Course Profile for MATH4303 Semester 1, 2006

Course Code: MATH4303
Course Title: Advanced Combinatorics
Course website: http://www.maths.uq.edu.au/courses/MATH4303
Units: 2
Classes and Times: See my-SInet for class times and places. There are 3 lectures and 1 tutorial per week; you should attend all lectures, and the tutorial if required.

Course coordinator: Peter Adams

Lecturers: Peter Adams
Elizabeth Billington (first 2 weeks)
Darryn Bryant
Matt Dean
Dan Horsley

Elizabeth will lecture the first two weeks, and will be away from 13th March until 29th May. The rest of semester will be shared by the other lecturers, with the exact schedule to be decided upon later.

Contact details: Peter 67-547, 3365 3276, pa@maths.uq.edu.au
Elizabeth 67-653, 3365 2313, ejb@maths.uq.edu.au
Darryn 67-540, 3365 1342, db@maths.uq.edu.au
(Matt and Dan are casual lecturers; contact one of the others instead).

Consultation hours: Peter Mon 9am – 11am
Elizabeth Wed 10am – 12 noon
Darryn Tues 10am – noon
Feel free to drop by our offices at other times as well.

Course Aim: This course will provide students with detailed information and experience in the study of advanced combinatorics. This will include relevant mathematical theory and techniques, computational algorithms and methods, research problems and practical applications. There will be an emphasis on the role of advanced combinatorics in leading-edge research problems in other fields (such as drug discovery and DNA sequencing), and on developing techniques for applying mathematical knowledge to theoretical and applied research problems. We anticipate that students completing this course should be well-suited to undertaking research-based study in a field of physical sciences, particularly discrete mathematics, and will be familiar with a number of the current research projects being undertaken at The University of Queensland.

Assumed Background: Given the diverse nature of the topics covered, we will not assume any particular in-depth background. If you are a motivated 3rd/4th year student of Mathematics, Physics or Computer Science, you should be able to complete this course.

Course Syllabus: The following is intended as a rough guide only. The time spent on each section will vary. Guest lectures will be given by a number of experts in these fields.

1. Pigeonhole principle, consequences and examples
2. Ramsey numbers; existence; few easy results; Erdos-Szekeres bound
3. Generalised graph Ramsey numbers (including chromatic numbers, and Chvatal's result for any tree and complete graph)
4. Turan's theorem; extremal graphs, triangle-free graphs
5. Introduction to basic combinatorial terminology
6. DNA and novel DNA sequencing methods
7. Enumeration I – selections and permutations
8. Graph decomposition problems and graph labellings
9. Algorithms for, and applications of, sequence alignment
10. Enumeration II – generating functions
11. Combinatorial matching theorems
12. Combinatorial methods for drug discovery
13. Combinatorial computing and parallel algorithms

**Course Materials:** There is no set textbook for this course. We will distribute relevant notes, references and information as we go. There is a lot of material available on the web, so you can seek extra information there. Certainly, we anticipate that the web will be a primary source of information for your projects.

**Course Assessment:** We will discuss assessment details in the first lecture. The proposed assessment model is as follows:

- A short quiz (true/false & short answer) in the tutorial at 3pm on Wed 8 March, based on the first 5 lectures, worth 4%
- **Four assignments,** due at various times throughout the semester, contributing 48% towards your final grade. Assignment 1 is due on Wednesday 22 March by 3.50pm (the end of the tutorial), and is worth 8%. Assignment 2 will be worth 18% of your final grade and will involve you writing a short research paper on a graph decomposition problem. It is due by 3.50pm on Wednesday 26th April. Assignments 3 and 4 will each be worth 10% of your final grade, of which 2% is an oral component and 8% is written. Assignment 3 is due by 3.50pm on Wednesday May 10th and Assignment 4 is due by 3.50pm on Wednesday May 31st.
- A **project** that will contribute 35% towards your final grade. This project will involve you selecting a topic of your choice relevant to advanced combinatorics or discrete mathematics, and independently researching this topic (we are happy to suggest topics if you like). At the end of semester you will be asked to submit a substantial report on what you have discovered. More details will be discussed in class. This project is due to one of the lecturers by 2pm on Friday June 2nd.
- A 20-25 minute **oral presentation** related to your project, contributing 5% towards your final grade. These talks will be presented in lecture or tutorial timeslots in the last week(s) of semester.
- The final 10% of marks will be awarded for **attendance** at lectures and student talks. There are (approximately) 35 lectures scheduled for MATH4303. We will record attendance at each lecture (or tutorial, if student talks are scheduled for that tutorial). If you miss more than three classes during semester, you will lose 1% for each class in excess of three, to a maximum deduction of 10%. If you have a legitimate reason for missing classes (illness, lecture clashes), make sure you see us, to avoid penalty.

There are no examinations in this course. All items of assessment are compulsory, and count towards your final grade. Any item submitted up to one hour after the due time will receive at most half marks. Any work submitted after that time will not be graded. Extensions will not be granted, except in exceptional circumstances. If you feel that you qualify for an exceptional circumstance, make sure you contact one of us as soon as possible. **Pay attention to these strict date and time deadlines; we mean them!**

**Assessment Criteria:**
Assignment solutions will be marked for accuracy, appropriateness of mathematical techniques and quality of presentation.

Your grade for this course will be determined by which of the following levels of achievement that you consistently display in the items of summative assessment.

Grade of 7: (85% - 100%) the student demonstrates an excellent understanding of the theory of the topics listed in the course outline and is highly proficient in applying the techniques to solve both theoretical and practical problems.

Grade of 6: (75% - 84%) the student demonstrates a comprehensive understanding of the theory of the topics listed in the course outline and is proficient in applying the techniques to solve both theoretical and practical problems.

Grade of 5: (65% - 74%) the student demonstrates a good understanding of the theory of the topics listed in the course outline and can apply the techniques to solve problems.

Grade of 4: (50 - 64%) the student demonstrates an understanding of the theory of the topics listed in the course outline and demonstrates a knowledge of the techniques used to solve problems.

Grade of 3: (45% - 49%) the student demonstrates some understanding of the theory of the topics listed in the course outline and demonstrates some knowledge of the techniques used to solve problems, but fails to satisfy all of the basic requirements for a pass.
Grade of 2: (25 - 44%) the student demonstrates limited understanding of the theory of the topics listed in the course outline and demonstrates limited knowledge of the techniques used to solve problems. This includes attempts at expressing their deductions and explanations and attempts to answer a few questions accurately.

Grade of 1: (1 - 24%) the student demonstrates very limited understanding of the theory of the topics listed in the course outline and of the basic concepts in the course material. This includes attempts at answering some questions but demonstrating very limited understanding of the key concepts.

**Graduate Attributes:**

On completion of the course, the graduate will have

1. **In-depth Knowledge of the Field of Study**
   - An in-depth understanding and well-founded knowledge of the mathematics presented in this course, developed by observing complex examples and proofs and independently completing assigned problems.
   - An understanding of the applications of combinatorics to relevant fields in biotechnology, obtained by encountering various applications of combinatorics in cutting-edge biotechnology fields.

2. **Effective Communication**
   - An enhanced ability to present a logical sequence of reasoning using appropriate mathematical notation and language, developed by observing mathematical theorems and proofs presented in lectures.
   - An enhanced ability to give an effective oral presentation on technical subject matter, developed through the oral component of the assignments and the project seminar.
   - An enhanced ability to select and use the appropriate level, style and means of written communication, developed through writing a sample research paper and a substantial project.

3. **Independence and Creativity**
   - An enhanced ability to work and learn independently, developed by independent research on a topic of individual choice.
   - An enhanced ability to formulate problems mathematically, developed by observing how problems in biotechnology are formulated in combinatorial language.
   - An enhanced ability to generate approaches for the mathematical solution of problems including the identification and adaptation of existing methods, developed by solving new mathematical problems.

4. **Ethical and Social Understanding**
   - A knowledge and respect of ethical standards in relation to working in the area of mathematics, in particular by studying and discussing applications in biotechnology.
   - An appreciation of the power of mathematics to affect our culture and technology, obtained by examining cutting-edge applications of modern pure mathematics.

**Feedback on assessment:**

You may request feedback on assessment in this course progressively throughout the semester from the course coordinator. Feedback on assessment may include discussion, written comments on work, model answers, lists of common mistakes and the like. Students may peruse examinations scripts and obtain feedback on performance in a final examination provided that the request is made within six months of the release of final course results. After a period of twelve months following the release of results, examination scripts may be destroyed.

Information on the University’s policy on access to feedback on assessment may be found at [http://www.uq.edu.au/hupp/index.html?page=25114&pid=25075](http://www.uq.edu.au/hupp/index.html?page=25114&pid=25075)


**Students with disabilities:**
Any student with a disability who may require alternative academic arrangements in the course is encouraged to seek advice at the commencement of the semester from a Disability Adviser at Student Support Services. Refer to the University policy – Students with A Disability (Disability Action plan) HUPP 3.40.6

**Assistance for Students:**

Students with English language difficulties should contact the course coordinator or tutors for the course. Students with English language difficulties who require development of their English skills should contact the Institute for Continuing and TESOL Education on extension 56565. The Learning Assistance Unit located in the Relaxation Block in Student Support Services. You may consult learning advisers in the unit to provide assistance with study skills, writing assignments and the like. Individual sessions are available. Student Support Services also offers workshops to assist students. For more information, phone 51704 or on the web http://www.sss.uq.edu.au/index.html.

**Student Liaison Officer:**

The School of Physical Sciences has a Student Liaison Officer as an independent source of advice to assist students with resolving academic difficulties.

The Student Liaison officer during 2006 will be Peter Adams, Room 547 Priestley Building, (email pa@maths.uq.edu.au)

**Other Policies and Guidelines:**

**Working with Children:** Students who will be required to work with children as part of their studies should refer to the University policy – Working with Children Check – “Suitability Card” HUPP 1.60.7

**Occupational Health and Safety:** Students should be familiar with the University policy on Occupational Health and Safety in the Laboratory (Undergraduate Student) HUPP 2.30.14