Introduction

The BSc (Hons) Computational Mathematics is designed to ensure that you acquire skills in not only a blend of mathematical topics with related core areas of computing, selected from our professionally accredited computing programmes, but also a range of general transferable skills which will be attractive to a wide range of potential employers. The aim is to offer you an enjoyable and stimulating programme in a pleasant working atmosphere with excellent facilities.

The programme has been developed with a careful view to fulfilling the objectives of the 'Framework for Higher Education Qualifications: Descriptors for taught awards' and the Subject Benchmark Statements of the QAA for both 'Mathematics, statistics and operational research' (2007) and 'Computing' (2007).

In the first two years you will develop skills in Mathematics and Computing through a combination of theory and practice, whilst enhancing your key skills and ability to use modern PC software. In your final year you can choose from modules embracing more specialized subjects and will undertake a stimulating research-orientated project. This will instil not only a deeper understanding of mathematical topics, but also their utilization in computational applications, ranging, for example, from...

Additionally, you will be actively encouraged to develop a portfolio of appropriate transferable skills and attributes by providing a supportive, structured environment in which to achieve independent learning, team-working and personal skills. This will equip you with the ability and confidence to enter directly into responsible employment, or to pursue further study.

The programme can be studied over four years to incorporate an optional placement year in supervised practice taken between Levels five and six in an industrial, commercial or educative organisation. Undertaking an extramural year enables you to extend and apply your learning; gain practical experience which is highly valued by employers.

Programme Aims

The aim of BSc (Hons) Computational Mathematics is to provide you with the theoretical base in mathematics and computing and this will be achieved by delivering core themes that run through the programme. In computing these are modules selected from our accredited programmes, in mathematics they are focused around Statistics and Reliability, Differential Equations and Engineering applications. In the first two years of the programme, core skills are developed in mathematics, statistics and computing. In the final year, students can choose from a variety of more specialised subjects, and undertake a research-oriented project. This aim will be achieved by:

- providing you with a core of fundamental modules that are essential to all mathematicians and computer scientists, which are introduced in the first year and built upon in the second year. The final year consists of a major project, together with choices from a range of options, so that you may choose the particular area in which you are strong or wish to specialize, which builds on the knowledge and understanding gained earlier.
- providing the support, in the form of lectures, labs and tutorials together with up-to-date computing facilities, that will help you to successfully complete your programme.
- developing your discipline skills and personal transferable skills so that on graduation you are in a position to apply for positions in industry or commerce, or pursue further programmes of study.

Programme Learning Outcomes

Upon successful completion of the programme you will have a highly-developed range of knowledge-based and transferable skills. As such you will have achieved:

- **Knowledge and Understanding** of general principles, methods and techniques and a range of major areas of Mathematics and Computing. You will understand the role of logical mathematical argument and deductive reasoning, computational thinking and its relevance to everyday life, numerical mathematics and mathematical computing, and modelling and design.
• **Discipline Skills** including the ability to comprehend and abstract the essential features of problems and formulate them so as to facilitate their analysis and solution. You will be able to construct and develop logical arguments with clear identification of assumptions and conclusions, while deploying effectively the appropriate mathematical, computational and more general IT skills as an aid to solving practical problems.

• **Personal Transferable Skills** including the ability to learn independently using a variety of media such as books, learned journals, browsers, search engines and catalogues, and to work independently with persistence and patience in pursuing a problem's solution relentlessly. You will be able to assess problems logically with an analytical approach, write coherently and generally communicate clearly with an appreciation of the necessity for continuing professional and personal development in recognition of the need for lifelong learning.

More specifically, when you have completed the programme you will be able to:

LO1. Demonstrate a working knowledge of the methods and application or advanced calculus.

LO2. Demonstrate a working knowledge of the methods and applications of linear mathematics.

LO3. Demonstrate a working knowledge of the fundamentals of statistics, probability and reliability theory.

LO4. Demonstrate knowledge of and competence in programming languages, applications, algorithms and data structures.

LO5. Show an understanding of the mathematical foundations of Computing.

LO6. Be able to formulate simple problems in statistical terms and analyse data using standard techniques.

LO7. Analyse mathematical problems and select and apply appropriate mathematical tools and techniques in their solution.

LO8. Demonstrate a knowledge and understanding of the mathematics necessary for the application of an area of engineering science.

LO9. Produce complex designs to meet specified requirements.

LO10. Exercise independent thought and judgement.

LO11. Show judgement in the selection and application of mathematical tools and techniques.

LO12. Use engineering science, mathematics and information technology to analyse complex engineering problems.

LO13. Be able to design and conduct experimental investigations and analyse the results.

LO14. Command practical skills in data management & presentation, interpretation of information, IT and communication skills, and demonstrate experience of creative and systematic problem solving through reflective and enquiring learning. This includes teamwork and leadership, effective project management and personal management.
On completion of this award at Certificate of Higher Education level you will be able to:

1. Demonstrate a knowledge of basics of software construction and the tools required to support it, develop skill in constructing software.
2. Use the j2se core packages library and select appropriate components for particular purposes.
3. Recognise and implement some software design patterns.
4. Manipulate data using the basic principles of event theory and discrete random variables.
5. Apply the underlying properties of mathematical expectation, sample analysis, regression modelling, estimation, sampling and statistical inference.
6. Manipulate and apply the fundamental properties of geometry, matrices, sequences, series and complex number theory.
7. Work effectively as individuals and in groups.
8. Communicate accurately and reliably with a range of audiences using basic theories and concepts of the subjects of study.
9. Explain and apply a range of mathematical concepts and techniques to describe, model, analyse and evaluate mechanical and general engineering problems.

On completion of this award at Diploma of Higher Education level you will be able to:

1. Construct and test simple algorithms, and calculate asymptotic order of run times for algorithms.
2. Define the Abstract Data Types in terms of their data structures and algorithms and demonstrate their operation and effect.
3. Apply difference equations and iterative processes to solve Ordinary Differential Equations in realistic situations.
4. Apply in realistic situations the fundamental methods of numerical algebra and calculus.
5. Manipulate and apply to realistic physical cases the fundamental theories of ordinary differential equations and orthogonal polynomials.
6. Manipulate and apply in simple cases, the fundamental theory of differential equations, functions of several variables and multiple integrals.
7. Formulate suitable statistical hypotheses concerning real-life phenomena, select and correctly apply an appropriate test procedure, and draw relevant conclusions.
8. Demonstrate an ability to plan an experiment including a consideration of appropriate methods of analysis and interpretation of results.
9. Use personal and technical skills to communicate effectively within computing and mathematical environments.
Although the University does not recruit directly to Ordinary degrees this route is available. Ordinary degrees comprise 100 credits at each stage. A Bachelor’s degree (Ordinary) is awarded to students who have demonstrated:

- a systematic understanding key aspects of their field of study, including acquisition of coherent and detailed knowledge informed by aspects of mathematical and computational concepts and techniques.
- an ability to deploy accurately established techniques of analysis and enquiry within computing and mathematics.
- conceptual understanding that enables the student:
  - to devise and sustain arguments, and/or to solve problems, using ideas and techniques.
  - to describe and comment upon particular aspects of current research, or equivalent scholarship, or practice in computational mathematics.
- an appreciation of the uncertainty, ambiguity and limits of knowledge.
- the ability to manage their own learning, and to make use of primary sources.

Typically, holders of the qualification will be able to:

- apply the methods and techniques that they have learned to review, consolidate, extend and apply their knowledge and understanding.
- communicate information, ideas, problems and solutions to both specialist and non specialist audiences.

And holders will have:

- the qualities and transferable skills necessary for employment requiring:
  - the exercise of initiative and personal responsibility
  - the learning ability needed to undertake appropriate further training of a professional or equivalent nature.

### Curriculum

The matrix of studies offered in the programme is detailed below.

#### Stage 1 [FHEQ Level 4]

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Title</th>
<th>Type</th>
<th>Credits</th>
<th>Level</th>
<th>Study period</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM-0125L</td>
<td>Fundamental Mathematics</td>
<td>C C</td>
<td>20</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>CM-0113L</td>
<td>Developing Professional Skills</td>
<td>C C</td>
<td>20</td>
<td>4</td>
<td>1 &amp; 2</td>
</tr>
<tr>
<td>CM-0123L</td>
<td>Statistics (Discrete and Continuous)</td>
<td>C C</td>
<td>20</td>
<td>4</td>
<td>1 &amp; 2</td>
</tr>
<tr>
<td>CM-0116D</td>
<td>Software Development 1</td>
<td>C C</td>
<td>20</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>ENG1074L</td>
<td>Engineering Analysis</td>
<td>C C</td>
<td>20</td>
<td>4</td>
<td>1 &amp; 2</td>
</tr>
<tr>
<td>CM-0117D</td>
<td>Software Development 2</td>
<td>C C</td>
<td>20</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

Students who have achieved at least 120 credit points at Level 4 may exit the programme and are eligible for the award of Certificate of Higher Education.
Stage 2 [FHEQ Level 5]

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Title</th>
<th>Type</th>
<th>Credits</th>
<th>Level</th>
<th>Study period</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM-0225D</td>
<td>Ordinary Differential Equations</td>
<td>C</td>
<td>20</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>CM-0216D</td>
<td>Numerical Algebra and Calculus</td>
<td>C</td>
<td>20</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>CM-0316L</td>
<td>Data Structures and Algorithms</td>
<td>C</td>
<td>20</td>
<td>5</td>
<td>1 &amp; 2</td>
</tr>
<tr>
<td>CM-0318L</td>
<td>Symbolic and Declarative Computing and Artificial Intelligence</td>
<td>C</td>
<td>20</td>
<td>5</td>
<td>1 &amp; 2</td>
</tr>
<tr>
<td>CM-0227D</td>
<td>Mathematical Methods</td>
<td>C</td>
<td>Top up</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>CM-0226D</td>
<td>Statistics and Data analysis</td>
<td>C</td>
<td>20</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

Students who have achieved at least 120 credit points at Level 5 may exit the programme and are eligible for the award of Diploma of Higher Education.

Stage 3 [Level 6]

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Title</th>
<th>Type</th>
<th>Credits</th>
<th>Level</th>
<th>Study period</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM-0344D</td>
<td>Partial Differential Equations</td>
<td>C</td>
<td>20</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>CM-0347K</td>
<td>Final Year Project</td>
<td>C</td>
<td>40</td>
<td>6</td>
<td>1 &amp; 2</td>
</tr>
<tr>
<td>CM-0353D</td>
<td>Advanced Rendering and Real Time Graphics</td>
<td>O</td>
<td>20</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>CM-0348D</td>
<td>Foundations of Cryptography</td>
<td>O</td>
<td>20</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>CM-1068D</td>
<td>Reliability Modelling and Analysis</td>
<td>C</td>
<td>20</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>CM-0518D</td>
<td>Concurrent and Distributed Systems</td>
<td>O</td>
<td>20</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>CM-0328D</td>
<td>Artificial Intelligence for Games</td>
<td>O</td>
<td>20</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>

The core (C) and optional (O) modules are shown at the various levels.

Each year, or Stage, of a three-year Honours (Hons) degree comprises two semesters (Sem) with 60 credits (Crd) studied in each; these are all 20-credit modules however some may be spread over both semesters, these are called 20-credit linked (L) modules. This necessitates a total of 360 credits for a degree. Although the University does not recruit directly to Ordinary (Ord) degrees, this route is available to students for whom a less intense programme of study is appropriate after Level 4. Ordinary degree students are required to achieve 100 credits in each Level, giving a total of 300 credits for the degree. If, after successfully completing an ordinary degree, a student wishes to ‘top up’ to an honours award they must study and pass the level 5 module CM-0215D and an optional level 6 module. If a candidate is transferred onto the Ordinary route at the end of Stage 3 having already
passed CM-0215D then another second year module that has not been completed can be taken as a top up.

Additionally, in the final year of the Honours programme it may be possible, subject to timetabling constraints, for you to replace some of the above optional modules by a selection of your choice of elective (E) modules which may for example include:

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Title</th>
<th>Type</th>
<th>Credits</th>
<th>Level</th>
<th>Study period</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM-1076D</td>
<td>Foundations Cryptography</td>
<td>E</td>
<td>10</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>CM-0428D</td>
<td>Statistical Data Analysis</td>
<td>E</td>
<td>20</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>ENG3079M</td>
<td>Environmental Computational Fluid Dynamics</td>
<td>E</td>
<td>10</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>ENG4025M</td>
<td>Finite Element Methods</td>
<td>E</td>
<td>10</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

The curriculum may change, subject to the University’s programme approval, monitoring and review procedures.

**Assessment Regulations**

This Programme conforms to the standard University Regulations which are available at the following link: [http://www.bradford.ac.uk/aqpo/ordinances-and-regulations/](http://www.bradford.ac.uk/aqpo/ordinances-and-regulations/)

**Learning and Assessment Strategies**

As a student on the BSc (Hons) Computational Mathematics programme you will experience a wide range of teaching and learning environments. These have been determined appropriately for particular subject areas, as being suitable both for the students and for achieving the desired learning objectives. Concepts, theories and principles will be explored generally in formal lectures and practiced in associated example classes, tutorials and directed reading. Practical skills will be developed especially in tutorials and laboratory sessions. The development of personal and professional skills will be through presentations, discussion and project work involving problem-solving and design exercises.

During Level 4, basic principles and concepts will be introduced. By Level 5, you will be required to take an even more analytical approach. Level 6 offers the opportunity to specialize in particular areas of study and to develop further the applications of the knowledge, understanding and skills previously acquired. A significant 40-credit ‘Technical Investigation and Report’ will be produced on a topic of your choice.

Methods of assessment will be varied and include formal examinations, coursework assignments, laboratory tests and project reports as appropriate. Each assessment has been considered carefully so that you can demonstrate that the desired learning outcomes have been met.

**Admission Requirements**
The University welcomes applications from all potential students regardless of their previous academic experience; offers are made following detailed consideration of each individual application. Most important in the decision to offer a place is our assessment of a candidate’s potential to benefit from their studies and of their ability to succeed on this particular programme. Entrance requirements for each programme will vary but consideration of your application will be based on a combination of your formal academic qualifications and other relevant experience.

If you have prior certificated learning or professional experience which may be equivalent to parts of this programme, the University has procedures to evaluate this learning in order to provide you with exemptions from specified modules contained within the curriculum. Please talk to us if you do not fit the standard pattern of entry qualifications.

The University of Bradford has always welcomed applications from disabled students, and these will be considered on the same academic grounds as are applied to all applicants. If you have some form of disability you may wish to contact the programme leader before you apply.

**Entry requirements:** Typical offer (UCAS tariff points): 260

- To include 160 points from 2 GCE A levels or equivalent, preferably in relevant subjects (e.g. Computing, ICT, sciences). Or DMM in a relevant BTEC Diploma. Must include A-level Maths minimum grade C. International Baccalaureate (see UCAS tariff point requirements).
- GCSE English and Maths minimum grade C.

Offers are made following detailed consideration of each individual application. Most important in the decision to offer a place is our assessment of a candidate’s potential to benefit from their studies and of their ability to succeed on this particular programme. Entrance requirements will vary but are set after consideration of each applicant’s academic background and achievements and all other relevant experience. A typical offer to someone seeking entry through the UCAS scheme would be the attainment of a total of 260 UCAS tariff points, which includes A-Level Mathematics or its equivalent.

Applications are welcome from candidates with non-standard qualifications or who, lacking academic qualifications, have significant relevant experience. They will be assessed on an individual basis using the University’s APL procedures. It may be necessary for applicants without the relevant formal qualifications and/or readily recognizable experience in a particular additional field to be interviewed before deciding on their application for admission.

Applicants whose first language is not English will also be expected to possess an University approved English Language qualification such as IELTS at 6.0 or TOEFL at 550.
Learning Resources
The JB Priestley Library on the city campus and our specialist libraries in the School of Health Studies and the School of Management provide a wide range of printed and electronic resources to support your studies. We offer quiet study space if you want to work on your own, and group study areas for the times when you need to discuss work with fellow students. Subject librarians for each School provide training sessions and individual guidance in finding the information you need for your assignment, and will help you organise your references properly.

Student PC clusters can be found in all our libraries and elsewhere on the campus. Many of these are open 24/7. You can also use the University's wireless network to access the internet from your own laptop. Most of our online journals are available on the internet (both on and off campus), and you can also access your University email account, personal information and programme-related materials this way.

Staff are on hand during the daytime to help you if you get stuck, and there is a 24/7 IT helpline available.

Student Support and Guidance
All students admitted to School of Electrical Engineering and Computer Science undertake a process of induction led by a senior member of staff. Thereafter, ongoing support for students is provided in the form of one-stop facilities located at the School's Student Support Office (SSO) in the Horton Building, which is open throughout the day during term, and in the mornings and afternoons outside term. Also support for registered students is provided 24/7 via the intranets of the School and the School's Technical Support. The School uses the University's Virtual Learning Environment (VLE) to support students on their individual modules.

All students on the BSc (Hons) Computational Mathematics will be allocated a personal tutor who provides support and guidance on matters relating to your learning, teaching and academic progress. There are specialist tutors in the School who deal with issues where other social factors (relating to gender or disability, for example) may have an impact on your academic performance. The Student Staff Liaison Committee gives the opportunity for you to give formal feedback to the Programme Team and School about curricular issues and the general running of the programme.

Programme Team
Support for you personally and in your programme of study, will be provided both by the University and the Programme Team. You will be allocated a personal tutor who is someone with whom you will be able to talk about any academic or personal concerns. The School will ensure that there is someone available with whom you feel comfortable to help and support you. You will be provided with a comprehensive series of handbooks that you can consult on a range of learning issues and your programme tutors will be available to consult on subject specific queries.

The Hub, Student Support Centre
The Hub, Student Support Centre provides a central reception where students can receive information, advice and guidance on a whole range of topics about their life at University. The Hub is located in the Richmond Building adjacent to the Atrium.
The teams located within The Hub:

- Accommodation
- Admissions
  - Education Liaison
  - Enquiries
- Student Administration and Support
  - Bursaries and Financial Support
  - Finance and Credit Control Group
  - Payzone
  - Records and Tuition Fees
- International Office
- Customer Service Team

www.brad.ac.uk/hub
+44 1274 232233

Students’ Union

We value the feedback provided by students and collaborate with the Students’ Union, through a system of programme representatives and formal staff student liaison committees, so that any issues you wish to raise are addressed rapidly.

The Students’ Union and the University of Bradford work in partnership to provide confidential counselling and welfare services where you can get help with any aspect of your personal or academic life. Student Financial and Information Services (based in the Hub) will provide you with information about a diverse range of issues such as council tax, personal safety and tourist information. International Students can access a range of additional advice and support services through the Student’s Union.

Employability and Career Development

The University is committed to helping students develop and enhance their employability profile and capabilities through learning opportunities embedded within the curriculum. Furthermore, the University is committed to supporting students to develop their commitment towards a career pathway(s) and to implementing a career plan. Professional career guidance and development support is available throughout your time as a student and as a graduate from Career Development Services. The support available from Career Development Services includes a wide range of information resources, one to one appointments, a weekly workshop programme, a mentoring programme, graduate recruitment and careers fairs, plus information and help to you find part time work, summer work placements, graduate internship programmes and graduate entry vacancies. In addition, some students as part of their programme of study may have the opportunity to complete a Career & Personal Development accredited module delivered by the Career Development Service. All students are encouraged to access Career Development Services at an early stage during their studies and to use the extensive resources available on their web site www.careers.brad.ac.uk.

Career Development Services annually undertakes a survey of all graduates to find out their destination six months after graduation. The survey gathers data on the employment and further study routes graduates have entered and a range of other
information including job roles, name and location of employers, salary details etc. The survey findings for each programme of study are presented on the programme information pages on the University website and via Career Development Services' website www.careers.brad.ac.uk

**Learner Development Unit for Academic Skills Advice**

For undergraduate students who are looking to improve their marks during their time at university, study skills and maths advice is available to all regardless of degree discipline or level of study. Students can access a programme of interactive workshops and clinics which is delivered throughout the year. This is in addition to our extremely popular face-to-face guidance from our advisers, who also offer a wide range of online and paper based materials for self-study.

http://www.bradford.ac.uk/academic-skills/index.php

**Disability**

Disabled students will find a supportive environment at Bradford where we are committed to ensuring that all aspects of student life are accessible to everyone. The Disability Service can help by providing equipment and advice to help you get the most out of your time at Bradford and is a place where you can discuss any concerns you may have about adjustments that you may need, whether these relate to study, personal care or other issues. For more information contact the Disability Service by phoning: 01274 233739 or via email: disabilities@bradford.ac.uk

**University policies and initiatives**

**Learning and Teaching**

Our University approach to learning, teaching and assessment is encapsulated by an integrated set of themes and principles within our Curriculum Framework. All of our degree programmes have been designed to provide you with an inclusive and engaging learning environment which gives you the opportunity to thrive and develop in your area of study. Our research-informed programmes have a particular focus on developing your employability. We also place a strong emphasis on collaborative, real-world and enquiry-based learning, supported by appropriate learning technologies. Our assessment is designed not just to measure your achievement, but also to shape and guide your learning through preparing you for the increasing level of challenge as you progress through your degree. Together, these lead to you developing a distinctive set of graduate attributes which will prepare you for life beyond University.

**Ecoversity:**

Ecoversity is a strategic project of the University which aims to embed the principles of sustainable development into our decision-making, learning and teaching, research activities campus operations and lives of our staff and students. We do not claim to be a beacon for sustainable development but we aspire to become a leading University in this area. The facilities we create for teaching and learning, including teaching spaces, laboratories, IT labs and social spaces, will increasingly reflect our commitments to sustainable development. Staff and student participation in this
initiative is crucial to its success and its inclusion in the programme specification is a clear signal that it is at the forefront of our thinking in programme development, delivery, monitoring and review. For more details see www.bradford.ac.uk/ecoversity

Further Information
For further information, please check the University prospectus or contact Admissions.

The Admissions Office
The University of Bradford
Richmond Road
Bradford, BD7 1DP
UK
+44 (0)1274 233054
http://www.brad.ac.uk/courses/

The Admissions Office
Faculty of Engineering and Informatics
The University of Bradford
Horton Building
Richmond Road
Bradford, BD7 1DP
UK
+44 (0)1274 235963
ugadmissions@scim.brad.ac.uk
http://www.bradford.ac.uk/ei/electrical-engineering-and-computer-science/about/computing/courses/

Disclaimer
The details of this Programme Specification and information contained therein are subject to change in accordance with the University of Bradford’s course approval, monitoring and review procedures.