## Computer Science and Maths BSc (Hons) 2019-2020

### Summary

<table>
<thead>
<tr>
<th>UCAS code</th>
<th>Award</th>
<th>Title</th>
<th>Duration</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>GG14</td>
<td>BSc</td>
<td>Computer Science and Maths BSc (Hons)</td>
<td>3 years</td>
<td>FT</td>
</tr>
</tbody>
</table>

- **Schools**: Computer Science, Mathematics  
- **Faculty**: Engineering and Physical Sciences  
- **Awarding Institution**: University of Manchester  
- **Programme Accreditation**: BCS  
- **Relevant QAA benchmark(s)**: Computing, Mathematics
Aims and intended learning outcomes

The programmes aim to:

1) enable graduates to exhibit a high level of practical and theoretical skills over a broad range of Computer Science together with a knowledge of currently available techniques and technologies.

2) enable students to acquire a knowledge and understanding of mathematical ideas, including the concepts of rigorous argument and formal proof, and an appreciation of the power and generality of abstract formulation and the analytic method.

3) enable students to develop their capacity to learn and apply mathematical ideas and skills.

4) give students the opportunity to have studied a combination of mathematics and computer science and have an appreciation of the subjects themselves and their close relationship.

5) give students sufficient knowledge of mathematics and computer science principles to be able to meet confidently future developments in a rapidly changing area.

6) provide the opportunity for students to study on a programme at the forefront of both computer science and mathematics which is informed by current research and in particular by the research specialisations of the teaching staff.

7) In addition, the with Industrial Experience programme aims to: give extensive practical experience of an industrial or business environment where students are able to apply and develop their skills, both technical and personal.

Intended learning outcomes

Knowledge & understanding

A1 Know and understand the essential mathematics relevant to computer science.

A2 Understand and apply a wide range of principles and tools available to the software engineer, such as design methodologies, choice of algorithm, language, software libraries and user interface techniques

A3 Demonstrate a grasp of the principles of computer systems, including architecture, networks and communication

A4 Recognise and appreciate the professional and ethical responsibilities of the practising computer professional, including understanding the need for quality

A5 Know and understand the principles and techniques of a number of application areas informed by the research directions of the subject, such as artificial intelligence, databases and computer graphics

A6 Apply their knowledge of computing in a commercial or industrial context

A7 Show a critical understanding of the broad context within which Computer Science resides, including issues such as quality, reliability, enterprise, employment law, accounting and health and safety

A8 Have a comprehensive knowledge and critical awareness of selected specialist fields at the forefront of computer science, studied at masters level

Intellectual (thinking) skills

B1 Solve a wide range of problems related to the analysis, design and construction of computer systems.

B2 Design and implement a software or hardware system of significant size

B3 Identify a range of solutions and critically evaluate and justify proposed design solutions

B4 Solve computer science problems with pressing commercial or industrial constraints

B5 Generate an innovative design to solve a problem containing a range of commercial and industrial constraints

Practical skills
C1 Plan and undertake a major individual project
C2 Prepare and deliver coherent and structured verbal and written technical reports
C3 Give technical presentations suitable for the time, place and audience
C4 Use the scientific literature effectively and make discriminating use of Web resources
C5 Design, write and debug computer programs in appropriate languages
C6 Use appropriate computer-based design support tools
C7 Apply computer science skills in a commercial or industrial environment
C8 Demonstrate initiative taking, innovation and self-management in an industrially related group project
C9 Integrate previously acquired skills and apply them to new, demanding situations

**Transferable skills**
D1 Display an integrated approach to the deployment of communication skills
D2 Use IT skills and display mature computer literacy
D3 Work effectively with and for others
D4 Strike the balance between self-reliance and seeking help when necessary in new situations
D5 Display personal responsibility by working to multiple deadlines in complex activities
D6 Employ discrete and continuous mathematical skills as appropriate
D7 Demonstrate significantly enhanced group working abilities
D8 Further develop career plans and personal objectives
D9 Communicate effectively with non-specialist as well as computer scientist professionals at a range of levels
D10 Undertake a range of technical roles within a team and be able to display leadership
Teaching, learning and assessment methods

Learning and Teaching on all our programmes aims to combine an understanding of fundamental CS principles, development of strong practical skills and the group-working, learning and communication skills that are essential for any computing professional.

Course units which involve practical elements all have associated laboratory exercises, usually in timetabled sessions with staff and demonstrator support. Most labs operate a system of face-to-face marking in the lab so that students receive immediate feedback on their work. Units without labs all have regular coursework exercises to support skills development and feedback.

Most units are lecture based, with lab or coursework exercises used to reinforce and enhance knowledge and skills first encountered in lectures. The first year team project deviates significantly from this model and takes an Enquiry Based Learning approach. This unit aims to encourage students to be more actively engaged with, and responsible for, their own learning, to develop skills in problem solving, communication, independent learning, and group work, and to signal the importance we attach to independent learning. This approach is followed up in the second year with the workshop based approach used in the compulsory Software Engineering unit, which also contains a major group working component.

All students undertake an individual 3rd year project, supervised by a member of academic task, which usually involves the development of significant software or hardware product. Assessment of this unit involves presentations of plans and results and a major written report.

Assessment in almost all units is a combination of lab/coursework and examination.

The following mandatory course units are non-compensatable:

* MATH10111 Sets, Numbers and functions B (15 credits)
* MATH10131 Calculus and Vectors B (15 credits)
* MATH10212 Linear Algebra B (15 credits)
* MATH10232 Calculus and Applications B (15 credits)
* COMP16121 Object Oriented Programming with Java 1 (20 credits)
* COMP16212 Object Oriented Programming with Java 2 (10 credits)

Learning, Teaching and Assessment of intended learning outcomes

Knowledge and Understanding

<table>
<thead>
<tr>
<th>Learning and Teaching Processes</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures (A1, A2, A3, A4, A5, A6, A7)</td>
<td>Unseen written examinations (A1, A2, A3, A4)</td>
</tr>
<tr>
<td>Laboratory sessions (A2, A3)</td>
<td>Marked tutorial exercises (A1, A2, A3, A4)</td>
</tr>
<tr>
<td>Personal tutorials (A1, A2, A3, A4, A7)</td>
<td>Laboratory reports (A2, A3)</td>
</tr>
<tr>
<td>Problem solving classes (A1, A2, A3, A4)</td>
<td>Project reports (individual and group) (A3, A4, A5, A6, A7)</td>
</tr>
<tr>
<td>Problem-based learning (A2, A3, A4, A5, A6, A7)</td>
<td>Oral presentations (individual and group) (A3, A4, A5, A6, A7)</td>
</tr>
<tr>
<td>Projects (A3, A4, A5, A6, A7)</td>
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<tr>
<td>Industrial seminars (A4, A5, A6, A7)</td>
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Intellectual Skills

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<thead>
<tr>
<th>Learning and Teaching Processes</th>
<th>Assessment</th>
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<tbody>
<tr>
<td>Lectures (B1, B2, B4, B5)</td>
<td>Unseen written examinations (B1, B2, B4)</td>
</tr>
<tr>
<td>Laboratory sessions (B1, B2)</td>
<td>Marked tutorial exercises (B1, B2)</td>
</tr>
<tr>
<td>Personal tutorials (B1, B2, B4)</td>
<td>Laboratory reports (B1, B2)</td>
</tr>
<tr>
<td>Problem solving classes (B1, B2, B4)</td>
<td>Project reports (individual and group) (B1, B2, B3, B4, B5)</td>
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<tr>
<td>Problem-based learning (B1, B2, B4)</td>
<td>Oral presentations (individual and group) (B1, B2, B3, B4, B5)</td>
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<tr>
<td>Projects (B1, B2, B3, B4, B5)</td>
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Practical Skills

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<thead>
<tr>
<th>Learning and Teaching Processes</th>
<th>Assessment</th>
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<tbody>
<tr>
<td>Lectures (C4, C6)</td>
<td>Laboratory reports (C1, C2, C3, C4, C5, C6, C7)</td>
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<tr>
<td>Learning and Teaching Processes</td>
<td>Assessment</td>
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<tr>
<td>Lectures (D3, D4, D5, D7)</td>
<td>Laboratory reports (D1, D3, D5, D6)</td>
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<tr>
<td>Laboratory sessions (D1, D3, D5, D6)</td>
<td>Essays (D2, D3)</td>
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<tr>
<td>Personal tutorials (D1, D2, D3, D4, D7)</td>
<td>Project reports (individual and group) (D1, D2, D3, D4, D5, D6, D7)</td>
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<td>Problem solving classes (D4)</td>
<td>Oral presentations (individual and group) (D1, D3, D6, D7, D8)</td>
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<td>Problem-based learning (D1, D2, D3, D4, D5, D6)</td>
<td>Industrial placement reports (D8)</td>
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<td>Projects (D1, D2, D3, D4, D5, D6, D7)</td>
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<tr>
<td>Industrial placement (D8)</td>
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Programme structure

MANDATORY UNITS - 110 CREDITS
OPTIONAL UNITS - 10 CREDITS

Level 1 - compulsory units
All of the units in this pool are mandatory.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>COMP10120</td>
<td>First Year Team Project</td>
<td>20</td>
</tr>
<tr>
<td>COMP16321</td>
<td>Introduction to Programming 1</td>
<td>20</td>
</tr>
<tr>
<td>COMP16412</td>
<td>Introduction to Programming 2</td>
<td>10</td>
</tr>
<tr>
<td>MATH10111</td>
<td>Foundations of Pure Mathematics B</td>
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</tr>
<tr>
<td>MATH10131</td>
<td>Calculus and Vectors B</td>
<td>15</td>
</tr>
<tr>
<td>MATH10212</td>
<td>Linear Algebra</td>
<td>15</td>
</tr>
<tr>
<td>MATH10232</td>
<td>Calculus and Applications</td>
<td>15</td>
</tr>
</tbody>
</table>

Level 1 - option pool 1
From this option pool choose 10 credits.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>COMP11212</td>
<td>Fundamentals of Computation</td>
<td>10</td>
</tr>
<tr>
<td>COMP13212</td>
<td>Data Science</td>
<td>10</td>
</tr>
<tr>
<td>COMP15212</td>
<td>Operating Systems</td>
<td>10</td>
</tr>
</tbody>
</table>

Level 2 options

MANDATORY UNITS - 60 CREDITS
OPTIONAL UNITS - 60 CREDITS

If you take a 20 credit whole year course unit you are not permitted to drop this unit when course unit selection reopens at the start of semester 2.

Level 2 - compulsory units
All of the units in this pool are mandatory.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>COMP23311</td>
<td>Software Engineering 1</td>
<td>10</td>
<td>Agile Methods</td>
</tr>
<tr>
<td>COMP23412</td>
<td>Software Engineering 2</td>
<td>10</td>
<td>Agile Methods</td>
</tr>
<tr>
<td>COMP26120</td>
<td>Algorithms and Imperative Programming</td>
<td>20</td>
<td>Computer Languages</td>
</tr>
<tr>
<td>MATH20111</td>
<td>Real Analysis</td>
<td>10</td>
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<tr>
<td>MATH20142</td>
<td>Complex Analysis</td>
<td>10</td>
<td>None</td>
</tr>
<tr>
<td>MATH20201</td>
<td>Algebraic Structures 1</td>
<td>10</td>
<td>None</td>
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</table>

Level 2 - option pool 1
From this option pool choose 10 credits.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Theme</th>
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</thead>
<tbody>
<tr>
<td>COMP21111</td>
<td>Logic and Modelling</td>
<td>10</td>
<td>Rigorous Development</td>
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<tr>
<td>COMP23111</td>
<td>Fundamentals of Databases</td>
<td>10</td>
<td>Web and Distributed Systems</td>
</tr>
<tr>
<td>COMP24111</td>
<td>Machine Learning and Optimisation</td>
<td>10</td>
<td>Learning and Search in Artificial Intelligence</td>
</tr>
<tr>
<td>COMP25111</td>
<td>Operating Systems</td>
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<td>Computer Architecture</td>
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</table>

Level 2 - option pool 2
From this option pool choose 10 credits.

<table>
<thead>
<tr>
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<th>Title</th>
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<tbody>
<tr>
<td>MATH10141</td>
<td>Probability 1</td>
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<tr>
<td>MATH20411</td>
<td>Partial Differential Equations and Vector Calculus B</td>
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Level 2 - option pool 3
From this option pool choose 10 credits.

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<tbody>
<tr>
<td>COMP24412</td>
<td>Symbolic AI</td>
<td>10</td>
<td>Natural Language, Representation and Reasoning</td>
</tr>
<tr>
<td>COMP27112</td>
<td>Computer Graphics and Image Processing</td>
<td>10</td>
<td>Visual Computing</td>
</tr>
<tr>
<td>COMP28112</td>
<td>Distributed Computing</td>
<td>10</td>
<td>Web and Distributed Systems</td>
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</table>

Level 2 - option pool 4
From this option pool choose 20 credits.

<table>
<thead>
<tr>
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<th>Theme</th>
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</thead>
<tbody>
<tr>
<td>MATH20122</td>
<td>Metric Spaces</td>
<td>10</td>
<td>None</td>
</tr>
<tr>
<td>MATH20212</td>
<td>Algebraic Structures 2</td>
<td>10</td>
<td>None</td>
</tr>
<tr>
<td>MATH20302</td>
<td>Introduction to Logic</td>
<td>10</td>
<td>None</td>
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<tr>
<td>MATH20502</td>
<td>Fluid Mechanics</td>
<td>10</td>
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<tr>
<td>MATH20512</td>
<td>Classical Mechanics</td>
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<tr>
<td>MATH20602</td>
<td>Numerical Analysis 1</td>
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<tr>
<td>MATH20902</td>
<td>Discrete Mathematics</td>
<td>10</td>
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<tr>
<td>MATH20912</td>
<td>Introduction to Financial Mathematics</td>
<td>10</td>
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**Level 3 options**

MANDATORY UNITS - 30 CREDITS

OPTIONAL UNITS - 90 CREDITS

You must register for the following:

A minimum of 50 COMP units (including the project).
A minimum of 50 MATH units, of which at least 40 credits must be at level 3.

The remaining 20 credits can be either COMP on level 3 or MATH on level 2 or 3.

Overall from the 120 credits, a minimum of 100 must be level 3.

If you take a 20 credit whole year course unit you are not permitted to drop this unit when course unit selection reopens at the start of semester 2.

Please note that some combinations of course units may not be possible due to timetable clashes.

If you wish to enrol on optional units (COMP or MATH) that are not listed below you must have permission from the Programme Tutor - Dr Andrea Schalk.

**Level 3 - compulsory units**

All of the units in this pool are mandatory.

<table>
<thead>
<tr>
<th>Code</th>
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</thead>
<tbody>
<tr>
<td>COMP30030</td>
<td>3rd Year Project (Joint Hons 30 Credits)</td>
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**Level 3 - option pool 1**

From this option pool choose a maximum of 40 credits and a minimum of 20 credits.

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<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>COMP33511</td>
<td>User Experience</td>
<td>10</td>
<td>Interactive Systems Design</td>
</tr>
<tr>
<td>COMP33711</td>
<td>Agile Software Engineering</td>
<td>10</td>
<td>Agile Methods</td>
</tr>
<tr>
<td>COMP34120</td>
<td>AI and Games</td>
<td>10</td>
<td>Learning and Search in Artificial Intelligence</td>
</tr>
<tr>
<td>COMP34412</td>
<td>Natural Language Systems</td>
<td>10</td>
<td>Natural Language, Representation and Reasoning</td>
</tr>
<tr>
<td>COMP36111</td>
<td>Advanced Algorithms 1</td>
<td>10</td>
<td>Programming and Algorithms</td>
</tr>
<tr>
<td>COMP36512</td>
<td>Compilers</td>
<td>10</td>
<td>Computer Languages</td>
</tr>
<tr>
<td>COMP37111</td>
<td>Advanced Computer Graphics</td>
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<td>Visual Computing</td>
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<tr>
<td>COMP37212</td>
<td>Computer Vision</td>
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<td>Visual Computing</td>
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<tr>
<td>COMP38411</td>
<td>Cryptography and Network Security</td>
<td>10</td>
<td>Mobile Computing and Networks</td>
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<tr>
<td>COMP39112</td>
<td>Quantum Computing</td>
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<tr>
<td>COMP39212</td>
<td>Cognitive Robotics</td>
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<tr>
<td>COMP39211</td>
<td>Documents and Data on the Web</td>
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**Level 3 - option pool 2**

From this option pool choose a maximum of 70 credits and a minimum of 40 credits.

<table>
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<th>Code</th>
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<tbody>
<tr>
<td>MATH30002</td>
<td>Mathematics Education</td>
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<tr>
<td>MATH31052</td>
<td>Topology</td>
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<tr>
<td>MATH32001</td>
<td>Group Theory</td>
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<tr>
<td>MATH32011</td>
<td>Commutative Algebra</td>
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<tr>
<td>MATH32032</td>
<td>Coding Theory</td>
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<tr>
<td>MATH32051</td>
<td>Hyperbolic Geometry</td>
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<tr>
<td>MATH32062</td>
<td>Introduction to Algebraic Geometry</td>
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<td>MATH32072</td>
<td>Introduction to Number Theory</td>
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<td>MATH32091</td>
<td>Combinatorics and Graph Theory</td>
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<tr>
<td>COMP30020</td>
<td>First Year Team Project</td>
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<td>COMP31012</td>
<td>Fundamentals of Computation</td>
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<td>COMP32012</td>
<td>Data Science</td>
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<td>COMP33222</td>
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<td>COMP34021</td>
<td>Introduction to Programming 1</td>
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<td>COMP35021</td>
<td>Introduction to Programming 2</td>
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<tr>
<td>COMP35111</td>
<td>Logic and Modelling</td>
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<td>COMP35311</td>
<td>Fundamentals of Database</td>
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<td>COMP35411</td>
<td>Software Engineering 1</td>
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<td>COMP35622</td>
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<td>COMP36111</td>
<td>Machine Learning and Optimisation</td>
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<td>COMP36212</td>
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<td>COMP39400</td>
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<td>COMP39511</td>
<td>User Experience</td>
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<td>COMP39512</td>
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<td>COMP39520</td>
<td>AI and Data Mining</td>
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<tr>
<td>COMP39715</td>
<td>Advanced Algorithms I</td>
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<td>COMP39822</td>
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<td>COMP40112</td>
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<td>MATH30601</td>
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<td>Problem Solving by Computer</td>
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<tr>
<td>MATH30661</td>
<td>Convex Optimisations</td>
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</table>
Mechanisms for programme revision

Course units are reviewed annually by the Undergraduate Committee, as part of the Annual Review process, taking into account the results and comments from Course Unit Evaluation Questionnaires. Input is also received from the Teaching Assessment Panel, which has a responsibility for monitoring teaching quality in the School.

Programmes have been reviewed regularly by groups created specifically for this purpose; the last major review resulted in a new programme portfolio design which started in the first year in 2008-9. The responsibility for leadership of programme review is now in the hands of the Director of Teaching Strategy (currently Dr Steve Pettifer) who chairs a School Teaching Strategy Committee.
<table>
<thead>
<tr>
<th>UCAS code</th>
<th>Award</th>
<th>Title</th>
<th>Duration</th>
<th>Mode</th>
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<tr>
<td>GG14</td>
<td>BSc</td>
<td>Computer Science and Maths BSc (Hons)</td>
<td>3 years</td>
<td>FT</td>
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</table>

<table>
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<tr>
<th>Schools</th>
<th>Computer ScienceMathematics</th>
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<tbody>
<tr>
<td>Faculty</td>
<td>Engineering and Physical Sciences</td>
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<tr>
<td>Awarding Institution</td>
<td>University of Manchester</td>
</tr>
<tr>
<td>Programme Accreditation</td>
<td>BCS</td>
</tr>
<tr>
<td>Relevant QAA benchmark(s)</td>
<td>Computing, Mathematics</td>
</tr>
</tbody>
</table>
Aims and intended learning outcomes

The programmes aim to:

1) enable graduates to exhibit a high level of practical and theoretical skills over a broad range of Computer Science together with a knowledge of currently available techniques and technologies.

2) enable students to acquire a knowledge and understanding of mathematical ideas, including the concepts of rigorous argument and formal proof, and an appreciation of the power and generality of abstract formulation and the analytic method.

3) enable students to develop their capacity to learn and apply mathematical ideas and skills.

4) give students the opportunity to have studied a combination of mathematics and computer science and have an appreciation of the subjects themselves and their close relationship.

5) give students sufficient knowledge of mathematics and computer science principles to be able to meet confidently future developments in a rapidly changing area.

6) provide the opportunity for students to study on a programme at the forefront of both computer science and mathematics which is informed by current research and in particular by the research specialisations of the teaching staff.

7) In addition, the with Industrial Experience programme aims to: give extensive practical experience of an industrial or business environment where students are able to apply and develop their skills, both technical and personal.

Intended learning outcomes

Knowledge & understanding

A1 Know and understand the essential mathematics relevant to computer science.

A2 Understand and apply a wide range of principles and tools available to the software engineer, such as design methodologies, choice of algorithm, language, software libraries and user interface techniques.

A3 Demonstrate a grasp of the principles of computer systems, including architecture, networks and communication.

A4 Recognise and appreciate the professional and ethical responsibilities of the practising computer professional, including understanding the need for quality.

A5 Know and understand the principles and techniques of a number of application areas informed by the research directions of the subject, such as artificial intelligence, databases and computer graphics.

A6 Apply their knowledge of computing in a commercial or industrial context.

A7 Show a critical understanding of the broad context within which Computer Science resides, including issues such as quality, reliability, enterprise, employment law, accounting and health and safety.

A8 Have a comprehensive knowledge and critical awareness of selected specialist fields at the forefront of computer science, studied at masters level.

Intellectual (thinking) skills

B1 Solve a wide range of problems related to the analysis, design and construction of computer systems.

B2 Design and implement a software or hardware system of significant size.

B3 Identify a range of solutions and critically evaluate and justify proposed design solutions.

B4 Solve computer science problems with pressing commercial or industrial constraints.

B5 Generate an innovative design to solve a problem containing a range of commercial and industrial constraints.

Practical skills
C1 Plan and undertake a major individual project

C2 Prepare and deliver coherent and structured verbal and written technical reports

C3 Give technical presentations suitable for the time, place and audience

C4 Use the scientific literature effectively and make discriminating use of Web resources

C5 Design, write and debug computer programs in appropriate languages

C6 Use appropriate computer-based design support tools

C7 Apply computer science skills in a commercial or industrial environment

C8 Demonstrate initiative taking, innovation and self-management in an industrially related group project

C9 Integrate previously acquired skills and apply them to new, demanding situations

**Transferable skills**

D1 Display an integrated approach to the deployment of communication skills

D2 Use IT skills and display mature computer literacy

D3 Work effectively with and for others

D4 Strike the balance between self-reliance and seeking help when necessary in new situations

D5 Display personal responsibility by working to multiple deadlines in complex activities

D6 Employ discrete and continuous mathematical skills as appropriate

D7 Demonstrate significantly enhanced group working abilities

D8 Further develop career plans and personal objectives

D9 Communicate effectively with non-specialist as well as computer scientist professionals at a range of levels

D10 Undertake a range of technical roles within a team and be able to display leadership
Teaching, learning and assessment methods

Learning and Teaching on all our programmes aims to combine an understanding of fundamental CS principles, development of strong practical skills and the group-working, learning and communication skills that are essential for any computing professional.

Course units which involve practical elements all have associated laboratory exercises, usually in timetabled sessions with staff and demonstrator support. Most labs operate a system of face-to-face marking in the lab so that students receive immediate feedback on their work. Units without labs all have regular coursework exercises to support skills development and feedback.

Most units are lecture based, with lab or coursework exercises used to reinforce and enhance knowledge and skills first encountered in lectures. The first year team project deviates significantly from this model and takes an Enquiry Based Learning approach. This unit aims to encourage students to be more actively engaged with, and responsible for, their own learning, to develop skills in problem solving, communication, independent learning, and group work, and to signal the importance we attach to independent learning. This approach is followed up in the second year with the workshop based approach used in the compulsory Software Engineering unit, which also contains a major group working component.

All students undertake an individual 3rd year project, supervised by a member of academic task, which usually involves the development of significant software or hardware product. Assessment of this unit involves presentations of plans and results and a major written report.

Assessment in almost all units is a combination of lab/coursework and examination.

The following mandatory course units are non-compensatable:

* MATH10111 Sets, Numbers and functions B (15 credits)
* MATH10131 Calculus and Vectors B (15 credits)
* MATH10212 Linear Algebra B (15 credits)
* MATH10232 Calculus and Applications B (15 credits)
* COMP16121 Object Oriented Programming with Java 1 (20 credits)
* COMP16212 Object Oriented Programming with Java 2 (10 credits)

Learning, Teaching and Assessment of intended learning outcomes

Knowledge and Understanding

<table>
<thead>
<tr>
<th>Learning and Teaching Processes</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures (A1, A2, A3, A4, A5, A6, A7)</td>
<td>Unseen written examinations (A1, A2, A3, A4)</td>
</tr>
<tr>
<td>Laboratory sessions (A2, A3)</td>
<td>Marked tutorial exercises (A1, A2, A3, A4)</td>
</tr>
<tr>
<td>Personal tutorials (A1, A2, A3, A4, A7)</td>
<td>Laboratory reports (A2, A3)</td>
</tr>
<tr>
<td>Problem solving classes (A1, A2, A3, A4)</td>
<td>Project reports (individual and group) (A3, A4, A5, A6, A7)</td>
</tr>
<tr>
<td>Problem-based learning (A2, A3, A4, A5, A6, A7)</td>
<td>Oral presentations (individual and group) (A3, A4, A5, A6, A7)</td>
</tr>
<tr>
<td>Projects (A3, A4, A5, A6, A7)</td>
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</tr>
<tr>
<td>Industrial seminars (A4, A5, A6, A7)</td>
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Intellectual Skills

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<thead>
<tr>
<th>Learning and Teaching Processes</th>
<th>Assessment</th>
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<tbody>
<tr>
<td>Lectures (B1, B2, B4, B5)</td>
<td>Unseen written examinations (B1, B2, B4)</td>
</tr>
<tr>
<td>Laboratory sessions (B1, B2)</td>
<td>Marked tutorial exercises (B1, B2)</td>
</tr>
<tr>
<td>Personal tutorials (B1, B2, B4)</td>
<td>Laboratory reports (B1, B2)</td>
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<tr>
<td>Problem solving classes (B1, B2, B4)</td>
<td>Project reports (individual and group) (B1, B2, B3,B4, B5)</td>
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<td>Problem-based learning (B1, B2, B4)</td>
<td>Oral presentations (individual and group) (B1, B2, B3, B4, B5)</td>
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<td>Projects (B1, B2, B3, B4, B5)</td>
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Practical Skills

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<td>Laboratory reports (C1, C2, C3, C4, C5, C6, C7)</td>
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<td>Laboratory sessions (C1, C2, C3, C4, C5, C6, C7)</td>
<td>Project reports (individual and group) (C3, C4, C5, C6)</td>
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<tr>
<td>Projects (C3, C4, C5, C6, C9)</td>
<td>Oral presentations (individual and group) (C6, C8, C9)</td>
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<tr>
<td>Industrial placement (C8, C9)</td>
<td>Industrial placement reports (C8, C9)</td>
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**Transferable skills**

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<tr>
<td>Lectures (D3, D4, D5, D7)</td>
<td>Laboratory reports (D1, D3, D5, D6)</td>
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<td>Personal tutorials (D1, D2, D3, D4, D7)</td>
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<td>Oral presentations (individual and group) (D1, D3, D6, D7, D8)</td>
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<tr>
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Programme structure

MANDATORY UNITS - 110 CREDITS
OPTIONAL UNITS - 10 CREDITS

Level 1 - compulsory units
All of the units in this pool are mandatory.

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<td>COMP1020</td>
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<tr>
<td>COMP16321</td>
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<td>COMP16421</td>
<td>Introduction to Programming 2</td>
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<td>MATH10111</td>
<td>Foundations of Pure Mathematics B</td>
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<tr>
<td>MATH10131</td>
<td>Calculus and Vectors B</td>
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<tr>
<td>MATH10212</td>
<td>Linear Algebra</td>
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<tr>
<td>MATH10232</td>
<td>Calculus and Applications</td>
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</table>

Level 1 - option pool 1
From this option pool choose 10 credits.

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<tr>
<td>COMP11212</td>
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<tr>
<td>COMP13212</td>
<td>Data Science</td>
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<tr>
<td>COMP15212</td>
<td>Operating Systems</td>
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Level 2 options

MANDATORY UNITS - 60 CREDITS
OPTIONAL UNITS - 60 CREDITS

If you take a 20 credit whole year course unit you are not permitted to drop this unit when course unit selection reopens at the start of semester 2.

Level 2 - compulsory units
All of the units in this pool are mandatory.

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<td>COMP23311</td>
<td>Software Engineering 1</td>
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<td>Agile Methods</td>
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<tr>
<td>COMP23412</td>
<td>Software Engineering 2</td>
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<td>Agile Methods</td>
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<tr>
<td>COMP26120</td>
<td>Algorithms and Imperative Programming</td>
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Level 2 - option pool 1
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<tr>
<td>COMP24111</td>
<td>Machine Learning and Optimisation</td>
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<td>Learning and Search in Artificial Intelligence</td>
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<td>COMP25111</td>
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Level 2 - option pool 2
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<td>Partial Differential Equations and Vector Calculus B</td>
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Level 2 - option pool 3
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<tr>
<td>COMP24412</td>
<td>Symbolic AI</td>
<td>10</td>
<td>Natural Language, Representation and Reasoning</td>
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<td>COMP27112</td>
<td>Computer Graphics and Image Processing</td>
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<td>Visual Computing</td>
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<tr>
<td>COMP28112</td>
<td>Distributed Computing</td>
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<td>Web and Distributed Systems</td>
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Level 2 - option pool 4
From this option pool choose 20 credits.

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<td>MATH20122</td>
<td>Metric Spaces</td>
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<td>MATH20302</td>
<td>Introduction to Logic</td>
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<td>Introduction to Financial Mathematics</td>
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**Level 3 options**

MANDATORY UNITS - 30 CREDITS

OPTIONAL UNITS - 90 CREDITS

You must register for the following:

A minimum of 50 COMP units (including the project).
A minimum of 50 MATH units, of which at least 40 credits must be at level 3.

The remaining 20 credits can be either COMP on level 3 or MATH on level 2 or 3.

Overall from the 120 credits, a minimum of 100 must be level 3.

If you take a 20 credit whole year course unit you are not permitted to drop this unit when course unit selection reopens at the start of semester 2.

Please note that some combinations of course units may not be possible due to timetable clashes.

If you wish to enrol on optional units (COMP or MATH) that are not listed below you must have permission from the Programme Tutor - Dr Andrea Schalk.

**Level 3 - compulsory units**

All of the units in this pool are mandatory.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP30030</td>
<td>3rd Year Project (Joint Hons 30 Credits)</td>
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</table>

**Level 3 - option pool 1**

From this option pool choose a maximum of 40 credits and a minimum of 20 credits.

<table>
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<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>COMP33511</td>
<td>User Experience</td>
<td>10</td>
<td>Interactive Systems Design</td>
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**Level 3 - option pool 2**

From this option pool choose a maximum of 70 credits and a minimum of 40 credits.

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Mechanisms for programme revision

Course units are reviewed annually by the Undergraduate Committee, as part of the Annual Review process, taking into account the results and comments from Course Unit Evaluation Questionnaires. Input is also received from the Teaching Assessment Panel, which has a responsibility for monitoring teaching quality in the School.

Programmes have been reviewed regularly by groups created specifically for this purpose; the last major review resulted in a new programme portfolio design which started in the first year in 2008-9. The responsibility for leadership of programme review is now in the hands of the Director of Teaching Strategy (currently Dr Steve Pettifer) who chairs a School Teaching Strategy Committee.