MATH 132, Discrete and Combinatorial Mathematics, Spring 2014

Course specification

Laurence Barker, Bilkent University, version: 20 March 2014.

Course Aims: To supply an introduction to some concepts and techniques associated with discrete mathematical methods in engineering and information technology; in particular, to provide experience of the art of very clear deductive explanation.

Formal Course Description: The two terms *discrete mathematics* and *combinatorics* mean the same thing, except that the former has the flavour of applicable mathematics, the latter has the flavour of pure mathematics. The terms refer to a branch of mathematics which arose with the advent of electronic computers and information technology. It is the study of mathematical objects which do not have very much topological, geometric or algebraic structure.

Unlike calculus, linear algebra, statistics, it does not have deep theory. Solutions tend to comparatively unsystematic, though certain fundamental ideas do tend to be used quite frequently. For that reason, the study of discrete mathematics depends heavily on the art of *very clear deductive explanation*, which will be emphasized throughout the course.

The course is intended only as an introduction, for students who have little or no previous experience of this kind of mathematics.

We shall be studying four main areas, separate but with some interactions: graph theory; relations and enumerative combinatorics; coding theory; Boolean algebra and gating networks.

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Assistants: Hatice Mutlu, Mehmet Akif Erdal, Bengi Ruken Yavuz.

Text: R. P. Grimaldi, "Discrete and Combinatorial Mathematics", 5th Ed. (Pearson, 2004).

Some notes will be supplied, on my webpage, for some of the syllabus material.

Classroom hours:
Section 1, Wednesday 9:30 - 10:20, Friday 10:30 - 12:20.
Section 2, Tuesday 10:30 - 12:20, Friday 9:30 - 10:20.
Section 3, Monday 9:30 - 10:20, Wednesday 10:30 - 12:20.

Office Hours: For all sections, 08:30 - 09:20 Monday, Wednesday, Friday in room SAZ 129 of Fen A Building. (During Week 8, before the Midterm, Office Hours will be held in the classroom G-236.)

Office Hours is not just for the stronger students. If you are having difficulty with the course, then you must come to me for help with the mathematics. In fact, I need students at all levels to come, to make sure that I pitch the classes appropriately.

Class Announcements: All students, including any absentees from a class, will be deemed responsible for awareness of announcements made in class.

Assessment

Homeworks: The only way to pick up skill at mathematical communication is through lots of practise. Because of the continuous assessment system, natural communication between students is subject to a constraint: *You may discuss homeworks solutions amongst yourselves, but you may not copy and you may not do paraphrase rewrites of work by others.*

I encourage you to discuss the homeworks with me during office hours. I will tend to give help to students who have at least some thoughts or questions of their own about the homework. Just to be clear: you will not lose any marks for any help I may give you with the homework.

However, before asking anyone else for help, *first do your best with the homework on your own.* If you get stuck on problems and then find out the solutions, the ideas will sink in. If you just lazily wait for other people to give you the solutions, then you will not learn how to do mathematics.

Participation: Each section will have different quizzes. The total mark for quizzes will incorporate a mark for the academic participation performance of the whole class: for example, addressing questions to the teacher, not making a distracting noise by murmuring just to your neighbours.

Principle of marking: In mathematics, marks for written work are not awarded according to guesses about what the student might have had in mind when writing out the solution. They are awarded according to *how helpful the explanation would be to other students in the class.*

Grading percentages:

- Quizzes, participation and homework, 20%,
- Midterm 30%, (Wednesday, 2 April, at 18:00).
- Final, 50%.

Letter Grades: This is done by the "curve method". A grade C requires an understanding of the concepts and reasonable attempts at the easiest exam questions. That fulfills the aim of the course: a competent grasp at an introductory level.

Some of the exercises and exam questions will be quite difficult. It has to be that way, not only for the benefit of the strongest students, but also because, without difficult questions, it would be hard to see the purpose of the art of *very clear deductive explanation.* However, students aiming for a grade C need not worry about being unable to do the more difficult questions.

Attendance: A minimum of 75% attendance is compulsory. Exceptions may be made for students with very good exam results. However, less than 50% attendance as measured by quizzes will result in an FZ grade.

Syllabus

Week number: Monday date: Subtopics. Section numbers

1: 3 Feb: (Classes start 5 Feb.) Discrete methods and information technology. Examples of problems in discrete mathematics. Sketch of the use of mathematical induction, 4.1.

2: 10 Feb: Recursive definitions and mathematical induction, 4.2. Second order recurrence relations as an application of induction, 10.2.

3: 17 Feb: Graphs. Sum of degrees formula. Circuits and Trees, 11.1, 11.2.

4: 24 Feb: Criteria for existence of Euler paths or Euler circuits, proved by mathematical induction, 11.3.

5: 3 Mar: Euler's characteristic formula for planar graphs, proved by mathematical induction. The non-planarity of the graphs K_5 and $K_{3,3}$, 11.4.

6: 10 Mar: Review of mathematical induction and graph theory. More practise at exercises.

7: 17 Mar: Permutations, combinations, the Binomial theorem, 1.2, 1.3, 1.4.

8: 24 Mar: Sets and correspondences. Functions. Injections, surjections and bijections, 5.1, 5.2, 5.3, 5.6.

9: 31 Mar: Relations. Incidence matrices. Reflexive, irreflexive, symmetric, antisymmetric and transitive relations. Enumeration of relations using incidence matrices, 7.1, 7.2.

Midterm: Wednesday, 2 April, at 18:00.

10: 7 Apr: Partial ordering relations and Hasse diagrams, equivalence relations, 7.3, 7.4.

11: 14 Apr: Coding theory, Hamming metric, 16.5, 16.6.

12: 21 Apr: Parity-check and generator matrics, decoding using syndromes and coset leaders, 16.7, 16.8.

13: 28 Apr: Logic, evaluation of compound statements using truth tables or laws of logic, 2.1, 2.2.

14: 5 May: Logic, Boolean algebra, gating networks, 5.1, 15.2.

15: 12 May: (Classes end 16 May.) Review of enumerative combinatorics, coding theory and Boolean algebra. More practise at exercises.