Knowledge of Probability Theory is advised but not required.

(WTW 850) Mathematical epidemiology 850 (40 credits)
The spread of infections is modelled via dynamical systems defined by sets of differential equations. Compartmental models of the spread of contagious infection (e.g. MSEIR) and models of vector borne diseases are considered. Methods of analysis of the local and global asymptotic stability of the disease free and endemic equilibria and their characterization in terms of the basic reproduction number. Reliable numerical simulations and sensitivity analysis with respect to the parameters of the models.

Prerequisites: Dynamical Systems and Ordinary Differential Equations (ODEs).

(WTW 851) Introduction to categories and sheaves 851 (40 credits)
The language of categories; limits; additive and abelian categories; abelian sheaves; cohomology of sheaves; homotopy and fundamental groupoid.

Prerequisites: Algebra at 3rd year and honours levels.

(WTW 855) Lattice theory 855 (40 credits)
The following topics will be studied: Ordered sets; down-sets of ordered sets; lattices and complete lattices; modular, distributive and Boolean lattices (as algebras and as ordered sets); the representation of lattices by collections of sets; the lattice of congruences of a lattice; complete partially ordered sets and fixed point theorems and maximality principles.

Prerequisites: Algebra on 3rd year level.

(WTW 863) Finite element analysis 863 (40 credits)

Finite element interpolation theory. Finite element approximation of elliptic boundary value problems and eigenvalue problems. Finite element approximation of parabolic and hyperbolic initial value problems. Applications in a project.

Prerequisites: Finite Element Method and Functional Analysis on honours level.

(WTW 865) Graph theory 865 (40 credits)

The basics (including a variety of topics); matchings; connectivity; planarity; colourings and generalised colourings and hereditary properties of graphs.

Prerequisites: Discrete Structures on 3rd year level.

(WTW 866) Hyperbolic systems of partial differential equations 866 (40 credits)

Systems of first order partial differential equations and their relationship to wave phenomena. The course will show that the traditional wave equation is over-rated as study material.
More detailed contents: Hyperbolicity of first order systems (linear and nonlinear); characteristic curves and surfaces; domains of influence and dependence; well-posedness of initial and boundary value problems; shock phenomena; numerical calculation of solutions; application to the equations of compressible gas dynamics and Maxwell's equations for electromagnetism.

Prerequisites: Partial Differential Equations at third year and honours levels; Advanced Calculus and Linear Algebra.

(WTW 869) Differential geometry 869 (40 credits)

Differentiable manifolds; multilinear algebra; exterior differential calculus; integration of differential forms and De Rham cohomology; connections on frame bundles; Riemannian manifolds and submanifolds; second fundamental form; harmonic mappings between Riemannian manifolds.

Prerequisites: Linear Algebra, Differential and Integral Calculus, Partial Differential Equations on honours level.

(WTW 887) Dynamical Systems 887 (40 credits)

Finite dimensional dynamical systems: Autonomous and non-autonomous systems of differential equations, dynamical systems, linear and nonlinear systems, existence and uniqueness of solutions, extension of solutions, maximal solution and maximal interval of existence, phase space and phase portrait. Stability theory for equilibria and periodic orbits using linear approximation, Liapunov's method and other energy methods and discrete dynamical systems (Poincarè map). Introduction to strange attractors. Application to mechanics and population models. Infinite dimensional dynamical systems: Semigroups, first and second order abstract differential equations, Sobolev spaces, finite dimensional approximation. Application to heat conduction and mechanical vibration. Examples of nonlinear systems.

Prerequisites: Functional Analysis, Partial Differential Equations and Finite Element Method on honours level.

(WTW 888) Special topics in mathematics (40 credits)
Content will vary from time to time depending on the availability of expertise in the Department.

3.6 Evaluation of Formal Course Work

1. Evaluation takes place continuously during the semester. The nature of the evaluation is determined by the supervisor and the lecturers concerned and consists of written and oral examinations. If a candidate's progress is unsatisfactory at any stage, the Postgraduate Coordinator may terminate his/her studies.
2. Examination of course work is problem orientated.

3.7 The Dissertation

1. Originality is required of the candidate, either in the content (for strong candidates) or in the presentation of the dissertation.
2. The candidate must become knowledgeable with the relevant subject literature, be able to collect information from various sources, arrange the material logically, and present it systematically as a meaningful whole.
3. The candidate must learn to write Mathematics in an exact form as required for publication.
4. The candidate must learn to distinguish between important and less important results.
5. The candidate should be able to critically evaluate the importance of his/her dissertation.
6. The candidate's knowledge of the relevant subject should expand significantly.
7. The dissertation must be submitted in required form before or on the following dates:

   For the autumn graduation ceremony: **30 August**

   For the spring graduation ceremony: **30 April**
8. The final mark for the dissertation comes from two components:
   - Evaluation of the dissertation by duly appointed external examiners.
   - Oral examination where the candidate presents his/her results and the examiners have the opportunity to ask questions.

3.8 Period of Study

The period for which a candidate may be enrolled for Master’s study is at least one year and at most four years. (Regulations G32 and G36) The duration of the study for this degree is normally two years, i.e. the course work in the first year and the dissertation in the second year.

4. Doctoral study

A PhD in Mathematical Sciences (degree code 02260761) consists of a thesis in one of several fields in which research is actively being done in the Department. The research fields and the names of possible supervisors are given in Section 5.

- WIS 990 (Thesis Mathematics) (360 credits)
  or
- TWS 990 (Thesis Applied Mathematics) (360 credits)

A PhD in Mathematics and Science Education (degree code 02260753) consists of a thesis in the research field described in Section 5.2.2.

- WTW 993 (Thesis Mathematics Education) (360 credits)

A total of 360 credits is required.

4.1 Admission Criteria

An appropriate Master’s degree is required for admission to the **PhD in Mathematical Sciences** i.e. doctoral study in Mathematics or Applied Mathematics. The programme composition of the Master’s degree must include a heavy research component that led to a dissertation reflecting originality either in the content or in the presentation.

For admission to the **PhD in Mathematics Education**, an appropriate Master’s degree is required. The programme composition of the Master’s degree must include a reasonable research component that led to a dissertation.

For both the above-mentioned degrees, the candidate’s complete Honours and Master’s academic records will be considered for the selection procedure. In particular, it is required that the Master’s degree be obtained with distinction. If a candidate did not pass his/her Master’s degree with distinction, he/she may submit an application together with a motivation by his/her potential supervisor to the Postgraduate Coordinator.

Admission is also subject to the availability of a suitable supervisor for the study.

The progress of all doctoral candidates is monitored biannually by the supervisor and the Postgraduate Coordinator. 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.

4.2 Aims of the Thesis

1. The candidate should be able to do an independent scientific investigation and to evaluate and present the results obtained.
2. The candidate must acquire a thorough knowledge of the state of his/her research field in the international community of mathematicians.
3. Original work is essential.
4. Rigour in the writing of the thesis is essential.
5. At least one refereed journal article should have been accepted for publication before the end of the research period.

6. The thesis must be submitted in required form before or on the following dates:

For the autumn graduation ceremony:	**30 August**
For the spring graduation ceremony:	**30 April**

4.3 Evaluation of the Thesis

The final mark for the thesis comes from two components:

- Evaluation of the thesis by duly appointed external examiners.
- Oral examination where the candidate presents his/her results and the examiners have the opportunity to ask questions.

4.4 Period of Study

Subject to other faculty regulations, a student for a doctoral degree must complete his or her studies within four years after first registering for the degree. Under special circumstances, the Dean, on the recommendation of the head of department, may give approval for a limited fixed extension of this period. (See Regulations G47 and G51.)

5. Research Areas

5.1 Main research focus areas

The Department currently has two main research focus areas:

5.1.1 Partial differential equations, their numerical analysis and mathematical modelling

Description

A. Partial and ordinary differential equations, stochastic partial differential equations with special attention to mathematical models in applied sciences such as engineering, physics, biology, chemistry, etc. The research covers:

- Function spaces (distributions, Sobolev spaces, etc)
- Existence, uniqueness, regularity and singularity properties of solutions
- Singularly perturbed problems
- Numerical treatment by finite element, finite difference and boundary element methods
- Dynamical systems
- Interval methods
- Modification of mathematical models
- Fluid mechanics
- Nonlinear theories of generalized functions.

B. The study of dense singularities of solutions of nonlinear partial differential equations with emphasis on:

- Lie semigroups of noninvertible transformations of solutions
- Abstract differential geometry of algebras of generalised functions and de

Rham cohomology
- Space-time foam structures with dense singularities.

C. Homogenization of elliptic and evolution problems.

D. Geometric partial differential equations related to:
- Harmonic and wave maps on Riemann-Finsler manifolds
- Ricci flow on Finsler manifolds.

E. Mathematical biology with emphasis on epidemiology. (This is a new direction of work on which the Department is embarking, with the aim of engaging into multi-disciplinary research with the School of Biological Sciences at the University of Pretoria.)

Associated staff: Anguelov R, Chapwanya M, Djoko Kamdem J, Garba S M, Le Roux C, Lubuma J M-S, Mureithi E W, Neossi Nguetchue S N, Rosinger E E, Sango M, Sauer N, Van der Walt J H, Van Rensburg N F J

5.1.2 Abstract analysis, topology and applications

Description

A. Banach space analysis and measure theory
- Tensor products and operator ideals
- Geometry of Banach spaces
- Interplay between Banach space theory and measure theory.

B. Operator algebras
- Noncommutative analysis on C^*-dynamical systems, with emphasis on the recurrence properties of such systems, and applications to quantum statistical mechanics.

C. Transformation groups

D. Geometric algebra and abstract differential geometry

E. Approximation theory and orthogonal polynomials

F. Stochastic analysis and applications to the mathematics of finance

G. Theory of double families of evolution operators, their spectral theory and applications to
- dynamic boundary condition problems
- the Navier-Stokes equations (existence and uniqueness results)
- problems in nonlinear elasticity theory
- non-Newtonian fluid mechanics.

Associated staff: Beyers F J C, Jordaan K H, Kufakunesu R, Le Roux C, Maepa S M, Maré E, Moubandjo D V, Mutangadura S A, Ntumba P P, Sauer N, Ströh A, Swart J, Van den Berg J E, Van der Walt J H, Van Zyl A J

5.2 Other research areas

5.2.1 Discrete Mathematics

Description

The following aspects of combinatorics and of discrete geometry are studied: Ramsey theory of combinatorial structures; Linear incidence geometry.

Associated staff: Broere I, Pretorius L M, Kellerman R, Van den Berg J E

5.2.2 Undergraduate Mathematics teaching

Description

The issues to be addressed are to investigate the following aspects of diversity at university level:

The diversity of teaching methods with the emphasis on the development of internet courses and the efficacy of the different learning elements built into these courses, the diversity of assessment mechanisms in the classroom and web environment. The diversity of students' conceptions of Mathematics and its applications in their proposed professions. The diversity of thinking styles in undergraduate mathematics. The transition from secondary to undergraduate mathematics.

Associated staff: Engelbrecht J C, Harding A F

6. Postgraduate teaching personnel

Prof R ANGUELOV
PhD (Unisa) Professor
(Mathematics Teaching, Numerical Analysis, Mathematical Epidemiology, Image Analysis)

Dr A R APPADU
PhD (University of Mauritius) Lecturer
(Partial Differential Equations, Computational Fluid Dynamics, Computational Aeroacoustics)

Prof I BROERE
PhD (RAU) Professor
(Combinatorics, Graph Theory)

Dr M CHAPWANYA
PhD (Univ of Limerick, Ireland) Lecturer
(Mathematical Modelling, Industrial Mathematics, Scientific Computing)

Prof F E DELBAEN
PhD (Free Univ Brussels) Extraordinary professor
(Stochastics, Probability Theory, Financial Mathematics)

Prof J DIESTEL
PhD (Cath Univ of America) Extraordinary professor
(Banach Spaces, Measure Theory)

Dr J DJOKO KAMDEM
PhD (UCT) Senior lecturer
(Partial Differential Equations, Numerical Analysis)

Prof J C ENGELBRECHT

DSc (PU for CHE) Professor and Deputy Dean of Faculty Natural and Agricultural Sciences
(Mathematics Teaching)

Dr S M GARBA

PhD (Putra University, Malaysia) Lecturer
(Mathematical Biology)

Prof A F HARDING

DSc (Pretoria) Professor
(Mathematics Teaching)

Prof K H JORDAAN

PhD (Witwatersrand) Associate professor
(Special functions, Approximation Theory, Orthogonal Polynomials)

Dr R KELLERMAN

PhD (Witwatersrand) Lecturer
(Mathematical Logic)

Dr R KUFAKUNESU

DPhil (Univ of Zimbabwe) Lecturer
(Mathematics of Finance, Financial Engineering)

Dr C LE ROUX

PhD (Pretoria) Senior lecturer
(Partial Differential Equations, Fluid Mechanics)

Prof J M-S LUBUMA

PhD (Louvain) Professor/Head
(Partial Differential Equations, Numerical Analysis, Function Spaces, Integral Equations)

Dr S M MAEPA

PhD (Pretoria) Senior lecturer
(Geometry of Banach Spaces)

Dr G MALULEKE

PhD (Witwatersrand) Lecturer (part-time)
(Information Security; Mathematical Modelling)

Dr R E MICKENS

PhD (Vanderbilt University) Extraordinary professor
(Theoretical Physics, Mathematics applied to Vibrational Engineering, Nonlinear Dynamics, Mathematical Biosciences)

Prof E MARÉ

PhD (UOFS) Associate professor (part-time)
(Financial Engineering)

Dr D V MOUBANDJO

PhD (Stellenbosch) Lecturer
(Approximation Theory, Wavelets Analysis)

Dr E W MUREITHI
PhD (New South Wales) Senior lecturer
(Partial Differential Equations)

Dr S A MUTANGADURA
PhD (London) Senior lecturer
(Geometry of Banach Spaces, Operator Algebras)

Dr S N NEOSSI NGUETCHUE
PhD (Witwatersrand) Lecturer
(Partial Differential Equations, Numerical Analysis)

Dr P P NTUMBA
PhD (UCT) Senior lecturer
(Algebraic Topology, Differential Geometry)

Prof L M PRETORIUS
DSc (Pretoria) Professor
(Module Theory, Combinatorics)

Prof K R RAJAGOPAL
PhD (Univ of Minnesota) Extraordinary professor
(Continuum Mechanics)

Prof E E ROSINGER
DrSc (Bucharest) Emeritus professor
(Non-linear Partial Differential Equations, Algebraic and Order Theoretical Methods, Numerical Methods)

Prof M SANGO
PhD (Valenciennes) Professor
(Partial Differential Equations)

Prof N SAUER
PhD (Unisa) Extraordinary professor
(Equations of Evolution, Fluid Dynamics)

Prof A STRÖH
PhD (Pretoria) Professor and Dean of Faculty of Natural and Agricultural Sciences
(Operator Theory, Von Neumann Algebras, Non-commutative Integration Theory, Ergodic Theory)

Prof J SWART
DrPhil (Zürich) Professor
(Abstract Analysis: Geometry of Banach Spaces, Measure and Integration Theory; Mathematics of Finance)

Prof J E VAN DEN BERG
PhD (Natal) Associate professor
(Algebra, Analysis)

Dr J H VAN DER WALT

PhD (Pretoria) Senior lecturer
(Partial Differential Equations, Convergence Spaces, Topology)

Prof N F J VAN RENSBURG

DSc (Pretoria) Associate professor
(Partial Differential Equations, Numerical Analysis)

Dr A J VAN ZYL

PhD (Pretoria) Lecturer
(Functional Analysis, Stochastics)