

COMS10003: Mathematical Methods for Computer Scientists

20CP unit for first year computer scientists

Summary

Mathematics is the language of Computer Science. It allows us to communicate and to reason, about ideas and techniques, both formally and informally. This might be to sketch out an algorithm, to prove the validity of a program or to demonstrate the computational complexity of a solution.

Computer Scientists need to be fluent in this language, readily able to construct theoretical representations of problems and to use them to develop solutions, in terms of algorithms and programs. You also need to be flexible - having the confidence and skills to pick up new ideas and techniques from mathematics, as and when needed.

The aim of this unit is to give you a basic grounding in these skills, building on your existing mathematical knowledge, whilst at the same time covering the principles of key topics relevant to computer science. These come from the following areas: logic and proof; objects and functions; analysis; linear algebra; and probability and random variables. The relevance of each topic will be demonstrated using practical examples.

Learning Outcomes

On successful completion of the unit, you will:

1. Fully appreciate the importance of mathematics in computer science and be able to identify the areas of mathematics which are relevant to a given area of computer science;
2. Be able to formulate theoretical representations of a range of problems, with rigor and with the correct use of notation, and to link this to the definition of algorithms and implementation of programs;
3. Have a thorough understanding of key topics from mathematics relevant to computer science from the areas listed above;
4. Be able to converse using mathematical terms and representation with confidence and agility, on a range of topics from computer science, both verbally and in writing;
5. Have the confidence and ability to research and learn about previously unseen areas of mathematics and be able to extract relevant knowledge and understanding for a given task.

Syllabus

- **Logic and proof:** propositional logic; syntax and semantics; truth tables; validity, satisfiability and equivalence; proof by induction; proof strategies.
- **Number theory:** modular arithmetic; gcd and Euclid's algorithm; modular inverses; Fermat's little theorem and Euler's theorem, application - public key cryptography and RSA.

- **Probability and combinatorics:** probability, conditional probability and independence; permutations and combinatorics; Bayes' theorem
- **Analysis:** differential equations; Taylor series, Euler's method; Ruge Kutta method; partial differentiation and the gradient vector; Fourier series and the Fourier transform.
- **Linear algebra:** vectors and vector spaces; matrices; linear equations and inverting matrices; eigenvalues and eigenvectors.
- **Random variables:** probability distributions and densities; mean and variance; Bernoulli and binomial distributions; the normal distribution and the central limit theorem.

People

Andrew Calway (AC): andrew@cs.bris.ac.uk - Unit director
 Kerstin Eder (KE): kerstin.eder@bristol.ac.uk - Lecturer
 Julian Gough (JG): Julian.Gough@bristol.ac.uk - Lecturer
 Lewis Roberts: Lewis.Roberts@bristol.ac.uk - Teaching assistant
 Yani Berdeni: Yani.Berdeni@bristol.ac.uk - Teaching assistant

Schedule

Week 1	Introduction	AC/KE
Weeks 2-6	Logic and Proof	KE
Weeks 7-10	Number Theory	JG
Weeks 11-12	Probability and combinatorics	AC
Weeks 13-17	Analysis	JG
Weeks 18-22	Linear algebra	AC
Weeks 23-24	Random variables	AC

Unit Sessions

There are three sessions each week: a 50-minute lecture, a 2-hour workshop and a 1-hour help session. In the **lecture** the topic for the week will be introduced and key concepts covered. You are expected to follow up the lecture with self-study - using unit materials, textbooks and online material to fully understand the key concepts and reading around the topic to gain wider knowledge and more in-depth understanding.

In the **workshops** you will work in groups to tackle problems from a worksheet related to the current topic. The aim of the workshop is for everyone to gain full understanding of the problems through interaction with other students. You are encouraged to use whiteboards and discuss your solutions and problems within your group. You will get feedback and help from teaching assistants and lecturers. It is important to complete each worksheet by the end of each week, ready to start a new topic in the following week.

If you are having difficulties with the current topic and/or worksheet then you can get help and feedback from the **weekly help session**. These will take place in the MVB atrium and will give you the opportunity for one-to-one tuition from the teaching assistants.

Unit Forum and Unit Web Page

Everyone is encouraged to use the unit forum, which you can access via the unit web page: <https://www.cs.bris.ac.uk/Teaching/Resources/COMS10003/>. The forum allows you to post questions about lectures, workshops and worksheets and enables you to get help and feedback from other students and from teaching assistants. It is a very effective resource if used correctly in the spirit of everyone helping everyone else. The unit web page also contains links to lectures slides, lecture notes and other relevant material.

Assessment

The assessment for the unit consists of two main parts: coursework, worth 50%, and an exam, worth 50%. The exam will take place at the end of the unit in May/June. The coursework is divided into two parts, worth 25% each, and each consists of two parts: the submission of solutions to a set of questions and a viva on your solutions. Further details will be released later in the unit.

There are also class tests throughout the year. These will enable you to assess your progress and get feedback on your ability to answer questions in preparation for the coursework and for the exam.

Feedback and Help

Our aim is that everyone will pass this unit and finish it with a thorough understanding of the topics covered and having developed a fluency and confidence in mathematics to prepare them for the remainder of the CS programme.

You can achieve this if you put in sufficient time and effort, making use of the lectures and workshops and working with your fellow students and with the unit teaching staff. If you have difficulties then make use of the help sessions and also ask the lecturers and teaching assistants for help – we are here to help you.

Time allocation

It is important that you set enough time aside to allow yourself to learn – we expect you to spend at least 3 hours per week on self-study for the unit, in addition to the 1-hour lecture and 2-hour workshop, i.e. you should be looking to spend around 6/7 hours per week on the unit – it is worth $20/120=1/6$ of your first year and you we expect you to allocate around 40 hours per week on your studies, which means that you should spend around $40/6=6.6$ hours per week on this unit.