On-line course materials

MATH39001 - Combinatorics and Graph Theory

Year: 3 - **Semester:** 1 - **Credit Rating:** 10

Aims

To introduce the students to graphs, their properties and their applications as models of networks.

To introduce the students to generating functions and their applications.

Brief Description

A graph consists of a set of vertices with a set of edges connecting some pairs vertices. Depending on the context, the edges may represent a mathematical relation, two people knowing each other or roads connecting towns, etc. The graph theory part of the course deals with networks, structure of graphs, and extremal problems involving graphs.

The combinatorial half of this course is concerned with enumeration, that is, given a family of problems P(n), n a natural number, find a(n), the number of solutions of P(n) for each such n. The basic device is the generating function, a function F(t) that can be found directly from a description of the problem and for which there exists an expansion in the form F(t) = sum {a(n)gn(t); n a natural number}. Generating functions are also used to prove a family of counting formulae to prove combinatorial identities and obtain asymptotic formulae for a(n).

Learning Outcomes

On successful completion of the course students will be:

- able to formulate problems in terms of graphs, solve graph theoretic problems and apply algorithms taught in the course;
- able to use generating functions to solve a variety of combinatorial problems.

Syllabus

Graph Theory

- Introduction. [1 lecture]
- Electrical networks. [2]
- Flows in graphs, Max-flow min-cut theorem. [3]
- Matching problems. [3]
- Extremal problems. [3]

Combinatorics

- Examples using ordinary power series and exponential generating functions, general properties of such functions. [3]
- Dirichlet Series as generating functions. [1]
- A general family of problems described in terms of "cards, decks and hands" with solution methods using generating functions. [3]
- Generating function proofs of the sieve formula and of various combinatorial identities. Certifying combinatorial identities. [2]
- Some analytical methods and asymptotic results. [2]

Teaching & Learning Process (Hours Allocated To)

Lectures	Tutorials/ Example Classes	Practical Work/ Laboratory	Private Study	Total
22	11	0	67	100

Assessment and Feedback

- Coursework: in-class test in week 5, weighting 20%
- End of semester examination: two hours, weighting 80%

Further Reading

- B Bollobas, Graph theory, An introductory course (Graduate Texts in Mathematics 63), Springer, 1979.
- B Bollobas, Modern graph theory, (Graduate Texts in Mathematics 184), Springer, 1998.
- D Jungnickel, Graphs, Networks and Algorithms (Algorithms & Computation in Mathematics 5), Springer, 1998.
- H S Wilf, generatingfunctionology, A K Peters, 3rd ed., 2006.

Staff Involved

Dr Gabor Megyesi - Lecturer

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