This is a 6 UOC level V course, suitable for Honours students or coursework Masters students. There are no official prerequisites and no exclusions.

There will be two lectures per week in weeks 1 - 12, and one tutorial per week in weeks 2 - 13. Please attend the timetabling meeting at 9:30am on Thursday 12 July 2012 in RC-4082, where the timetable for all Honours courses will be decided.

Course aims

Graphs are fundamental objects in combinatorics, which can be used to model the relationships between the members of a network or system. They have many applications in areas such as computer science, statistical physics and computational biology. Specifically, a graph consists of a set of vertices and a set of edges, where (generally) an edge is an unordered pair of distinct vertices.

The course aims to cover various combinatorial aspects of graph theory and introduces some of the tools used to tackle graph theoretical questions. A particular focus will be on the use of probability to answer questions in graph theory. This is known as the “Probabilistic Method”, initiated by Erdős. A further aim is to help students develop their ability to create their own mathematical proofs.

Relation to other mathematics courses

Graph Theory is an important part of Combinatorics, which is itself a subset of Discrete Mathematics. If you have taken a Discrete Mathematics course then you will have already been introduced to graph theory.

Probability Theory is an extremely useful part of Mathematics and Statistics, used in many areas. The School’s first year mathematics courses provide an introduction to probability.

In MATH5425 no prior knowledge of graph theory or probability theory is assumed.
Student learning outcomes

Students taking this course will:

• come to understand many concepts and definitions used in graph theory,
• master various combinatorial and probabilistic techniques used in graph theory,
• develop their ability to manipulate and apply these concepts and techniques to solve simple and complex problems in graph theory.

These outcomes particularly relate to Faculty of Science Graduate Attribute 1: Research, inquiry and analytical thinking abilities and UNSW Graduate Attribute 3: the capacity for analytical and critical thinking and for creative problem solving.

Teaching strategies used

New concepts and techniques are first introduced and demonstrated in lectures, then students master these concepts and techniques by applying them to problem sheet questions and assessment tasks. In lectures, students will be expected to think, as well as listen, and will have the opportunity to test their understanding by answering questions posed by the lecturer. In tutorials, discussion of a particular problem sheet question may reveal a new concept or method to the students which then forms part of the content of the course.

Rationale: We believe that effective learning is best supported when students are actively engaged with the new mathematical concepts and techniques, for example by thinking about the new material, asking questions during lectures and making a serious attempt to solve the problem sheet questions before attending the tutorials.

Assessment

The plan is to have 2 assignments worth 25% each, due in weeks 6 and 10, and a final exam worth 50%. This plan will be discussed at the first lecture.

Assessment criteria: In the assignments and the exam, marks will be awarded for correct working, logical setting out, appropriate explanations, clear notation and presentation, as well as for the final answer. The aim of this is to develop students’ ability to present their mathematics in a professional way.

Assessment rationale: Assessment in this course will evaluate the students’ understanding of the graph-theoretical concepts presented in lectures (Science Graduate Attribute 1) and their mastery of problem-solving techniques developed in lectures, as well as creativity and critical thinking (UNSW Graduate Attribute 3). The assignments will also provide feedback on students’ progress and may introduce new concepts not covered in lectures.

Further assessment information

Assignments may be handwritten or prepared using the mathematical typesetting language \LaTeX.
Students may discuss solutions to assignment questions with other students currently taking the course, provided that they write up their solution independently (and not simply copy from each other) and acknowledge help that they have received from fellow students or from books (giving a reference).

Further information about the exam will be given out in lectures towards the end of the course.

**Detailed course outline**

The topics will be covered in the following order, but note that the indicated weeks (in brackets) are approximate.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Weeks</th>
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<tbody>
<tr>
<td>Introduction</td>
<td>(Weeks 1 &amp; 2)</td>
</tr>
<tr>
<td>Matchings, Hamilton cycles, the probabilistic method</td>
<td>(Weeks 3 &amp; 4)</td>
</tr>
<tr>
<td>Graph colourings</td>
<td>(Weeks 5 &amp; 6)</td>
</tr>
<tr>
<td>Connectivity</td>
<td>(Week 7)</td>
</tr>
<tr>
<td>Planar graphs</td>
<td>(Weeks 8 &amp; 9)</td>
</tr>
<tr>
<td>Ramsey Theory</td>
<td>(Week 10)</td>
</tr>
<tr>
<td>Random graphs</td>
<td>(Weeks 11 &amp; 12)</td>
</tr>
</tbody>
</table>

**Additional resources**

**Textbooks:** Much of the course will be based on Reinhard Diestel’s book *Graph Theory* 4th edn. (Springer 2010). This book can be viewed for free at [http://diestel-graph-theory.com](http://diestel-graph-theory.com) and the 2nd and 3rd editions can be found in the library, (P511.5/8).

Other material will be drawn from


There are no lecture notes for this course.

A set of problem sheets will be handed out during the semester. It is very strongly recommended that you make a serious attempt at these problems yourselves before attending the tutorials.

Some miscellaneous handouts will be given out at various points of the course.

The problem sheets, handouts and assignments will also be made available on Blackboard during the semester.
Course evaluation and development

The School of Mathematics and Statistics evaluates each course each time it is run. Feedback on the course is gathered, using among other means, UNSW’s Course and Teaching Evaluation and Improvement (CATEI) Process. Student feedback is taken seriously and continual improvements are made to the course based in part on such feedback.

The MATH5425 students in previous years felt that they would have liked more tutorial time. Consequently, tutorials are now weekly.

Administrative matters

- The School of Mathematics and Statistics has policies regarding attendance, additional assessment, special consideration in the event of illness and misadventure, and so on. We assume that you are familiar with these policies, so please familiarise yourself with them! See
  
  http://www.maths.unsw.edu.au/currentstudents/student-services

  and

  https://my.unsw.edu.au/student/resources/Policies.html

- You should also know what plagiarism is and be aware of UNSW’s plagiarism policy. See

  http://www.lc.unsw.edu.au/plagiarism/

  and

  https://my.unsw.edu.au/student/academiclife/assessment/StudentMisconduct.html

- Keep it safe! UNSW has policies on Occupational Health and Safety:


- Equity and Diversity issues should be directed to the Student Equity Officers in the Student Equity and Diversity Unit (ph. 9385 4734).

- Further information for students with disabilities is available at

  https://my.unsw.edu.au/student/atoz/Disability.html