University of Dundee Mathematics Division

MA21003: Discrete Mathematics Guide

Organisation

The MA21003 module runs for 11 teaching weeks in the first semester, and is worth 20 SCQF credits (equal to 10 ECTS points). The members who are responsible for the entire organisation and teaching are:

Dr Mariya Ptashnyk  Dr. Hiroko Kamei
Mathematics Division  Mathematics Division
Room Fulton G9,  Fulton G6,
01382 – 384467  01382 – 384476
mptashnyk@maths.dundee.ac.uk  hiroko@maths.dundee.ac.uk

Dr Simon Candelaresi
Mathematics Division
Room Fulton G19
01382 – 384485
scandelaresi@maths.dundee.ac.uk

The Module Leader is Dr Ptashnyk.

You will have up to four lectures and attend one of two workshop sessions each week (in order to have smaller groups, the class will be divided in two for the workshops). You may bring matters of concern about the course to the attention of the Mathematics Division Staff/Student Committee, which meets once each semester. A volunteer will act as class representative to sit on the Staff–Student Committee; their name will be posted on BlackBoard.

Your Commitment

You should attend all lectures and workshops except on medical grounds or with the special permission of the lecturer concerned. If you are absent from a Class Test (Quizzes) on account of medical problems, you should submit a medical certificate to your Faculty Office. You should also complete all the homework exercises and keep a record of all your work requiring use of the software package Scientific Notebook.

Study Support

If you are having difficulty with the course work you are encouraged to seek help at an early stage at the Workshops or from your lecturers. You are also very much encouraged to use Maths Base, a drop-in facility in the Division which provides an additional source of help with your studies, http://www/teaching/mathbase.shtml.

Syllabus

This module involves 200 hours of student effort, with 66 contact hours (comprising lectures, workshops and other class meetings).

Sets and Graphs  (4 lectures)

Sets: Definition, Definition of a n-Set.
Subsets: Definition, Examples, $|2^A| = 2^{|A|}$.
Cartesian product of sets. Relations on sets.
Basic Graph Terminology. Connectivity of graphs. Definition of a tree.

**Combinatorics** (4 lectures)
- Permutations and Combinations.
- Binomial coefficients and their properties. Binomial Theorem.
- Principle of inclusion and exclusion.
- Derangements.
- Partitions and Stirling numbers.
- Transpositions and Cycles.
- Multinomial Theorem.
- Newton’s Binomial Theorem.

**Recurrence relations** (4 lectures)
- Definition of a recurrence relation.
- Application: Newton and Secant Methods to solve non-linear equations \( f(x) = 0 \).
- Programming: Short introduction to Matlab.

**Recurrence relations (Difference Equations) continuation** (4 lectures)
- Homogeneous and inhomogeneous difference equations.
- Finite differences. Factorial polynomials. Nonlinear difference equations: \( x_{n+1} = g(x_n) \). Fixed points, linearisation, stability.
- Second order equations: general solution of homogeneous equations.
- Generating functions: the connection between the difference equation \( u_{n+2} + pu_{n+1} + qu_n = 0 \) and the Maclaurin expansion of \( \frac{ax + b}{1 + px + qx^2} \).

**Game Theory** (16 lectures)
- Strategic form games
- Dominated Strategies
- Nash Equilibrium
- Prisoner’s Dilema
- Two-person zero-sum games
- The minimax Theorem
- Extensive form games with perfect information

**Markov Chains** (8 lectures)
- Definition of a Markov chain. Probability vectors, stochastic matrices.
- Connection with second order difference equations.
- Long time behaviour of a process described by a Markov chain.
- Random walk as a Markov chain.
- Absorbing and irreducible Markov chains. Hitting probabilities and mean hitting times.
- Law of Large Numbers for Markov chains.
An Introduction into Boolean Algebra (3 lectures)
- Definition of Boolean Algebra.
- Properties and relations in Boolean algebra.
- Circuit Diagrams.

Assessment

There will be Homworks, Quizzes (small Class Tests of 15 minutes) and a Degree Examination in the December diet of examinations. These contribute to the overall assessment as shown in the Table below.

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homeworks (typically weekly)</td>
<td>20%</td>
</tr>
<tr>
<td>Quizzes (roughly every two weeks)</td>
<td>20%</td>
</tr>
<tr>
<td>Degree Examination</td>
<td>60%</td>
</tr>
</tbody>
</table>

Marks in these assessments will be deducted for work if the presentation is deemed unsatisfactory or not handed in by the deadline given.

To pass this module in December it is necessary to gain at least 40% in the overall assessment and hand in all work requested and attempt class tests. There will be penalties for late submission of work.

For those who fail the module in December there will be a two-hour examination paper at the July/August Examination diet. The overall assessment will be based on 60% of the mark gained at the resit examination with the remaining 40% coming from homework/class test (quizzes) marks in the first semester.

The Head of Division may debar a student not performing at a satisfactory level in the continuous assessments from entering the Degree Examination in December.

Awards

A medal may be awarded to the best student in the class.

Feedback

At the end of each section of the module you will be asked to complete a confidential questionnaire regarding the content and presentation of the module. This is an important element in the University’s Academic Standards procedures.

Recommended Books


• *Linear Algebra: a modern introduction*, David Poole, 2011.


**Web Resources**

Advance@Dundee http://www.dundee.ac.uk/advancedundee/

This is the University of Dundee Transferable Skills Website and is divided into eight key skill areas and over 60 specific topics giving access to hundreds of interlinked articles about personal transferable skills. The eight skill areas include pages on Basic Maths & Stats. There are many other resources available on the web that are relevant to these modules.

Study Skills online:  http://people.brunel.ac.uk/~mastmmg/ssguide/sshome.htm

A useful set of pages written by Martin Greenhow of Brunel University.

We suggest you use Google or some other search engine to discover further web resources.