Postgraduate Mathematics

Degrees, courses, opportunities

Mathematics Postgraduate Advisor
Dr. Steve Taylor
Department of Mathematics,
Room 306, Level 3 Science Centre (Building 303)
pgadvice@math.auckland.ac.nz

THE UNIVERSITY OF AUCKLAND
FACULTY OF SCIENCE

The Department of Mathematics

- research-based environment
- local and visiting academics, world leaders in

  Algebra
  Analysis
  Bioinformatics
  Combinatorics
  Differential Geometry
  Dynamical Systems
  Fluid Dynamics
  Inverse Problems
  Mathematical Biology
  Mathematical Modelling
  Mathematics Education
  Numerical Analysis
  Topology

- small class lectures
- one-to-one research supervision of projects, reading courses, dissertations, theses
- scholarships
- students participate in departmental research activities, seminars and colloquia

Mathematics Postgraduate Programmes

- International **Exchange** Programmes
- **Certificate** of Proficiency
- **Graduate Diploma** in Science
- **Postgraduate Diploma** in Science
  - **PGDipSci in Mathematics: A major in Mathematics including MATHS 332 and either MATHS 320 or 328.**
  - **PGDipSci in Applied Mathematics: A major in Applied Mathematics**
- **Bachelor of Science or Arts (Honours)**
  - **BSc(Hons) BA(Hons) in Mathematics: A major in Mathematics including MATHS 332 and either MATHS 320 or 328 and 90 points at Stage 3.**
  - **BSc(Hons) in Applied Mathematics: A major in Applied Mathematics and 90 points at Stage 3.**
- **Master** of Science, Arts or Education
  - **MSc: BSc(Hons) or PGDipSci in Applied Mathematics or Mathematics.**
- **Doctor of Philosophy**

Semester 2 2008 Postgraduate Courses

- 702 Mathematics Curriculum
- 714 Number Theory (B+ in 320 or 328)
- 721 Rings, Modules, Algebras & Representations* (320)
- 731 Functional Analysis (332 & 333; Rec. 730 & 750)
- 735 Analysis on Manifolds & Differential Geometry* (332, Rec.333 &340)
- 750 Topology (332 or 353; Rec 333)
- 782 Discrete Geometry* (320 or 328)
- 784 An Introduction to Finite Tight Frames* (253 or 255 and320)
- 761 Dynamical Systems (361)
- 769 Applied Differential Equations (340 & 361)
- 787 Numerical Methods for Differential Equations* (270 and one of 361, 340, 363)
- 789 Advanced Topic in Non-linear PDEs* (361 & 362)

* Courses that might not be available in 2009

DEPARTMENT OF MATHEMATICS
GRADUATE COURSES AND PATHWAYS

SPECIAL TOPICS

Reading Papers / Research Projects

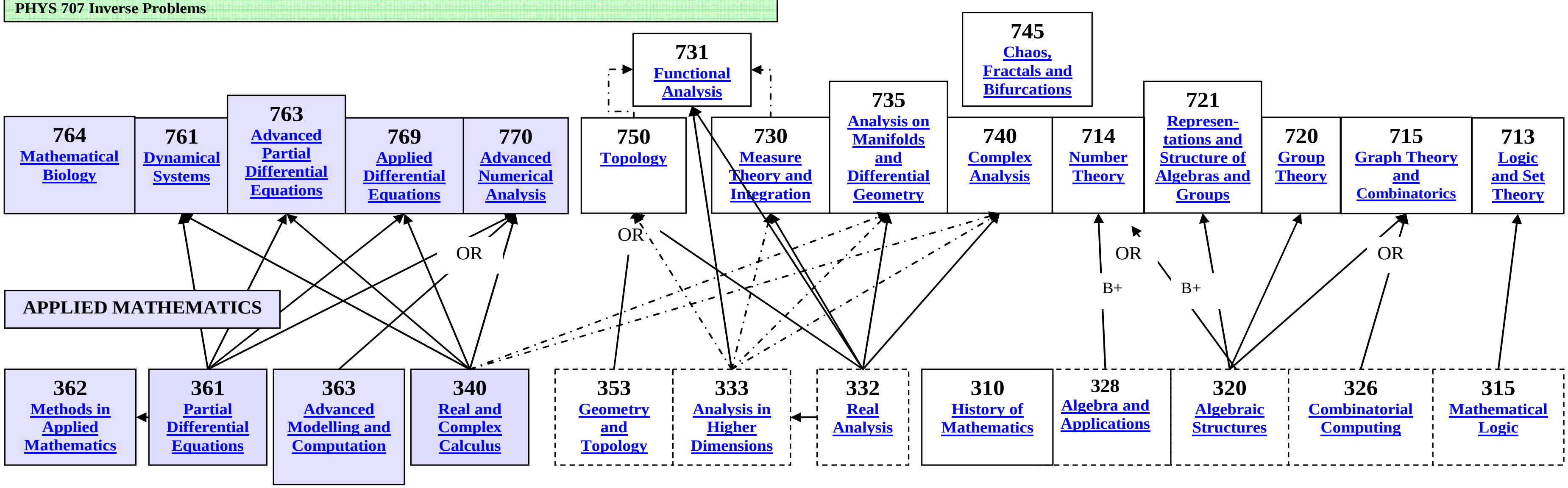
Mathematics Education	Mathematics	Applied Mathematics

707-711 Special Topics in Mathematics Education
737 Topic(s) in Analysis
747 Topic(s) in Complex Algebra
755 Topic(s) in Geometry
757 Topic(s) in Topoligy
775 Mathematical Software
781, 783-4 Advanced Topic(s) in Mathematics
782 Advanced Topic(s) in Mathematics 2: **Discrete Geometry (S2 2008)**
784 Advanced Topic(s) in Mathematics 4: **An Introduction to Finite Tight Frames (S2 2008)**
786,788 Advanced Topic(s) in Applied Mathematics
787 Advanced Topic(s) in Applied Mathematics 2: **Numerical Methods for Differential Equations (S2 2008)**
789 Advanced Topic(s) in Applied Mathematics4: **Advanced Topic in Non-linear PDEs (S2 2008)**
776 Honours Dissertatioin in Mathematics or Applied Mathematics
777, 793-4 Project in Mathematics
795 MSc Thesis in Applied Mathematics
796 MSc Thesis in Mathematics
797-8 Research Portfolio in Mathematics
STATS 708 Topics in Statistical Education
PHYS 701 Linear systems
PHYS 707 Inverse Problems

MATHEMATICS EDUCATION

701	702	703	705	706	712
Research Skills in Mathematics Education	Mathematics Curriculum	Theoretical Issues in Mathematics Education	Social Issues in Mathematics Education	Technology and Mathematics Education	Mathematics and Learning

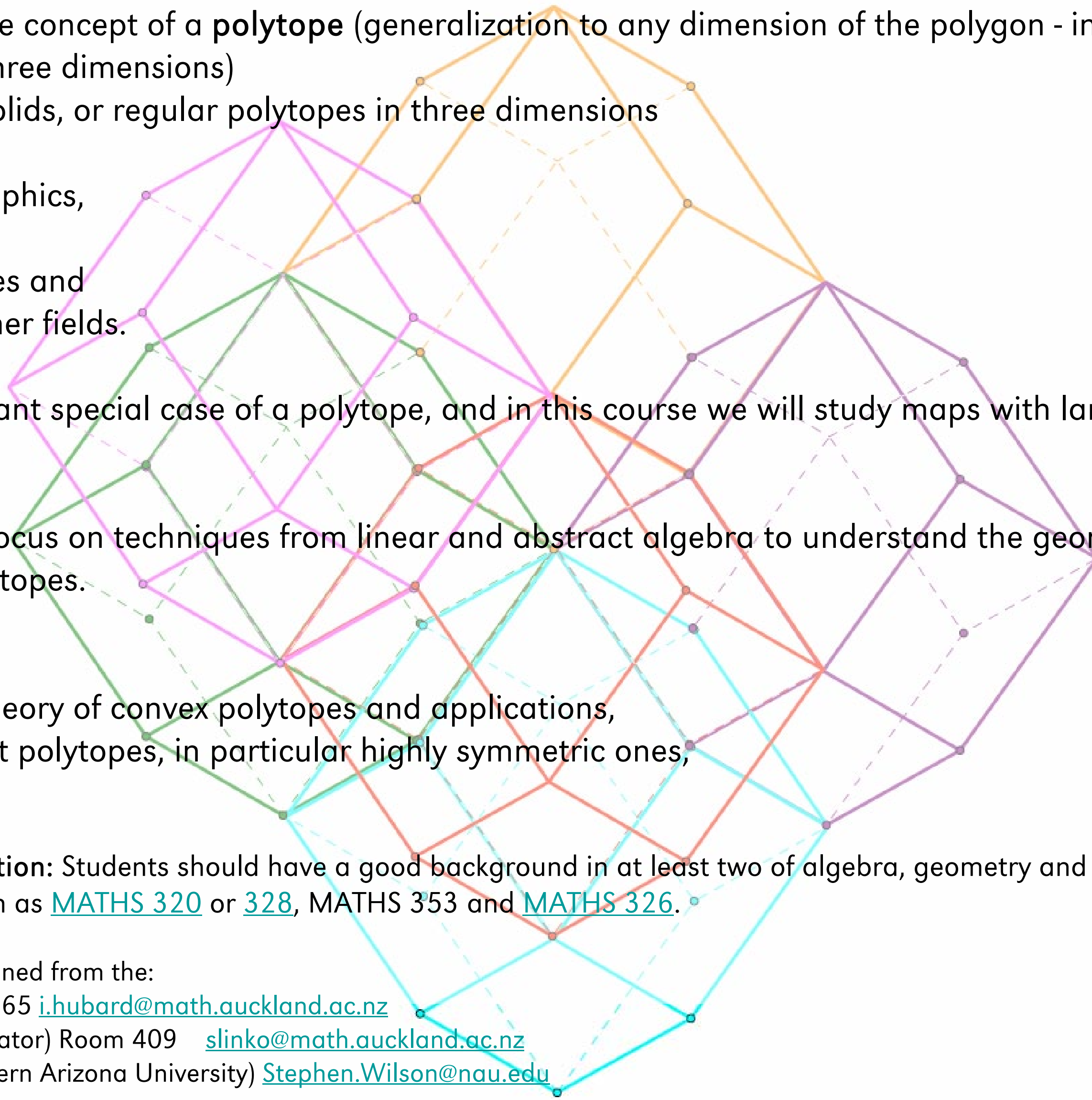
302 Teaching and Learning Mathematics



Special Topics in Semester 2 2008

- Taught courses
  - 782 Discrete Geometry
  - 784 An Introduction to Finite Tight Frames
  - 787 Numerical Methods for Differential Equations
  - 789 Advanced Topic in Non-linear PDEs
- Projects and/ or reading courses requiring a supervisor

MATHS 782: Discrete geometry



- Centered around the concept of a **polytope** (generalization to any dimension of the polygon - in two dimensions - and polyhedron - in three dimensions)
- Example: Platonic solids, or regular polytopes in three dimensions
- applications in
    - computer graphics,
    - optimization,
    - search engines and
    - numerous other fields.

- A **map** is an important special case of a polytope, and in this course we will study maps with large groups of symmetries.

- These lectures will focus on techniques from linear and abstract algebra to understand the geometry and combinatorics of polytopes.

- Content:
    - basic theory of convex polytopes and applications,
    - abstract polytopes, in particular highly symmetric ones,
    - maps.

Recommended preparation: Students should have a good background in at least two of algebra, geometry and combinatorics, as gained from courses such as MATHS 320 or 328, MATHS 353 and MATHS 326.

Further details can be obtained from the:
Dr Isabel Hubard Room 365 i.hubard@math.auckland.ac.nz
Dr Arkadii Slinko (Coordinator) Room 409 slinko@math.auckland.ac.nz
Dr Stephen Wilson (Northern Arizona University) Stephen.Wilson@nau.edu

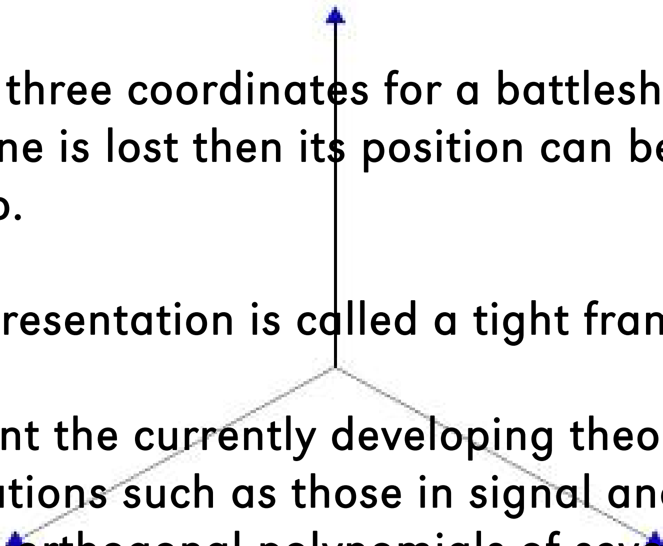
MATHS 784: An Introduction to Finite Tight Frames

If two coordinates of a battle ship are given, and one is lost, then it is impossible to determine its position from the remaining one.

It is possible to specify three coordinates for a battleship in such a way, that if one is lost then its position can be determined from the remaining two.

Such a (redundant) representation is called a tight frame.

In this course we present the currently developing theory of finite tight frames, and some of its applications such as those in signal analysis, quantum information theory and orthogonal polynomials of several variables.



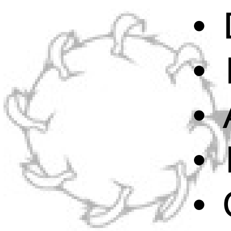
Recommended preparation: Full familiarity with basic linear algebra, and some knowledge of some important spaces of functions, such as multivariate polynomials (MATHS 253 or 255 and MATHS 320).

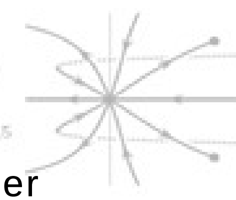
The prototypical example of a *finite tight frame* is three equally spaced unit vectors u_1, u_2, u_3 in $\mathbb{R}^2$, which provide the following *redundant* decomposition

$$f = \frac{2}{3}\sum_{j=1}^{3} \langle f, u_j \rangle u_j, \qquad \forall f \in \mathbb{R}^2.$$

MATHS 787: Numerical methods for differential equations

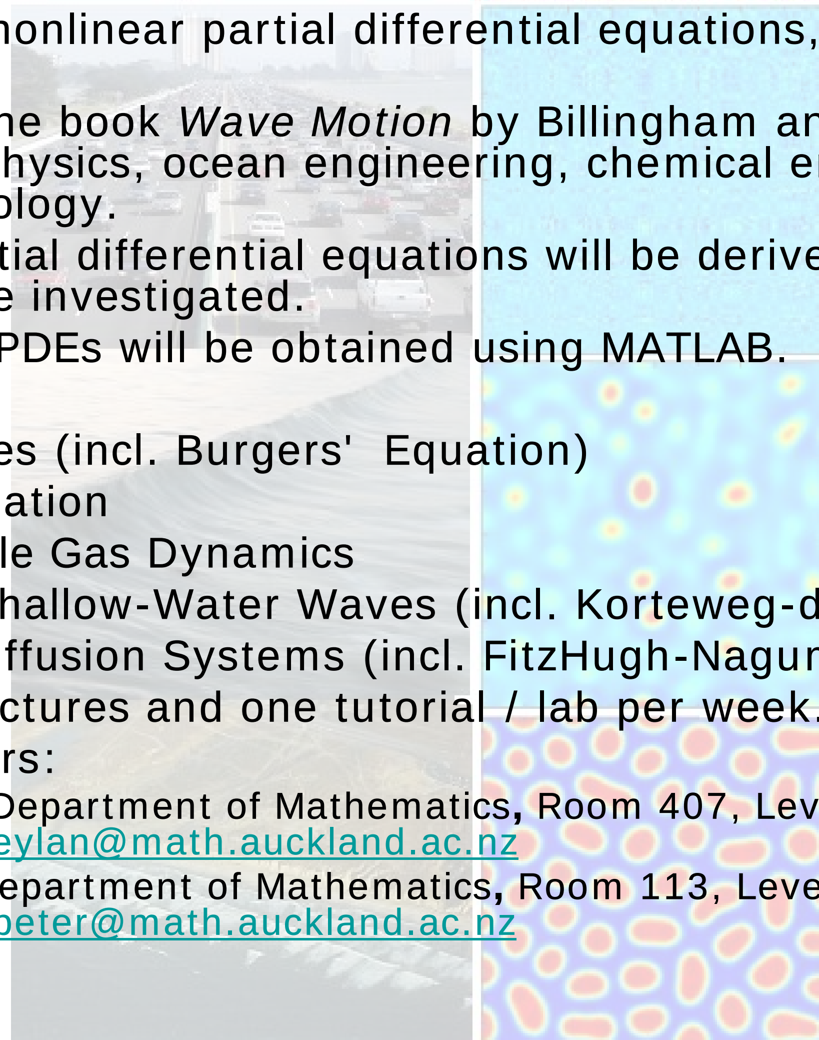
- For students familiar with or interested in standard methods for solving ordinary differential equations,
- Content
  - consolidate and formalise existing knowledge of the traditional methods.
  - new topics, as the so-called “General linear methods”, which are generalisations of both Runge-Kutta and linear multistep methods
  - we will go more seriously into some of the new topics, with the actual selection based on interests that will have developed amongst members of the class.
- Topics
  - Linear multistep methods: convergence, consistency, stability and order
  - The first Dahlquist barrier on the order of convergent linear multistep methods
  - Order conditions for Runge–Kutta methods
  - Derivation of high order explicit Runge–Kutta methods
  - Implicit Runge–Kutta methods
  - A-stability barriers
  - Implementation of implicit Runge–Kutta methods
  - General linear methods: convergence, consistency, stability and order
  - Order and stability barriers for general linear methods
  - Construction and implementation of practical general linear methods
  - Introduction to structure-preserving methods





- **Prerequisites:** MATHS 270 and one of MATHS 361, 340, 363
- **Timetable:** Room 401, 3-5 Tuesdays and Thursdays, starting 29 July (no classes on 21-25 July)
- Further details can be obtained from the: MATHS 787 lecturer : Prof. John Butcher, Department of Mathematics**,** Room 424B, Level 4, Science Centre (Building 303) butcher@math.auckland.ac.nz

MATHS 789: Advanced Topics in Nonlinear Partial Differential Equations



- an introduction to nonlinear partial differential equations, focusing on nonlinear wave phenomena.
- will closely follow the book *Wave Motion* by Billingham and King. We will consider applications from physics, ocean engineering, chemical engineering, civil engineering and biology.
- The underlying partial differential equations will be derived and the properties of the solutions will be investigated.
- Simulations of the PDEs will be obtained using MATLAB.
- Main topics
    - Traffic Waves (incl. Burgers' Equation)
    - Shock Formation
    - Compressible Gas Dynamics
    - Nonlinear Shallow-Water Waves (incl. Korteweg-deVries Equation)
    - Reaction–Diffusion Systems (incl. FitzHugh-Nagumo Equations)
- **Timetable:** Two lectures and one tutorial / lab per week.
- MATHS 789 lecturers:
    - Dr Mike Meylan, Department of Mathematics, Room 407, Level 4, Science Centre (Building 303) meylan@math.auckland.ac.nz
    - Dr Malte Peter, Department of Mathematics, Room 113, Level 1, Science Centre (Building 303) mpeter@math.auckland.ac.nz

Detailed Information

may be found on the

- Maths Department website:

http://www.math.auckland.ac.nz

- Graduate courses webpage:

http://www.math.auckland.ac.nz/wiki/2008_Postgraduate_courses

- Graduate Programme:

http://www.math.auckland.ac.nz/wiki/Graduate_students