SCHOOL OF MATHEMATICS AND STATISTICS
UNSW Sydney

MATH5425 Graph Theory Term 3 2019

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Email: c.greenhill@unsw.edu.au
Room: Red Center (east wing) room RC-5105
Consultation: Please email for an appointment, or drop by

Some lectures will be delivered by Dr Anita Liebenau.

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Room: Red Center (east wing) room RC-6105

MATH5425 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.

The class times and locations are as follows:

- Tuesday 10:00 – 12:00, RC-2063, weeks 1 – 5 and 7 – 10
- Thursday 14:00 – 16:00, RC-1043, weeks 1 – 5 and 7 – 10

There will be no classes in week 6. In total there will be 24 hours designated as lectures (L) and 12 hours designated as tutorials (T), as shown in the table below. However, in this course the boundary between lectures and tutorials is blurry, and this plan will be adjusted as needed throughout the term.

<table>
<thead>
<tr>
<th>Week</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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<th>10</th>
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Course description

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 probably seen some 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.

Course 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
<table>
<thead>
<tr>
<th>Assessment task</th>
<th>date released</th>
<th>due date</th>
<th>weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment 1</td>
<td>1st lecture, Week 1</td>
<td>1st lecture, Week 3</td>
<td>15%</td>
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<tr>
<td>Assignment 2</td>
<td>1st lecture, Week 5</td>
<td>1st lecture, Week 8</td>
<td>25%</td>
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<tr>
<td>Final exam</td>
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<td>60%</td>
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**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 are approximate.

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
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<tbody>
<tr>
<td>1</td>
<td>Introduction to graph theory</td>
</tr>
<tr>
<td>2</td>
<td>Matchings and Hamilton cycles</td>
</tr>
<tr>
<td>3</td>
<td>Introduction to the probabilistic method</td>
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<tr>
<td>4</td>
<td>Graph colourings</td>
</tr>
<tr>
<td>5</td>
<td>Connectivity; Planar graphs</td>
</tr>
<tr>
<td>6</td>
<td>(break: no MATH5425 lectures or tutorials)</td>
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<tr>
<td>7</td>
<td>Planar graphs</td>
</tr>
<tr>
<td>8</td>
<td>Ramsey Theory</td>
</tr>
<tr>
<td>9</td>
<td>Random graphs</td>
</tr>
<tr>
<td>10</td>
<td>Consolidation</td>
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Additional resources

Textbooks: Much of the course will be based on Reinhard Diestel’s excellent book *Graph Theory* 5th edn. (Springer 2016), 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.

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 myExperience surveys. 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, we have increased the amount of tutorials to 12 hours. Students also requested some lecture notes and, as a result, starting in 2015, summary notes are 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 and 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/ and https://student.unsw.edu.au/conduct
- Find support and resources related to your wellbeing, health and safety here: https://student.unsw.edu.au/wellbeing
- UNSW has a Student Equity and Disabilities Unit http://www.studendequity.unsw.edu.au