This is a 6 UOC level V course, suitable for Honours students or coursework Masters students, or for undergraduates with suitably high marks in relevant mathematics subjects, by permission of the lecturer. There are no official prerequisites and no exclusions.

We have been scheduled three hours of lectures, in weeks 1 - 12, all in the Red Centre.

- Wednesday 10:00 – 12:00, room RC-1042
- Friday 11:00 – 12:00, room RC-3085

(After we get going, we may designate the Friday time slot as a tutorial.)

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 covers 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. The basic discrete probability theory required for this course will be introduced when it is needed.
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

UNSW assesses students under a standards based assessment policy. For how this policy is applied in the School of Mathematics and Statistics see [http://www.maths.unsw.edu.au/currentstudents/assessment-policies](http://www.maths.unsw.edu.au/currentstudents/assessment-policies)

The plan is to have 2 assignments worth 25% each, due in weeks 5 and 10 (at the end of the Wednesday lectures), 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>Week(s)</th>
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</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>(Weeks 1 &amp; 2)</td>
</tr>
<tr>
<td>Matchings and Hamilton cycles</td>
<td>(Weeks 3 &amp; 4)</td>
</tr>
<tr>
<td>The probabilistic method</td>
<td>(Week 4)</td>
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<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>
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Additional resources

Textbooks: Much of the course will be based on Reinhard Diestel’s excellent book *Graph Theory* 3rd edn. (Springer 2005), which is available in the library – P511.5/8 – and online at http://diestel-graph-theory.com (I just use the Free Preview).

Other material will be drawn from


Summary notes containing definitions and theorem statements will be posted to Moodle. (This is a first for 2015: in previous years, students just had to take notes from the board for everything!)

A set of problem sheets will be posted to Moodle. It is very strongly recommended that you make a serious attempt at these problems yourselves before attending the tutorials.

Some miscellaneous handouts may also be made available at various points of the course.
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. They also requested some lecture notes and, as a result, I have made summary notes available.

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/assessment-policies](http://www.maths.unsw.edu.au/currentstudents/assessment-policies) and [https://student.unsw.edu.au/policy](https://student.unsw.edu.au/policy)

- You should also know what plagiarism is and be aware of UNSW’s plagiarism policy. See [https://student.unsw.edu.au/plagiarism/](https://student.unsw.edu.au/plagiarism/) and [https://student.unsw.edu.au/conduct](https://student.unsw.edu.au/conduct)

- Find support and resources related to your wellbeing, health and safety here: [https://student.unsw.edu.au/wellbeing](https://student.unsw.edu.au/wellbeing)

- UNSW has a Student Equity and Disabilities Unit [http://www.studentequity.unsw.edu.au](http://www.studentequity.unsw.edu.au)