UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Research Areas

Main research focus areas

This main focus area is divided into the following sub-areas and topics:

1. Partial differential equations, their numerical analysis and mathematical modelling

1.1 Partial Differential Equations, Ordinary Differential Equations and Stochastic Partial Differential Equation models in science and engineering.
The research covers:

- Function spaces (distributions, Sobolev spaces, etc)
- Existence, uniqueness, regularity and singular 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
- Nonlinear theories of generalized functions

1.2 Study of dense singularities of solutions of nonlinear PDEs:
The emphasis is placed 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.

1.3 Homogenization of elliptic and evolution problems

1.4 Geometric partial differential equations:
The focus is on:

- Harmonic and wave maps on Riemann-Finsler manifolds
- Ricci flow on Finsler manifolds.

1.5 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 multidisciplinary research with the cluster of Biological Sciences at the University of Pretoria.

Associated staff: Mr C Adams, Prof R Anguelov, Dr AR Appadu, Ms M Basson, Dr M Chapwanya, Dr PWM Chin, Dr J Djoko Kamdem, Dr SM Garba, Prof NF Janse van Rensburg, Prof JM-S Lubuma, Dr S Neossi Nguetchue, Prof EE Rosinger, Prof M Sango, Prof N Sauer, Dr Q van der Hoff, Dr JH van der Walt

2. Abstract analysis, topology and applications

This is the second main focus area and it is subdivided as follows:

2.1 Banach space analysis and measure theory
The following topics are covered:

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

2.2 Operator algebras
The focus is on:

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

2.3 Geometric algebra and abstract differential geometry

2.4 Transformation groups

2.5 Approximation theory and orthogonal polynomials

2.6 Stochastic analysis and applications to the mathematics of finance

2.7 Theory of double families of evolution operators, their spectral theory and applications
Applications are directed to:

- dynamic boundary condition problems
- the Navier-Stokes equations (existence and uniqueness results)
- problems in nonlinear elasticity theory
- non-Newtonian fluid mechanics

Associated staff: Dr AS Jooste, Prof KH Jordaan, Dr R Kufakunesu, Mr WS Lee, Dr SM Maepa, Prof E Maré, Dr DV Moubandjo, Dr SA Mutangadura, Dr PP Ntumba, Miss A Ostaszewicz, Prof N Sauer, Prof A Ströh, Prof J Swart, Prof JE van den Berg, Dr JH van der Walt, Dr AJ van Zyl, Mr DW van Wyk, Mrs B Yani

Other research areas

Apart from the main research focus areas presented above, the Department is active in the following areas:

3. Discrete mathematics

The following aspects of combinatorics and of discrete geometry are studied:

- Ramsey theory of combinatorial structures;
- Linear incidence geometry.

Associated staff: Prof I Broere, Dr R Kellerman, Prof LM Pretorius, Dr T Vetrik

4. Undergraduate Mathematics teaching

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 of secondary to undergraduate mathematics

Associated staff: Prof JC Engelbrecht, Prof AF Harding, Mrs JM Ohlhoff, Dr Q van der Hoff, Ms A Verwey