# School of Mathematics and Statistics
**Faculty of Science, Technology, Engineering and Mathematics**

## 2018 PhD Projects

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| **Project title** | Computer-assisted proofs in dynamical systems |
| **Principal supervisor** | Ben Mestel |
| **Second supervisor** | Robert Hasson |
| **Discipline** | Applied Mathematics |
| **Research area/keywords** | Computer-assisted proofs, functional equations, interval arithmetic/analysis |
| **Suitable for** | Full time applicants |

**Project background and description**

Many of the functional equations that arise in the study of chaotic transitions are not easily amenable to standard analytic methods, but may be readily solved numerically. Interval analysis with error bounding may be used to develop rigorous numerical functional analysis, which may be applied to develop computer-assisted proofs of the existence and properties of the solutions of these functional equations.

The aim of the project is to develop rigorous numerical functional analysis within the context of a computer package such as Python or SAGE and to use it to solve outstanding problems in critical dynamical systems.

After a review of interval analysis and of computer-assisted proofs in this field, you will develop a suite of programs to implement rigorous numerical functional analysis on spaces of analytic functions, most likely building on existing interval arithmetics routines in Python and/or SAGE, This will provide a tool for other practitioners in this field. You will then use your programs to develop computer-assisted proofs of conjectures in dynamical systems and applied mathematics.

This research project would suit a student with good programming skills and with a familiarity with computer environments such as SAGE and/or Python.

**Background reading/references**


- Ramon E. Moore, R. Baker Kearfott, Michael J. Cloud, Introduction to Interval Analysis, Cambridge University Press, 2009
- Jean-Pierre Eckmann, Hans Koch, Peter Wittwer, A Computer-Assisted Proof of Universality for Area-Preserving Maps, Memoirs of the American Mathematical Society, American Mathematical Society, 1984.