

UG Student Handbook - Appendix B

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B1. Single Honours Programmes – Computer Science

G400 BSc (Hons) Computer Science

G401 MEng (Hons) Computer Science

G403 BSc (Hons) Computer Science with a Year in Industry

G404 MEng (Hons) Computer Science with a Year in Industry

All of the programmes offered by the Department require students to take 120 credits in each year of study. This consists of required, optional and mandatory modules.

From 2017/18, every student on the Computer Science programmes takes the following required modules:

| | | |
|---|--|---|
| <ul style="list-style-type: none"> • COMP101 or COMP105 • COMP107 • COMP108 • COMP109 • COMP111 • COMP116 • COMP122 • COMP124 | <ul style="list-style-type: none"> • COMP201 • COMP207 • COMP202 • COMP208 | <ul style="list-style-type: none"> • COMP390 (mandatory) |
|---|--|---|

For Year in Industry/MEng students the following modules are also required

| Year in Industry | MEng only |
|--|--|
| <ul style="list-style-type: none"> • COMP299 • COMP221 (mandatory) | <ul style="list-style-type: none"> • COMP591 (mandatory) • COMP592 (mandatory) |

You can choose to maintain a mixture of modules throughout your degree or follow a specialism pathway in

- **Artificial Intelligence**
- **Algorithms and Optimisation**
- **Data Science**

| | | |
|---|---|---|
| <p>For the Artificial Intelligence specialism pathway <u>in addition</u> to the required modules listed above students should take</p> <ul style="list-style-type: none"> • COMP219 <p>and take at least one of the following</p> <ul style="list-style-type: none"> • COMP218 • COMP222 <p>and in Year 3 (or Year 4 for Year in Industry programmes)</p> | <p>For the Algorithms and Optimisation specialism pathway <u>in addition</u> to the required modules listed above, students should take at least 30 credits from</p> <ul style="list-style-type: none"> • COMP218 • COMP220 • COMP226 • COMP284 • COMP285 <p>and at least 60 credits from</p> <ul style="list-style-type: none"> • COMP305 | <p>For the Data Sciences specialism pathway <u>in addition</u> to the required modules students should take</p> <ul style="list-style-type: none"> • COMP219 • COMP281 • COMP284 <p>and get at least 60 credits from</p> <ul style="list-style-type: none"> • COMP310 • COMP313 • COMP318 • COMP329 |
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|---|---|---|
| <p>take at least four modules from</p> <ul style="list-style-type: none"> • COMP304 • COMP305 • COMP310 • COMP313 • COMP318 • COMP329 <p>MEng only Year 4 (or Year 5 for Year in Industry programmes) should take 60 credits from</p> <ul style="list-style-type: none"> • COMP521 • COMP522 • COMP523 • COMP528 • COMP529 • COMP524 • COMP525 • COMP526 • COMP527 • COMP575 • COMP532 | <ul style="list-style-type: none"> • COMP309 • COMP323 • COMP324 • COMP326 • COMP331 <p>MEng only Year 4 (or Year 5 for Year in Industry programmes) should take 60 credits from</p> <ul style="list-style-type: none"> • COMP521 • COMP522 • COMP523 • COMP528 • COMP529 • COMP524 • COMP525 • COMP526 • COMP527 • COMP575 • COMP532 | <ul style="list-style-type: none"> • COMP331 • ELEC319 • ELEC320 <p>MEng only Year 4 (or Year 5 for Year in Industry programmes) should take 60 credits from</p> <ul style="list-style-type: none"> • COMP521 • COMP522 • COMP523 • COMP528 • COMP529 • COMP524 • COMP525 • COMP526 • COMP527 • COMP575 • COMP532 |
|---|---|---|

More detailed information can be found in the Programme Specifications, students are welcome to contact the Student Office for more details about this. The structure for G403 BSc (Hons) Computer Science with a Year in Industry (without specialism pathways) has been included below as an example.

(●) indicates a required module and (+) indicates a mandatory module

| G400/G401/G403/G404 YEAR 1 | | | | | | |
|----------------------------|---|--------------|------------|--------------|--|---|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for* |
| Semester 1 | | | | | | |
| COMP101 or COMP105 | Introduction to Programming (●) Programming Language Paradigms (●) | 15 15 | 4 4 | - - | - A-level Computer Science expected | COMP122 COMP122 |
| COMP107 | Graduates for the Digital Society (●) | 15 | 4 | - | - | COMP201, COMP207, COMP208, COMP221, COMP283, COMP284, COMP390 |

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| G400/G401/G403/G404 YEAR 1 | | | | | | |
|-----------------------------------|---|----|---|---|-----------------------|---|
| COMP109 | Foundations of Computer Science (•) | 15 | 4 | - | - | COMP218, COMP304, COMP313 |
| COMP111 | Introduction to Artificial Intelligence (•) | 15 | 4 | - | - | COMP219, COMP222, COMP304, COMP310, COMP329 |
| Semester 2 | | | | | | |
| COMP108 | Data Structures and Algorithms (•) | 15 | 4 | - | - | COMP202, COMP208, COMP218 |
| COMP116 | Analytical Techniques in Computer Science (•) | 15 | 4 | - | - | COMP202, COMP219, COMP226, COMP305, COMP323, COMP326, COMP331 |
| COMP122 | Object-Oriented Programming (•) | 15 | 4 | - | COMP101 or COMP105 | COMP201, COMP207, COMP220, COMP211, COMP212, COMP222, COMP281, COMP284, COMP285, COMP208, COMP327, COMP390 |
| COMP124 | Computer Systems (•) | 15 | 4 | - | - | COMP208, COMP211, COMP212, COMP327, COMP329 |

*May also be a pre-requisite for modules on other programmes

| G400/G401/G403/G404 YEAR 2 | | | | | | |
|---|--------------------------------|--------------|-------|--------------|---------------------|---|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisite | Pre-requisite for* |
| Semester 1 | | | | | | |
| COMP201 | Software Engineering I (•) | 15 | 5 | - | COMP122, COMP107 | COMP208, COMP220, COMP285, COMP319, COMP313 |
| COMP207 | Database Development (•) | 15 | 5 | - | COMP122, COMP107 | COMP208, COMP283, COMP284, COMP315 |
| G403/G404 only | | | | | | |
| COMP221 | Planning Your Career (+) | 7.5 | 5 | - | COMP107 | - |
| <i>Plus options totalling 30 to 37.5 credits from the following modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP105** | Programming Language Paradigms | 15 | 4 | - | - | - |

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|---|---|-----|---|---|--|---|
| COMP211 | Internet Principles | 15 | 5 | - | COMP122, COMP124 | COMP212, COMP318 |
| COMP219 | Artificial Intelligence | 15 | 5 | - | COMP116, COMP111 or equivalent | COMP305, COMP313, COMP318, COMP329 |
| COMP221 | Planning Your Career | 7.5 | 5 | - | COMP107 | - |
| Semester 2 | | | | | | |
| COMP202 | Complexity of Algorithms (•) | 15 | 5 | - | COMP108, COMP116 | COMP309, COMP324 |
| COMP208 | Group Software Project (•) | 15 | 5 | - | COMP108, COMP107, COMP124, COMP122, or equivalents; COMP201; COMP207; or equivalent | COMP390 |
| <i>Plus options totalling 22.5 to 30 credits from the following modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP212 | Distributed Systems | 15 | 5 | - | COMP122, COMP124, COMP211 | COMP318 |
| COMP218 | Decision, Computation and Language | 15 | 5 | - | COMP108 COMP109 | - |
| COMP220* ¹ | Software Development Tools | 15 | 5 | - | COMP122; COMP201; | - |
| COMP222 | Principles of Computer Game Design and Implementation | 15 | 5 | - | COMP122, COMP111 | - |
| COMP226 | Computer-Based Trading in Financial Markets | 15 | 5 | - | COMP116 | - |
| COMP281 | Principles of C and Memory Management | 7.5 | 5 | - | COMP122 | COMP282 COMP327 |
| COMP282 | Advanced Object Oriented C Languages | 7.5 | 5 | - | COMP281 | COMP327 |
| COMP283 | Applied Database Management | 7.5 | 5 | - | COMP107 COMP207 | - |
| COMP284 | Scripting Languages | 7.5 | 5 | - | COMP122 COMP107 COMP207 | - |
| COMP285* ¹ | Computer Aided Software Development | 7.5 | 5 | - | COMP122 COMP201 | - |

*May also be a pre-requisite for modules on other programmes

**COMP105 cannot be taken again, if already taken in Year 1

*¹COMP220 and COMP285 cannot be taken in conjunction.

| G403/G404 YEAR 3 | | | | | | |
|------------------|-----------------------------|--------------|-------|--------------|----------------|-------------------|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for |
| Semester 1 and 2 | | | | | | |
| COMP299 | Industrial Placement Year 3 | 120 | 5 | - | COMP221 | - |

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| G400/G403 FINAL YEAR & G401/G404 YEAR 4 | | | | | | |
|---|--|--------------|-------|--------------|--|--------------------|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for* |
| Semester 1 and 2 | | | | | | |
| COMP390 | Honours Year Computer Science Project (+) | 30 | 6 | - | COMP122, COMP107 or equivalents, COMP208 and COMP108 recommended | - |
| Semester 1 | | | | | | |
| <i>Plus options totalling 30 credits from the following modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP304 | Knowledge Representation and Reasoning | 15 | 6 | - | COMP109, COMP111 | - |
| COMP305 | Biocomputation | 15 | 6 | - | COMP116, COMP219 | - |
| COMP309 | Efficient Sequential Algorithms | 15 | 6 | - | COMP202 | - |
| COMP319 | Software Engineering II | 15 | 6 | - | COMP201 | - |
| COMP323 | Introduction to Computational Game Theory | 15 | 6 | - | COMP116 or equivalent mathematical module | COMP326 |
| COMP327 | Mobile Computing | 15 | 6 | - | COMP122, COMP124, COMP281, COMP282 | - |
| COMP329 | Robotics and Autonomous Systems | 15 | 6 | - | COMP111, COMP124, COMP219 | - |
| COMP331 | Optimisation | 15 | 6 | - | COMP116 | - |
| ELEC319 | Image Processing | 7.5 | 6 | - | - | - |
| Semester 2 | | | | | | |
| <i>Plus options totalling 45 credits from the following modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP310 | Multi-Agent Systems | 15 | 6 | - | COMP111 | - |
| COMP313 | Formal Methods | 15 | 6 | - | COMP109, COMP201, COMP219 | - |
| COMP315 | Technologies for E-Commerce | 15 | 6 | - | COMP207 | - |
| COMP318 | Advanced Web Technologies | 15 | 6 | - | COMP211, COMP212, COMP219 | - |
| COMP324 | Complex Social Networks | 15 | 6 | - | COMP202 | - |
| COMP326 | Computational Game Theory and Mechanism Design | 15 | 6 | - | COMP116, COMP323 | - |
| ELEC320 | Neural Networks | 7.5 | 6 | - | - | - |
| Semester 1 and 2 | | | | | | |
| COMP335*** | Communicating Computer Science | 15 | 6 | - | - | - |

*May also be a pre-requisite for modules on other programmes

***Students who wish to choose this module will undergo an interview with the Module Co-ordinator before being selected.

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| G401/G404 FINAL YEAR | | | | | | |
|--|---|---------------------|--------------|----------------------|-------------------------------------|--------------------------|
| Module Code | Module Title | Credit Value | Level | Co-requisites | Pre-requisites | Pre-requisite for |
| Semester 1 | | | | | | |
| COMP591 | MEng Group Project (+) | 30 | 7 | - | Completion of first 3 years of MEng | - |
| <i>Plus options totalling 30 credits from the following four modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP521 | Knowledge Representation | 15 | 7 | - | Completion of first 3 years of MEng | - |
| COMP522 | Privacy and Security | 15 | 7 | - | | - |
| COMP523 | Advanced Algorithmic Techniques | 15 | 7 | - | | - |
| COMP528 | Multi-Core and Multi-Processor Programming | 15 | 7 | - | | - |
| COMP529 | Big Data Analysis | 15 | 7 | - | | - |
| Semester 2 | | | | | | |
| COMP592 | MEng Individual Project (+) | 30 | 7 | - | Completion of first 3 years of MEng | - |
| <i>Plus options totalling 30 credits from the following five modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP524 | Safety and Dependability | 15 | 7 | - | Completion of first 3 years of MEng | - |
| COMP525 | Reasoning about Action and Change | 15 | 7 | - | | - |
| COMP526 | Applied Algorithmics | 15 | 7 | - | | - |
| COMP527 | Data Mining and Visualisation | 15 | 7 | - | | - |
| COMP575 | Computational Intelligence | 15 | 7 | - | | - |
| COMP532 | Machine Learning and BioInspired Optimisation | 15 | 7 | - | COMP219 COMP310 | - |

Note:

In exceptional circumstances, and with the approval of the programme Director of Studies, alternative modules may be substituted for non-mandatory modules.

Students may undertake their second year of studies at Xian-Jiaotong Liverpool University (XJTLU), Suzhou, China.

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B2. Single Honours Programmes - Software Development

- **G610 BSc (Hons) Software Development (to be phased out from 2018/19)**
- **G611 BSc (Hons) Software Development with a Year in Industry (to be phased out from 2018/19)**
- **GZ10 BSc (Hons) Computer Science with Software Development**
- **G61Z BSc (Hons) Computer Science with Software Development with a Year in Industry**

All of the programmes offered by the Department require students to take 120 credits in each year of study. This consists of required, optional and mandatory modules.

Every student on the Computer Science with Software Development programme takes the following required modules:

| | | |
|---|--|---|
| <ul style="list-style-type: none"> • COMP101 or COMP105 • COMP107 • COMP108 • COMP109 • COMP111 • COMP116 • COMP122 • COMP124 | <ul style="list-style-type: none"> • COMP201 • COMP207 • COMP220 • COMP208 | <ul style="list-style-type: none"> • COMP390 (mandatory) |
|---|--|---|

For Year in Industry students the following modules are also required:

- COMP299
- COMP221

In addition to the required modules listed above students should take

| in Year 2 at least 30 credits from: | and in Year 3 (or Year 4 for the Year in Industry programme) take at least four modules from: |
|---|---|
| <ul style="list-style-type: none"> • COMP211 • COMP212 • COMP219 • COMP281 • COMP282 • COMP283 • COMP284 | <ul style="list-style-type: none"> • COMP310 • COMP313 • COMP318 • COMP319 • COMP323 • COMP327 • COMP329 |

Included below is the programme structure for G611, which is G610 with a Year in Industry.

| YEAR 1 | | | | | | |
|---------------|---------------------------------|--------------|-------|--------------|----------------|--------------------|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for* |
| Semester 1 | | | | | | |
| COMP101 or | Introduction to Programming (•) | 15 | 4 | - | - | COMP122 |

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| YEAR 1 | | | | | | |
|------------|---|-----|---|---|-----------------------------------|---|
| COMP105 | Programming Language Paradigms (•) | 15 | 4 | - | A-level Computer Science expected | COMP122 |
| COMP107 | Graduates for the Digital Society (•) | 15 | 4 | - | - | COMP201, COMP207, COMP208, COMP221, COMP283, COMP284, COMP390 |
| COMP109 | Foundations of Computer Science (•) | 15 | 4 | - | - | COMP218, COMP304, COMP313 |
| COMP111 | Introduction to Artificial Intelligence (•) | 15 | 4 | - | - | COMP219, COMP222, COMP304, COMP310, COMP329 |
| Semester 2 | | | | | | |
| COMP108 | Data Structures and Algorithms (•) | 15 | 4 | - | - | COMP202, COMP208, COMP218 |
| COMP116 | Analytical Techniques in Computer Science (•) | 7.5 | 4 | - | - | COMP202, COMP219, COMP226, COMP305, COMP323, COMP326, COMP331 |
| COMP122 | Object-Oriented Programming (•) | 15 | 4 | - | COMP101 or COMP105 | COMP201, COMP207, COMP220, COMP211, COMP212, COMP222, COMP281, COMP284, COMP285, COMP208, COMP327, COMP390 |
| COMP124 | Computer Systems (•) | 15 | 4 | - | - | COMP208, COMP211, COMP212, COMP327, COMP329 |

**May also be a pre-requisite for modules on other programmes*

| YEAR 2 | | | | | | |
|-------------|----------------------------|--------------|-------|--------------|---------------------|---|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisite | Pre-requisite for* |
| Semester 1 | | | | | | |
| COMP201 | Software Engineering I (•) | 15 | 5 | - | COMP122, COMP107 | COMP208, COMP220, COMP285, COMP319, COMP313 |

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|---|---|-----|---|---|---|---|
| COMP207 | Database Development (•) | 15 | 5 | - | COMP122, COMP107 | COMP208, COMP283, COMP284, COMP315 |
| For G611 only | | | | | | |
| COMP221 | Planning Your Career (+) | 7.5 | 5 | - | COMP107 | - |
| <i>Plus options totalling 30 to 37.5 credits from the following modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP105** | Programming Language Paradigms | 15 | 4 | - | - | - |
| COMP211 | Internet Principles | 15 | 5 | - | COMP122, COMP124 | COMP212, COMP318 |
| COMP219 | Artificial Intelligence | 15 | 5 | - | COMP116, COMP111 or equivalent | COMP305, COMP313, COMP318, COMP329 |
| COMP221 | Planning Your Career | 7.5 | 5 | - | COMP107 | - |
| Semester 2 | | | | | | |
| COMP220 | Software Development Tools (•) | 15 | 5 | - | COMP122; COMP201; | - |
| COMP208 | Group Software Project (•) | 15 | 5 | - | COMP108, COMP107, COMP124, COMP122, or equivalents; COMP201; COMP207;or equivalent | COMP390 |
| <i>Plus options totalling 22.5 to 30 credits from the following modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP202 | Complexity of Algorithms | 15 | 5 | - | COMP108, COMP116 | COMP309, COMP324 |
| COMP212 | Distributed Systems | 15 | 5 | - | COMP122, COMP124, COMP211 | COMP318 |
| COMP218 | Decision, Computation and Language | 15 | 5 | - | COMP108 COMP109 | - |
| COMP222 | Principles of Computer Game Design and Implementation | 15 | 5 | - | COMP122, COMP111 | - |
| COMP226 | Computer-Based Trading in Financial Markets | 15 | 5 | - | COMP116 | - |
| COMP281 | Principles of C and Memory Management | 7.5 | 5 | - | COMP122 | COMP282 COMP327 |
| COMP282 | Advanced Object Oriented C Languages | 7.5 | 5 | - | COMP281 | COMP327 |
| COMP283 | Applied Database Management | 7.5 | 5 | - | COMP107 COMP207 | - |

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|-----------------------|-------------------------------------|-----|---|---|-------------------------------|---|
| COMP284 | Scripting Languages | 7.5 | 5 | - | COMP122 COMP107 COMP207 | - |
| COMP285* ¹ | Computer Aided Software Development | 7.5 | 5 | - | COMP122 COMP201 | - |

*May also be a pre-requisite for modules on other programmes

**COMP105 cannot be taken again, if already taken in Year 1

| YEAR 3 | | | | | | |
|------------------|-----------------------------|--------------|-------|--------------|----------------|-------------------|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for |
| Semester 1 and 2 | | | | | | |
| COMP299 | Industrial Placement Year 3 | 120 | 5 | - | COMP110 | - |

| Final Year | | | | | | |
|---|---|--------------|-------|--------------|--|-------------------|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for |
| Semester 1 and 2 | | | | | | |
| COMP390 | Honours Year Computer Science Project (+) | 30 | 6 | - | COMP122, COMP107 or equivalents, COMP208 and COMP108 recommended | - |
| Semester 1 | | | | | | |
| <i>Plus options totalling 30 credits from the following modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP304 | Knowledge Representation and Reasoning | 15 | 6 | - | COMP109, COMP111 | - |
| COMP305 | Biocomputation | 15 | 6 | - | COMP116, COMP219 | - |
| COMP309 | Efficient Sequential Algorithms | 15 | 6 | - | COMP202 | - |
| COMP319 | Software Engineering II | 15 | 6 | - | COMP201 | - |
| COMP323 | Introduction to Computational Game Theory | 15 | 6 | - | COMP116 or equivalent mathematical module | COMP326 |
| COMP327 | Mobile Computing | 15 | 6 | - | COMP122, COMP124, COMP281, COMP282 | - |
| COMP329 | Robotics and Autonomous Systems | 15 | 6 | - | COMP111, COMP124, COMP219 | - |
| COMP331 | Optimisation | 15 | 6 | - | COMP116 | - |
| ELEC319 | Image Processing | 7.5 | 6 | - | - | - |

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| Semester 2 | | | | | | |
|---|--|-----|---|---|---------------------------------|---|
| <i>Plus options totalling 45 credits from the following modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP310 | Multi-Agent Systems | 15 | 6 | - | COMP111 | - |
| COMP313 | Formal Methods | 15 | 6 | - | COMP109, COMP201, COMP219 | - |
| COMP315 | Technologies for E-Commerce | 15 | 6 | - | COMP207 | - |
| COMP318 | Advanced Web Technologies | 15 | 6 | - | COMP211, COMP212, COMP219 | - |
| COMP324 | Complex Social Networks | 15 | 6 | - | COMP202 | - |
| COMP326 | Computational Game Theory and Mechanism Design | 15 | 6 | - | COMP116, COMP323 | - |
| ELEC320 | Neural Networks | 7.5 | 6 | - | - | - |
| Semester 1 and 2 | | | | | | |
| COMP335*** | Communicating Computer Science | 15 | 6 | - | - | - |

**May also be a pre-requisite for modules on other programmes*

****Students who wish to choose this module will undergo an interview with the Module Co-ordinator before being selected.*

Note:

In exceptional circumstances, and with the approval of the programme Director of Studies, alternative modules may be substituted for non-mandatory modules.

Students may undertake their second year of studies at Xian-Jiaotong Liverpool University (XJTLU), Suzhou, China.

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B3. G40E MEng (Hons) Computer Science with Education (with recommendation for Qualified Teacher Status)

This is an opt-in programme after Year 2 and is in collaboration with Liverpool John Moores University. The aim of the programme is to produce graduates who will have a complete and systematic understanding of the domain of computer science while at the same time gaining Qualified Teacher Status. As such this will enable students who successfully complete the programme to take up a rewarding career as teachers of Computer Science in schools. The programme is also designed equip students with the necessary skills required with respect to careers open to general Computer Science graduates.

Year 1 (Level 4) and Year 2 (Level 5) are all 15 credit modules at University of Liverpool, unless indicated otherwise.

MEng Computer Science with Education, with a recommendation for Qualified Teacher Status (QTS)

Year 1

COMP101 Introduction to Programming in Java

or

COMP105 Programming Language Paradigms

COMP107 Graduates for the Digital Society

COMP109 Foundations of Computer Science

COMP111 Introduction to Artificial Intelligence

COMP108 Data Structures and Algorithms

COMP116 Analytical Techniques in Computer Science

COMP122 Object-Oriented Programming

COMP124 Computer Systems

Year 2

COMP201 Software Engineering

COMP207 Software Development

Select 30 to 37.5 optional credits from

COMP105
COMP211
COMP219
COMP221 (7.5)

COMP202 Complexity of Algorithms

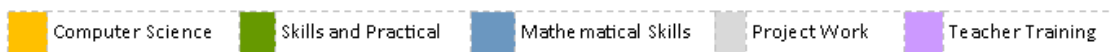
COMP208 Group Software Project

Select 22.5 to 37.5 optional credits from

COMP212
COMP218
COMP220
COMP222
COMP226
COMP281 (7.5)
COMP282 (7.5)
COMP283 (7.5)
COMP284 (7.5)
COMP285 (7.5)

Summer

Two weeks experience in a School



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In order to progress into Year 3, students must achieve an average of 55% in Year 2.

MEng Computer Science with Education, with a recommendation for Qualified Teacher Status (QTS)

Year 3

**Initial Teaching Training
60 credits Level 6 (Phase 1 &
2 of ITT school based training)**

6005ITTUG Subject Pedagogy
in Computer Science (20
credits)

6003ITTUG Inclusion (20
credits)

6002ITTUG Professional
Practice (20 credits)

**Select 60 optional credits
from**

COMP310

COMP313

COMP315

COMP318

COMP324

COMP326

ELEC320

Year 4

**Initial Teaching Training 60 credits Level 7 (Phase 3 of ITT
school based training)**

7136SLTA Learning and Teaching and Assessment in the 11-16
context (20 credits)

**Select 30 optional credits
from**

COMP521

COMP522

COMP523

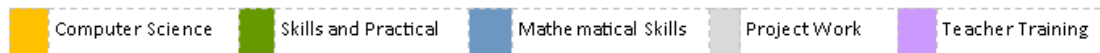
COMP528

COMP529

7226SPRAC Pedagogy in
Practice (20 credits)

7126SREF Developing Profes-
sional Reflective Practice
(20 credits)

COMP593 MEng Project, 30 credits, Level 7



In order to progress to Year 4, students must achieve an average of 55% in Year 3.

More detailed information can be found in the Programme Specification, please contact the Student Office (csstudy@liv.ac.uk) for further details.

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B4. Single Honours and Joint Programmes

- **G402 BSc (Hons) Computing with a Year in Industry**
- **G490/G491 BSc (Hons) Electronic Commerce Computing/with a Year in Industry**
- **G500(G50A)/G502 BSc (Hons) Computer Information Systems/with a Year in Industry**
- **G50E(G501)/G503 BSc (Hons) Internet Computing/with a Year in Industry**
- **G700/G701 BSc (Hons) Artificial Intelligence/with a Year in Industry**
- **GG14(GG1A)/GG16 BSc (Hons) Mathematics with Computer Science/with a Year in Industry**
- **GN34/G3N4 BSc (Hons) Financial Computing/with a Year in Industry**

Please see below the programme structures taken from the Programme Specifications, from 2018/19 these programmes will be phased out to accommodate the new structures with specialism pathways drawn up during a review of the Year 1 and 2 programme provisions.

All of the programmes offered by the Department require students to take 120 credits in each year of study. This consists of required, optional and mandatory modules.

Every student takes the following required modules in Year 1:

- COMP101 or COMP105
- COMP107
- COMP108
- COMP109
- COMP111
- COMP116
- COMP122
- COMP124

COMP221 is a mandatory 7.5 credit pass/fail module for Year in Industry programmes, which is taken out of the degree classification calculations. Progression from Year 2 to Year 3 on the Year in Industry programmes is subject to passing all modules at the first sitting. Students who do not pass their modules at the first attempt, will get transferred to the equivalent programme without a year in industry.

The programme of study is split into years and semesters as follows.

module (●) indicates a required module and (+) indicates a mandatory module

| G402 YEAR 2 | | | | | | |
|--------------------|----------------------------|--------------|-------|--------------|---------------------|---|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisite | Pre-requisite for* |
| Semester 1 | | | | | | |
| COMP201 | Software Engineering I (●) | 15 | 5 | - | COMP122, COMP107 | COMP208, COMP220, COMP285, COMP319, COMP313 |

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|---------|--------------------------|-----|---|---|---------------------|---|
| COMP207 | Database Development (•) | 15 | 5 | - | COMP122, COMP107 | COMP208, COMP283, COMP284, COMP315 |
| COMP221 | Planning Your Career (+) | 7.5 | 5 | - | COMP107 | - |

Plus options totalling 30 credits from the following modules provided pre-requisites are satisfied

| | | | | | | |
|-----------|--------------------------------|----|---|---|---|---|
| COMP105** | Programming Language Paradigms | 15 | 4 | - | - | - |
| COMP211 | Internet Principles | 15 | 5 | - | COMP122, COMP124 | COMP212, COMP318 |
| COMP219 | Artificial Intelligence | 15 | 5 | - | COMP116, COMP111 or equivalent | COMP305, COMP313, COMP318, COMP329 |

Semester 2

| | | | | | | |
|---------|------------------------------|----|---|---|--|---------------------|
| COMP202 | Complexity of Algorithms (•) | 15 | 5 | - | COMP108, COMP116 | COMP309, COMP324 |
| COMP208 | Group Software Project (•) | 15 | 5 | - | COMP108, COMP107, COMP124, COMP122, or equivalents; COMP201; COMP207; or equivalent | COMP390 |

Plus options totalling 22.5 credits from the following modules provided pre-requisites are satisfied

| | | | | | | |
|-----------------------|---|-----|---|---|---------------------------------|--------------------|
| COMP212 | Distributed Systems | 15 | 5 | - | COMP122, COMP124, COMP211 | COMP318 |
| COMP218 | Decision, Computation and Language | 15 | 5 | - | COMP108 COMP109 | - |
| COMP220* ¹ | Software Development Tools | 15 | 5 | - | COMP122; COMP201; | - |
| COMP222 | Principles of Computer Game Design and Implementation | 15 | 5 | - | COMP122, COMP111 | - |
| COMP226 | Computer-Based Trading in Financial Markets | 15 | 5 | - | COMP116 | - |
| COMP281 | Principles of C and Memory Management | 7.5 | 5 | - | COMP122 | COMP282 COMP327 |
| COMP282 | Advanced Object Oriented C Languages | 7.5 | 5 | - | COMP281 | COMP327 |
| COMP283 | Applied Database Management | 7.5 | 5 | - | COMP107 COMP207 | - |
| COMP284 | Scripting Languages | 7.5 | 5 | - | COMP122 COMP107 COMP207 | - |
| COMP285* ¹ | Computer Aided Software Development | 7.5 | 5 | - | COMP122 COMP201 | - |

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*May also be a pre-requisite for modules on other programmes

**COMP105 cannot be taken again, if already taken in Year 1

*¹COMP220 and COMP285 cannot be taken in conjunction.

| G402 YEAR 3 | | | | | | |
|------------------|-----------------------------|--------------|-------|--------------|----------------|-------------------|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for |
| Semester 1 and 2 | | | | | | |
| COMP299 | Industrial Placement Year 3 | 120 | 5 | - | - | - |

| G402 YEAR 4 | | | | | | |
|--|---|--------------|-------|--------------|--|-------------------|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for |
| Semester 1 and 2 | | | | | | |
| COMP390 | Honours Year Computer Science Project (+) | 30 | 6 | - | COMP122, COMP107 or equivalents, COMP208 and COMP108 recommended | - |
| Semester 1 | | | | | | |
| <i>Plus options totalling 45 credits from the following modules provided pre-requisites are satisfied*¹</i> | | | | | | |
| COMP304 | Knowledge Representation and Reasoning | 15 | 6 | - | COMP109, COMP111 | - |
| COMP305 | Biocomputation | 15 | 6 | - | COMP116, COMP219 | - |
| COMP309 | Efficient Sequential Algorithms | 15 | 6 | - | COMP202 | - |
| COMP319 | Software Engineering II | 15 | 6 | - | COMP201 | - |
| COMP323 | Introduction to Computational Game Theory | 15 | 6 | - | COMP116 or equivalent mathematical module | COMP326 |
| COMP327 | Mobile Computing | 15 | 6 | - | COMP122, COMP124, COMP281, COMP282 | - |
| COMP329 | Robotics and Autonomous Systems | 15 | 6 | - | COMP111, COMP124, COMP219 | - |
| COMP331 | Optimisation | 15 | 6 | - | COMP116 | - |
| ELEC319 | Image Processing | 7.5 | 6 | - | - | - |
| Semester 2 | | | | | | |
| <i>Plus options totalling 45 credits from the following modules provided pre-requisites are satisfied*¹</i> | | | | | | |
| COMP310 | Multi-Agent Systems | 15 | 6 | - | COMP111 | - |

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| | | | | | | |
|------------------|--|-----|---|---|---------------------------------|---|
| COMP313 | Formal Methods | 15 | 6 | - | COMP109, COMP201, COMP219 | - |
| COMP315 | Technologies for E-Commerce | 15 | 6 | - | COMP207 | - |
| COMP318 | Advanced Web Technologies | 15 | 6 | - | COMP211, COMP212, COMP219 | - |
| COMP324 | Complex Social Networks | 15 | 6 | - | COMP202 | - |
| COMP326 | Computational Game Theory and Mechanism Design | 15 | 6 | - | COMP116, COMP323 | - |
| ELEC320 | Neural Networks | 7.5 | 6 | - | - | - |
| Semester 1 and 2 | | | | | | |
| COMP335*** | Communicating Computer Science | 15 | 6 | - | - | - |

**May also be a pre-requisite for modules on other programmes*

****Students who wish to choose this module will undergo an interview with the Module Co-ordinator before being selected.*

**¹If ELEC319, ELEC320 or COMP335 are taken, an imbalance of 15 credits between the two semesters is allowed. 120 credits to be taken in Year 4.*

Note:

In exceptional circumstances, and with the approval of the programme Director of Studies, alternative modules may be substituted for non-mandatory modules.

Students may undertake their second year of studies at Xian-Jiaotong Liverpool University (XJTLU), Suzhou, China.

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| G490/G491 YEAR 2 | | | | | | |
|--|---------------------------------------|--------------|-------|---------------|--|---|
| Module Code | Module Title | Credit Value | Level | Co-requisites | Pre-requisites | Pre-requisite for* |
| Semester 1 | | | | | | |
| COMP201 | Software Engineering I (●) | 15 | 5 | - | COMP122 COMP107 | COMP215, COMP220, COMP285, COMP319, COMP313 |
| COMP207 | Database Development (●) | 15 | 5 | - | COMP122 COMP107 | COMP215, COMP283, COMP284, COMP315 |
| COMP211 | Internet Principles (+) | 15 | 5 | - | COMP122 COMP124 | COMP212, COMP318 |
| For G491 only | | | | | | |
| COMP221 | Planning Your Career (+) | 7.5 | 5 | - | COMP107 | - |
| <i>Plus options totalling 15 to 22.5 credits*¹ from the following modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP105* | Programming Language Paradigms | 15 | 4 | - | - | - |
| COMP219 | Artificial Intelligence | 15 | 5 | - | COMP116 COMP111 or equivalent | COMP305, COMP313, COMP329 |
| COMP221 | Planning Your Career | 7.5 | 5 | - | COMP107 | - |
| Semester 2 | | | | | | |
| COMP212 | Distributed Systems (●) | 15 | 5 | - | COMP122, COMP124, COMP211 | COMP318 |
| COMP215 | Group Software Project (●) | 15 | 5 | - | COMP108, COMP107, COMP124, COMP122 or equivalents; COMP201; COMP207 or equivalent | COMP394 |
| COMP220 | Software Development Tools (●) | 15 | 5 | - | COMP122 COMP201 | - |
| <i>Plus options totalling 7.5 to 15 credits*¹ from the following modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP281 | Principles of C and Memory Management | 7.5 | 5 | - | COMP122 | COMP282 COMP327 |
| COMP282 | Advanced Object Oriented C Languages | 7.5 | 5 | - | COMP281 | COMP327 |
| COMP283 | Applied Database Management | 7.5 | 5 | - | COMP107 COMP207 | - |
| COMP284 | Scripting Languages | 7.5 | 5 | - | COMP122 COMP107 COMP207 | - |

*COMP105 cannot be taken again if already taken in Year 1

*¹120 credits to be taken in Year 2

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| G491 YEAR 3 | | | | | | |
|------------------|-----------------------------|--------------|-------|--------------|----------------|-------------------|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for |
| Semester 1 and 2 | | | | | | |
| COMP299 | Industrial Placement Year 3 | 120 | 5 | - | | - |

| G490/G491 Final Year | | | | | | |
|---|--|--------------|-------|---------------|--|-------------------|
| Module Code | Module Title | Credit Value | Level | Co-requisites | Pre-requisites | Pre-requisite for |
| Semester 1 and 2 | | | | | | |
| COMP394 | Honours Year Computer Science Project (+) | 30 | 6 | - | COMP122, COMP107 or equivalents; COMP215 and COMP108 recommended | - |
| Semester 1 | | | | | | |
| COMP319 | Software Engineering II (•) | 15 | 6 | - | COMP201 | - |
| COMP323 | Introduction to Computational Game Theory (•) | 15 | 6 | - | COMP116 or equivalent mathematical module | COMP326 |
| COMP327 | Mobile Computing (•) | 15 | 6 | - | COMP122, COMP124, COMP281, COMP282 | - |
| Semester 2 | | | | | | |
| COMP315 | Technologies for E-Commerce (•) | 15 | 6 | - | COMP207 | - |
| COMP318 | Advanced Web Technologies (•) | 15 | 6 | - | COMP211, COMP212 | - |
| <i>Plus options totalling 15 credits from the following three modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP310 | Multi-Agent Systems | 15 | 6 | - | COMP111 | - |
| COMP324 | Complex Social Networks | 15 | 6 | - | - | - |
| COMP326 | Computational Game Theory and Mechanism Design | 15 | 6 | - | COMP116 COMP323 | - |

Note: in exceptional circumstances, and with the approval of the programme Director of Studies, alternative modules may be substituted for non-mandatory modules.

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| G500/G502 YEAR 2 | | | | | | |
|--|---|--------------|-------|---------------|--|---|
| Module Code | Module Title | Credit Value | Level | Co-requisites | Pre-requisites | Pre-requisite for* |
| Semester 1 | | | | | | |
| COMP201 | Software Engineering I (●) | 15 | 5 | - | COMP122 COMP107 | COMP208, COMP220, COMP285, COMP319, COMP313 |
| COMP207 | Database Development (●) | 15 | 5 | - | COMP122 COMP107 | COMP208, COMP283, COMP284, COMP315 |
| COMP211 | Internet Principles (●) | 15 | 5 | - | COMP122 COMP124 | COMP212, COMP318 |
| COMP219 | Artificial Intelligence (●) | 15 | 5 | - | COMP116 COMP111 or equivalent | COMP305, COMP313, COMP329 |
| Semester 2 | | | | | | |
| COMP208 | Group Software Project (●) | 15 | 5 | - | COMP108, COMP107, COMP124, COMP122 or equivalents; COMP201; COMP207 or equivalent | COMP390 |
| COMP220 | Software Development Tools (●) | 15 | 5 | - | COMP122 COMP201 | - |
| For G502 only | | | | | | |
| COMP221 | Planning Your Career (+) | 7.5 | 5 | - | COMP107 | - |
| <i>Plus options totalling 15 credits from the following two modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP212 | Distributed Systems | 15 | 5 | - | COMP122, COMP124, COMP211 | COMP318 |
| COMP222 | Principles of Computer Game Design and Implementation | 15 | 5 | - | COMP122 COMP111 | - |
| <i>Plus options totalling 15 credits from the following four modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP281 | Principles of C and Memory Management | 7.5 | 5 | - | COMP122 | COMP282 COMP327 |
| COMP282 | Advanced Object Oriented C Languages | 7.5 | 5 | - | COMP281 | COMP327 |
| COMP283 | Applied Database Management | 7.5 | 5 | - | COMP107 COMP207 | - |
| COMP284 | Scripting Languages | 7.5 | 5 | - | COMP122 COMP107 COMP207 | - |

*May also be a pre-requisite for modules on other programmes

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| G500/G502 Final Year | | | | | | | |
|--|--|--------------|-------|---------------|--|-------------------|--|
| Module Code | Module Title | Credit Value | Level | Co-requisites | Pre-requisites | Pre-requisite for | |
| Semester 1 and 2 | | | | | | | |
| COMP390 | Honours Year Computer Science Project (+) | 30 | 6 | - | COMP122, COMP107 or equivalents; COMP208 and COMP108 recommended | - | |
| Semester 1 | | | | | | | |
| <i>Plus options totalling 45 credits from the following modules provided pre-requisites are satisfied*¹</i> | | | | | | | |
| COMP304 | Knowledge Representation and Reasoning | 15 | 6 | - | COMP109 COMP111 | - | |
| COMP305 | Biocomputation | 15 | 6 | - | COMP116 COMP219 | - | |
| COMP319 | Software Engineering II | 15 | 6 | - | COMP201 | - | |
| COMP323 | Introduction to Computational Game Theory | 15 | 6 | - | COMP116 or equivalent mathematical module | COMP326 | |
| COMP327 | Mobile Computing | 15 | 6 | - | COMP122, COMP124, COMP281, COMP282 | - | |
| COMP329 | Robotics and Autonomous Systems | 15 | 6 | - | COMP111, COMP124, COMP219 | - | |
| Semester 2 | | | | | | | |
| <i>Plus options totalling 45 credits from the following seven modules provided pre-requisites are satisfied*¹</i> | | | | | | | |
| COMP310 | Multi-Agent Systems | 15 | 6 | - | COMP111 | - | |
| COMP313 | Formal Methods | 15 | 6 | - | COMP109, COMP201, COMP219 | - | |
| COMP315 | Technologies for E-Commerce | 15 | 6 | - | COMP207 | - | |
| COMP318 | Advanced Web Technologies | 15 | 5 | - | COMP211 COMP212 | - | |
| COMP324 | Complex Social Networks | 15 | 6 | - | - | - | |
| COMP326 | Computational Game Theory and Mechanism Design | 15 | 6 | - | COMP116 COMP323 | - | |
| Semester 1 and 2 | | | | | | | |
| COMP335*** | Communicating Computer Science | 15 | 6 | - | - | - | |

***Students who wish to choose this module will undergo an interview with the Module Co-ordinator before being selected.

*¹If COMP335 is taken, an imbalance of 15 credits between the two semesters is allowed. 120 credits to be taken in Year 3.

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| G501/G503 YEAR 2 | | | | | | |
|----------------------|---|--------------|-------|--------------|--|---|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisite | Pre-requisite for* |
| Semester 1 | | | | | | |
| COMP201 | Software Engineering I (●) | 15 | 5 | - | COMP122, COMP107 | COMP208, COMP220, COMP285, COMP319, COMP313 |
| COMP207 | Database Development (●) | 15 | 5 | - | COMP122, COMP107 | COMP208, COMP283, COMP284, COMP315 |
| COMP211 | Internet Principles (●) | 15 | 5 | - | COMP122, COMP124 | COMP212, COMP318 |
| COMP219 | Artificial Intelligence (●) | 15 | 5 | - | COMP116 COMP111 or equivalent | COMP305, COMP313, COMP329 |
| For G503 only | | | | | | |
| COMP221 | Planning Your Career (+) | 7.5 | 5 | - | COMP107 | - |
| Semester 2 | | | | | | |
| COMP212 | Distributed Systems (●) | 15 | 5 | - | COMP122, COMP124, COMP211 | COMP318 |
| COMP216 | Internet Computing Group Project (●) | 15 | 5 | - | COMP108, COMP107, COMP124, COMP122, or equivalents; COMP201; COMP207; or equivalent | COMP390 |
| COMP220 | Software Development Tools (●) | 15 | 5 | - | COMP122; COMP201; | - |
| COMP281 | Principles of C and Memory Management (●) | 7.5 | 5 | - | COMP122 | COMP282 COMP327 |
| COMP282 | Advanced Object Oriented C Languages (●) | 7.5 | 5 | - | COMP281 | COMP327 |

**May also be pre-requisite for modules on other programmes*

| G503 YEAR 3 | | | | | | |
|------------------|-----------------------------|--------------|-------|--------------|----------------|-------------------|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for |
| Semester 1 and 2 | | | | | | |
| COMP299 | Industrial Placement Year 3 | 120 | 5 | - | - | - |

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| G501/G503 Final Year | | | | | | |
|---|---|--------------|-------|--------------|--|-------------------|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for |
| Semester 1 and 2 | | | | | | |
| COMP395 | Honours Year Internet Computing Project (+) | 30 | 6 | - | COMP122, COMP107 or equivalents; COMP216 and COMP108 recommended | - |
| Semester 1 | | | | | | |
| COMP304 | Knowledge Representation and Reasoning (•) | 15 | 6 | - | COMP109, COMP111 | - |
| COMP319 | Software Engineering II (•) | 15 | 6 | - | COMP201 | - |
| COMP323 | Introduction to Computational Game Theory (•) | 15 | 6 | - | COMP116 or equivalent mathematical module | COMP326 |
| COMP327 | Mobile Computing (•) | 15 | 6 | - | COMP122, COMP124, COMP281, COMP282 | - |
| Semester 2 | | | | | | |
| COMP310 | Multi-Agent Systems (•) | 15 | 6 | - | COMP111 | - |
| COMP318 | Advanced Web Technologies (•) | 15 | 6 | - | COMP211, COMP212 | - |
| <i>Plus options totalling 15 credits from the following two modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP315 | Technologies for E-Commerce | 15 | 6 | - | COMP207 | - |
| COMP324 | Complex Social Networks | 15 | 6 | - | - | - |

Note: in exceptional circumstances, and with the approval of the programme Director of Studies, alternative modules may be substituted for non-mandatory modules.

Students may undertake their second year of studies at Xian-Jiaotong Liverpool University (XJTLU), Suzhou, China.

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| G700/G701 YEAR 2 | | | | | | |
|--|---|--------------|-------|--------------|--|---|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for* |
| Semester1 | | | | | | |
| COMP201 | Software Engineering I (●) | 15 | 5 | - | COMP122 COMP107 | COMP214, COMP220, COMP285, COMP319, COMP313 |
| COMP207 | Database Development (●) | 15 | 5 | - | COMP122 COMP107 | COMP214, COMP283, COMP284, COMP315 |
| COMP219 | Artificial Intelligence (+) | 15 | 5 | - | COMP116 COMP111 or equivalent | COMP305, COMP313, COMP318, COMP329 |
| For G701 only | | | | | | |
| COMP221 | Planning Your Career (+) | 7.5 | 5 | - | COMP107 | - |
| <i>Plus options totalling 15 to 22.5 credits*¹ from the following modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP105* | Programming Language Paradigms | 15 | 4 | - | - | - |
| COMP211 | Internet Principles | 15 | 5 | - | COMP122 COMP124 | COMP212, COMP318 |
| COMP221 | Planning Your Career | 7.5 | 5 | - | COMP107 | - |
| Semester 2 | | | | | | |
| COMP214 | Group Software Project (●) | 15 | 5 | - | COMP108, COMP107, COMP124, COMP122 or equivalents; COMP201; COMP207 or equivalent | COMP393 |
| COMP222 | Principles of Computer Game Design and Implementation (●) | 15 | 5 | - | COMP122 COMP111 | - |
| <i>Plus options totalling 15 credits from the following two modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP202 | Complexity of Algorithms | 15 | 5 | - | COMP108, COMP116 | COMP309, COMP324 |
| COMP218 | Decision, Computation and Language | 15 | 5 | - | COMP108 COMP109 | - |
| <i>Plus options totalling 7.5 to 15 credits*¹ from the following modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP281 | Principles of C and Memory Management | 7.5 | 5 | - | COMP122 | COMP282 COMP327 |
| COMP282 | Advanced Object Oriented C Languages | 7.5 | 5 | - | COMP281 | COMP327 |
| COMP283 | Applied Database Management | 7.5 | 5 | - | COMP107 COMP207 | - |
| COMP284 | Scripting Languages | 7.5 | 5 | - | COMP122 COMP107 COMP207 | - |
| COMP285 | Computer Aided Software Development | 7.5 | 5 | - | COMP122 COMP201 | - |

*COMP105 cannot be taken again if already taken in Year 1

*¹120 credits to be taken in Year 2

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| G701 Year 3 | | | | | | |
|------------------|-----------------------------|--------------|-------|--------------|----------------|-------------------|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for |
| Semester 1 and 2 | | | | | | |
| COMP299 | Industrial Placement Year 3 | 120 | 5 | - | - | - |

| G700/G701 Final Year | | | | | | |
|--|---|--------------|-------|---------------|--|-------------------|
| Module Code | Module Title | Credit Value | Level | Co-requisites | Pre-requisites | Pre-requisite for |
| Semester 1 and 2 | | | | | | |
| COMP393 | Honours Year Computer Science Project (+) | 30 | 6 | - | COMP122, COMP107 or equivalents; COMP208 and COMP108 recommended | - |
| Semester 1 | | | | | | |
| <i>Plus options totalling 45 credits from the following four modules provided pre-requisites are satisfied</i> | | | | | | |
| COMP304 | Knowledge Representation and Reasoning | 15 | 6 | - | COMP109, COMP111 | - |
| COMP305 | Biocomputation | 15 | 6 | - | COMP116, COMP219 | - |
| COMP323 | Introduction to Computational Game Theory | 15 | 6 | - | COMP116 or equivalent mathematical module | COMP326 |
| COMP327 | Mobile Computing | 15 | 6 | - | COMP122, COMP124, COMP281, COMP282 | - |
| COMP329 | Robotics and Autonomous Systems | 15 | 6 | - | COMP111, COMP124, COMP219 | - |
| Semester 2 | | | | | | |
| COMP310 | Multi-Agent Systems (•) | 15 | 6 | - | - | - |
| COMP313 | Formal Methods (•) | 15 | 6 | - | COMP109, COMP201, COMP219 | - |
| COMP324 | Complex Social Networks (•) | 15 | 6 | - | COMP202 | - |
| Semester 1 and 2 | | | | | | |
| COMP335* | Communicating Computer Science | 15 | 6 | - | - | - |

*COMP335 - students who wish to choose this module will undergo an interview with the module provider before being selected.

Note: In exceptional circumstances, and with the approval of the programme Director of Studies, alternative modules may be substituted for non-mandatory modules. Students may undertake their second year of studies at Xian-Jiaotong Liverpool University XJTLU, Suzhou, China.

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The programme of study is split into years and semesters as follows.
module (•) indicates a required module and (+) indicates a mandatory module

| GG14/GG16 YEAR 1 | | | | | | | |
|---|---------------------------------------|--------------|-------|---------------|-----------------------------------|---|-------------|
| Module Code | Module Title | Credit Value | Level | Co-requisites | Pre-requisites | Pre-requisite for* | Parent Dept |
| Semester 1 | | | | | | | |
| COMP101 | Introduction to Programming (•) | 15 | 4 | - | - | COMP122 | CS |
| or COMP105 | Programming Language Paradigms (•) | 15 | 4 | - | A-level Computer Science expected | | CS |
| COMP107 | Graduates for the Digital Society (•) | 15 | 4 | - | - | Number of second and third year modules | CS |
| MATH101 | Calculus I (•) | 15 | 4 | - | - | Number of second and third year modules | Maths |
| MATH103 | Introduction to Linear Algebra (•) | 15 | 4 | - | - | Number of second and third year modules | Maths |
| Semester 2 | | | | | | | |
| COMP108 | Algorithmic Foundations (•) | 15 | 4 | - | - | COMP218 COMP202 | CS |
| COMP122 | Object-Oriented Programming (•) | 15 | 4 | - | - | Number of second and third year modules | CS |
| MATH102 | Calculus II (•) | 15 | 4 | - | - | Number of second and third year modules | Maths |
| <i>Plus options totalling 15 credits from the following three modules provided pre-requisites are satisfied</i> | | | | | | | |
| MATH122 | Dynamic Modelling | 15 | 4 | - | - | Number of second and third year modules | Maths |
| MATH142 | Numbers, Groups and Codes | 15 | 4 | - | - | Number of third year modules | Maths |
| MATH162 | Introduction to Statistics | 15 | 4 | - | - | Number of second year modules | Maths |

*May also be a pre-requisite for modules on other programmes

| GG14/GG16 YEAR 2 | | | | | | | |
|------------------|--------------|--------------|-------|--------------|----------------|-------------------|-------------|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for | Parent Dept |

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| Semester 1 | | | | | | | |
|--|--|-----|---|---|--|---|-------|
| For GG16 only | | | | | | | |
| COMP221 | Planning Your Career (+) | 7.5 | 5 | - | COMP107 | - | CS |
| <i>Choose options totalling 30 credits from the following four modules provided pre-requisites are satisfied</i> | | | | | | | |
| COMP111 | Introduction to Artificial Intelligence | 15 | 4 | - | - | Number of second and third year modules | CS |
| COMP201 | Software Engineering I | 15 | 5 | - | COMP122 COMP107 | | CS |
| COMP207 | Database Development | 15 | 5 | - | COMP122 COMP107 | COMP315 | CS |
| <i>Plus options totalling 30 credits from the following eight modules provided pre-requisites are satisfied</i> | | | | | | | |
| MATH201 | Ordinary Differential Equations | 15 | 5 | - | MATH101 MATH102 MATH103 | Number of third year modules | Maths |
| MATH225 | Vector Calculus with Applications in Fluid Mechanics | 15 | 5 | - | MATH102 | - | Maths |
| MATH227 | Math Models: Micro-economics & Population Dynamics | 15 | 5 | - | MATH101 MATH102 MATH103 | - | Maths |
| MATH241 | Metric Spaces and Calculus | 15 | 5 | - | MATH101 MATH102 MATH103 | - | Maths |
| MATH243 | Complex Functions | 15 | 5 | - | MATH101 MATH102 MATH103 | - | Maths |
| MATH244 | Linear Algebra and Geometry | 15 | 5 | - | MATH101 MATH102 MATH103 | - | Maths |
| MATH261 | Introduction to Methods of Operational Research | 15 | 5 | - | MATH101 MATH102 MATH103 | - | Maths |
| MATH268 | Operational Research: Probabilistic Models | 15 | 5 | - | MATH101 MATH102 MATH103 MATH162 | - | Maths |
| Semester 2 | | | | | | | |
| COMP202 | Complexity of Algorithms (•) | 15 | 5 | - | COMP108 | Number of third year options | CS |
| <i>Plus options totalling 15 credits from the following two modules provided pre-requisites are satisfied:</i> | | | | | | | |

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| | | | | | | | |
|---------|------------------------------------|----|---|---|--------------------|---|----|
| COMP124 | Computer Systems | 15 | 4 | - | - | - | CS |
| COMP218 | Decision, Computation and Language | 15 | 5 | - | COMP108 COMP109 | - | CS |

Plus options totalling 30 credits from the following nine modules provided pre-requisites are satisfied:

| | | | | | | | |
|----------------------|--|----|---|---|--|------------------------------|-------|
| MATH206 | Group Project Module | 15 | 5 | - | - | - | Maths |
| MATH224 | Introduction to the Methods of Applied Mathematics | 15 | 5 | - | MATH101 MATH102 MATH103 | Number of third year modules | Maths |
| MATH228 | Classical Mechanics | 15 | 5 | - | MATH101 MATH102 MATH103 MATH122 | Number of third year modules | Maths |
| MATH247 | Commutative Algebra | 15 | 5 | - | MATH101 MATH102 MATH103 | - | Maths |
| MATH248 | Geometry of Curves | 15 | 5 | - | MATH101 MATH102 MATH103 | - | Maths |
| MATH262 | Financial Mathematics II | 15 | 5 | - | MATH101 MATH103 MATH162 | s- | Maths |
| MATH263 | Statistical Theory and Methods I | 15 | 5 | - | MATH101 MATH102 MATH103 MATH162 | Number of third year modules | Maths |
| MATH264 | Statistical Theory and Methods II | 15 | 5 | - | MATH101 MATH103 MATH162 | Number of third year modules | Maths |
| MATH266 ¹ | Numerical Methods | 15 | 5 | - | MATH101 MATH102 MATH103 | - | Maths |

*May also be a pre-requisite for modules on other programmes

¹ MATH266 is highly recommended

| GG16 YEAR 3 | | | | | | |
|------------------|-----------------------------|--------------|-------|--------------|----------------|-------------------|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for |
| Semester 1 and 2 | | | | | | |
| COMP299 | Industrial Placement Year 3 | 120 | 5 | - | - | - |

| GG14/GG16 Final Year | | | | | | | |
|---|--------------|--------------|-------|--------------|----------------|-------------------|-------------|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for | Parent Dept |
| Semester 1 | | | | | | | |
| <i>Choose options totalling 30 credits from the following eight modules provided pre-requisites are satisfied</i> | | | | | | | |

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| | | | | | | | | |
|--|--|----|---|---|--|----------|---|-------|
| COMP219 | Artificial Intelligence | 15 | 5 | - | COMP116, COMP111, equivalent | or | A number of third year modules | CS |
| COMP304 | Knowledge Representation and Reasoning | 15 | 6 | - | COMP109, COMP111 | | - | CS |
| COMP305 | Biocomputation | 15 | 6 | - | - | | - | CS |
| COMP309 | Efficient Sequential Algorithms | 15 | 6 | - | COMP202 | | - | CS |
| COMP319 | Software Engineering II | 15 | 6 | - | COMP201 | | - | CS |
| COMP323 | Introduction to Computational Game Theory | 15 | 6 | - | COMP109 equivalent mathematical module | or | - | CS |
| COMP331 | Optimization | 15 | 6 | - | COMP109 equivalent mathematical module | or | - | CS |
| COMP391 ¹ | Final Year First Semester 15 Credit Project | 15 | 6 | - | - | | - | CS |
| <i>Plus options totalling 30 credits from the following ten modules provided pre-requisites are satisfied¹:</i> | | | | | | | | |
| MATH322 | Chaos and Dynamical Systems | 15 | 6 | - | MATH101 MATH103 MATH201 | | - | Maths |
| MATH323 | Further Methods of Applied Mathematics | 15 | 6 | - | MATH101 MATH102 MATH103 MATH224 | | - | Maths |
| MATH324 | Cartesian Tensors and Mathematical Models of Solids and Viscous Fluids | 15 | 6 | - | MATH101 MATH102 MATH103 | | - | Maths |
| MATH325 | Quantum Mechanics | 15 | 6 | - | MATH101, MATH102, MATH103, MATH122; MATH201 MATH224 | or | - | Maths |
| MATH343 | Group Theory | 15 | 6 | - | MATH101, MATH103; MATH142 MATH244 MATH247 helpful | or or | - | Maths |
| MATH344 | Combinatorics | 15 | 6 | - | MATH101 MATH102 MATH103 | | - | Maths |
| MATH351 | Analysis and Number Theory | 15 | 6 | - | MATH101 MATH102 MATH103; MATH241 helpful | | - | Maths |
| MATH362 | Applied Probability | 15 | 6 | - | MATH264 | | - | Maths |
| MATH363 | Linear Statistical Models | 15 | 6 | - | MATH263 | | - | Maths |
| MATH367 | Networks in Theory and Practice | 15 | 6 | - | 2 nd Year Maths | | - | Maths |
| Semester 2 | | | | | | | | |
| <i>Plus options totalling 30 credits from the following six modules provided pre-requisites are satisfied¹</i> | | | | | | | | |
| COMP310 | Multi-Agent Systems | 15 | 6 | - | COMP111 | | - | CS |

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| | | | | | | | |
|--|--|----|---|---|---|---|-------|
| COMP313 | Formal Methods | 15 | 6 | - | COMP109, COMP201, COMP219 | - | CS |
| COMP315 | Technologies for E-Commerce | 15 | 6 | - | COMP207 | - | CS |
| COMP326 | Computational Game Theory and Mechanism Design | 15 | 6 | - | COMP323 COMP109 or equivalent mathematical module | - | CS |
| COMP392 ¹ | Final Year Second Semester 15 Credit Project | 15 | 6 | - | - | - | CS |
| Semester 1 and 2 | | | | | | | |
| ² COMP335 | Communicating Computer Science | 15 | 6 | - | - | - | CS |
| <i>Plus options totalling 30 credits from the following nine modules provided pre-requisites are satisfied</i> | | | | | | | |
| MATH326 | Relativity | 15 | 6 | - | MATH101 MATH102 MATH103 MATH122 MATH228 | - | Maths |
| MATH331 | Mathematical Economics | 15 | 6 | - | MATH101 MATH102 MATH103; MATH227 preferred | - | Maths |
| MATH332 | Mathematical Biology | 15 | 6 | - | MATH101 MATH102 MATH103 MATH201 | - | Maths |
| MATH342 | Number Theory | 15 | 6 | - | MATH101 MATH103 MATH142 | - | Maths |
| MATH349 | Differential Geometry | 15 | 6 | - | MATH101 MATH102 MATH103; MATH248 recommended | - | Maths |
| MATH361 | Theory of Statistical Inference | 15 | 6 | - | MATH263 MATH264 | - | Maths |
| MATH364 | Medical Statistics | 15 | 6 | - | - | - | Maths |
| MATH366 | Mathematical Risk Theory | 15 | 6 | - | MATH264 | - | Maths |
| MATH399 ² | Projects in Mathematics | 15 | 6 | - | MATH334 MATH302 MATH391 | - | Maths |

¹ COMP391/2 is highly recommended, but only one of COMP391/2 can be taken

²COMP335 – students who wish to choose this module will undergo an interview with the module provider before being selected.

¹If COMP335 is taken, an imbalance of 15 credits between the two semesters is allowed. 120 credits to be taken in Year 3.

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| GN34/G3N4 YEAR 1 | | | | | | | |
|--------------------------|---|--------------|------------|---------------|--|---|--------------|
| Module Code | Module Title | Credit Value | Level | Co-requisites | Pre-requisites | Pre-requisite for* | Parent Dept |
| Semester 1 | | | | | | | |
| ACFI101 | Introduction to Financial Accounting (•) | 15 | 4 | - | - | - | ULMS |
| COMP101 or COMP105 | Introduction to Programming (•) Programming Language Paradigms (•) | 15 15 | 4 4 | - - | - A-level Computer Science expected | COMP122 COMP122 | CS CS |
| COMP107 | Graduates for the Digital Society (•) | 15 | 4 | - | - | COMP201, COMP207, COMP208, COMP283, COMP284, COMP390 | CS |
| ECON121 | Principles of Microeconomics (•) | 15 | 4 | - | - | ECON241 | ULMS |
| Semester 2 | | | | | | | |
| ACFI102 | Introduction to Management Accounting (•) | 15 | 4 | - | - | - | ULMS |
| ACFI103 | Introduction to Finance (•) | 15 | 4 | - | - | ACFI213 ECON241 | ULMS |
| COMP116 | Analytical Techniques in Computer Science (•) | 15 | 4 | - | - | COMP202, COMP219, COMP226, COMP305, COMP323, COMP326, COMP331 | CS |
| COMP122 | Object-Oriented Programming (•) | 15 | 4 | - | COMP101 or COMP105 | COMP201, COMP207, COMP220, COMP211, COMP212, COMP222, COMP281, COMP284, COMP285, COMP208, COMP327, COMP390 | CS |

*May also be a pre-requisite for modules on other programmes

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| GN34/G3N4 YEAR 2 | | | | | | | |
|--|--|--------------|-------|--------------|--|---|-------------|
| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for | Parent Dept |
| Semester 1 | | | | | | | |
| For GN34 only | | | | | | | |
| COMP221 | Planning Your Career (+) | 7.5 | 5 | - | COMP107 | - | CS |
| <i>Choose options totalling 30 credits from the following four modules provided pre-requisites are satisfied</i> | | | | | | | |
| COMP111 | Introduction to Artificial Intelligence | 15 | 4 | - | - | Number of second and third year modules | CS |
| COMP201 | Software Engineering I | 15 | 5 | - | COMP122 COMP107 | | CS |
| COMP207 | Database Development | 15 | 5 | - | COMP122 COMP107 | COMP315 | CS |
| <i>Plus options totalling 30 credits from the following eight modules provided pre-requisites are satisfied</i> | | | | | | | |
| MATH201 | Ordinary Differential Equations | 15 | 5 | - | MATH101 MATH102 MATH103 | Number of third year modules | Maths |
| MATH225 | Vector Calculus with Applications in Fluid Mechanics | 15 | 5 | - | MATH102 | - | Maths |
| MATH227 | Math Models: Micro-economics & Population Dynamics | 15 | 5 | - | MATH101 MATH102 MATH103 | - | Maths |
| MATH241 | Metric Spaces and Calculus | 15 | 5 | - | MATH101 MATH102 MATH103 | - | Maths |
| MATH243 | Complex Functions | 15 | 5 | - | MATH101 MATH102 MATH103 | - | Maths |
| MATH244 | Linear Algebra and Geometry | 15 | 5 | - | MATH101 MATH102 MATH103 | - | Maths |
| MATH261 | Introduction to Methods of Operational Research | 15 | 5 | - | MATH101 MATH102 MATH103 | - | Maths |
| MATH268 | Operational Research: Probabilistic Models | 15 | 5 | - | MATH101 MATH102 MATH103 MATH162 | - | Maths |
| Semester 2 | | | | | | | |
| COMP202 | Complexity of Algorithms (•) | 15 | 5 | - | COMP108 | Number of third year options | CS |

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Plus options totalling 15 credits from the following two modules provided pre-requisites are satisfied:

| | | | | | | | |
|---------|------------------------------------|----|---|---|--------------------|---|----|
| COMP124 | Computer Systems | 15 | 4 | - | - | - | CS |
| COMP218 | Decision, Computation and Language | 15 | 5 | - | COMP108 COMP109 | - | CS |

Plus options totalling 30 credits from the following nine modules provided pre-requisites are satisfied:

| | | | | | | | |
|----------------------|--|----|---|---|--|------------------------------|-------|
| MATH206 | Group Project Module | 15 | 5 | - | - | - | Maths |
| MATH224 | Introduction to the Methods of Applied Mathematics | 15 | 5 | - | MATH101 MATH102 MATH103 | Number of third year modules | Maths |
| MATH228 | Classical Mechanics | 15 | 5 | - | MATH101 MATH102 MATH103 MATH122 | Number of third year modules | Maths |
| MATH247 | Commutative Algebra | 15 | 5 | - | MATH101 MATH102 MATH103 | - | Maths |
| MATH248 | Geometry of Curves | 15 | 5 | - | MATH101 MATH102 MATH103 | - | Maths |
| MATH262 | Financial Mathematics II | 15 | 5 | - | MATH101 MATH103 MATH162 | s- | Maths |
| MATH263 | Statistical Theory and Methods I | 15 | 5 | - | MATH101 MATH102 MATH103 MATH162 | Number of third year modules | Maths |
| MATH264 | Statistical Theory and Methods II | 15 | 5 | - | MATH101 MATH103 MATH162 | Number of third year modules | Maths |
| MATH266 ¹ | Numerical Methods | 15 | 5 | - | MATH101 MATH102 MATH103 | - | Maths |

*May also be a pre-requisite for modules on other programmes

¹ MATH266 is highly recommended

G3N4 YEAR 3

| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for |
|------------------|-----------------------------|--------------|-------|--------------|----------------|-------------------|
| Semester 1 and 2 | | | | | | |
| COMP299 | Industrial Placement Year 3 | 120 | 5 | - | - | - |

GN34/G3N4 Final Year

| Module Code | Module Title | Credit Value | Level | Co-requisite | Pre-requisites | Pre-requisite for | Parent Dept |
|-------------|--------------|--------------|-------|--------------|----------------|-------------------|-------------|
| Semester 1 | | | | | | | |

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| <i>Choose options totalling 30 credits from the following eight modules provided pre-requisites are satisfied</i> | | | | | | | |
|--|--|----|---|---|--|---|-------|
| COMP219 | Artificial Intelligence | 15 | 5 | - | COMP116, COMP111, equivalent | or A number of third year modules | CS |
| COMP304 | Knowledge Representation and Reasoning | 15 | 6 | - | COMP109, COMP111 | - | CS |
| COMP305 | Biocomputation | 15 | 6 | - | - | - | CS |
| COMP309 | Efficient Sequential Algorithms | 15 | 6 | - | COMP202 | - | CS |
| COMP319 | Software Engineering II | 15 | 6 | - | COMP201 | - | CS |
| COMP323 | Introduction to Computational Game Theory | 15 | 6 | - | COMP109 equivalent mathematical module | or - | CS |
| COMP331 | Optimization | 15 | 6 | - | COMP109 equivalent mathematical module | or - | CS |
| COMP391 ¹ | Final Year First Semester 15 Credit Project | 15 | 6 | - | - | - | CS |
| <i>Plus options totalling 30 credits from the following ten modules provided pre-requisites are satisfied¹:</i> | | | | | | | |
| MATH322 | Chaos and Dynamical Systems | 15 | 6 | - | MATH101 MATH103 MATH201 | - | Maths |
| MATH323 | Further Methods of Applied Mathematics | 15 | 6 | - | MATH101 MATH102 MATH103 MATH224 | - | Maths |
| MATH324 | Cartesian Tensors and Mathematical Models of Solids and Viscous Fluids | 15 | 6 | - | MATH101 MATH102 MATH103 | - | Maths |
| MATH325 | Quantum Mechanics | 15 | 6 | - | MATH101, MATH102, MATH103, MATH122; MATH201 MATH224 | or - | Maths |
| MATH343 | Group Theory | 15 | 6 | - | MATH101, MATH103; MATH142 MATH244 MATH247 helpful | or or - | Maths |
| MATH344 | Combinatorics | 15 | 6 | - | MATH101 MATH102 MATH103 | - | Maths |
| MATH351 | Analysis and Number Theory | 15 | 6 | - | MATH101 MATH102 MATH103; MATH241 helpful | - | Maths |
| MATH362 | Applied Probability | 15 | 6 | - | MATH264 | - | Maths |
| MATH363 | Linear Statistical Models | 15 | 6 | - | MATH263 | - | Maths |
| MATH367 | Networks in Theory and Practice | 15 | 6 | - | 2 nd Year Maths | - | Maths |
| Semester 2 | | | | | | | |
| <i>Plus options totalling 30 credits from the following six modules provided pre-requisites are satisfied¹</i> | | | | | | | |

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| | | | | | | | |
|--|--|----|---|---|---|---|-------|
| COMP310 | Multi-Agent Systems | 15 | 6 | - | COMP111 | - | CS |
| COMP313 | Formal Methods | 15 | 6 | - | COMP109, COMP201, COMP219 | - | CS |
| COMP315 | Technologies for E-Commerce | 15 | 6 | - | COMP207 | - | CS |
| COMP326 | Computational Game Theory and Mechanism Design | 15 | 6 | - | COMP323 COMP109 or equivalent mathematical module | - | CS |
| COMP392 ¹ | Final Year Second Semester 15 Credit Project | 15 | 6 | - | - | - | CS |
| Semester 1 and 2 | | | | | | | |
| ² COMP335 | Communicating Computer Science | 15 | 6 | - | - | - | CS |
| <i>Plus options totalling 30 credits from the following nine modules provided pre-requisites are satisfied</i> | | | | | | | |
| MATH326 | Relativity | 15 | 6 | - | MATH101 MATH102 MATH103 MATH122 MATH228 | - | Maths |
| MATH331 | Mathematical Economics | 15 | 6 | - | MATH101 MATH102 MATH103; MATH227 preferred | - | Maths |
| MATH332 | Mathematical Biology | 15 | 6 | - | MATH101 MATH102 MATH103 MATH201 | - | Maths |
| MATH342 | Number Theory | 15 | 6 | - | MATH101 MATH103 MATH142 | - | Maths |
| MATH349 | Differential Geometry | 15 | 6 | - | MATH101 MATH102 MATH103; MATH248 recommended | - | Maths |
| MATH361 | Theory of Statistical Inference | 15 | 6 | - | MATH263 MATH264 | - | Maths |
| MATH364 | Medical Statistics | 15 | 6 | - | - | - | Maths |
| MATH366 | Mathematical Risk Theory | 15 | 6 | - | MATH264 | - | Maths |
| MATH399 ² | Projects in Mathematics | 15 | 6 | - | MATH334 MATH302 MATH391 | - | Maths |

¹COMP391/2 is highly recommended, but only one of COMP391/2 can be taken

²COMP335 – students who wish to choose this module will undergo an interview with the module provider before being selected.

¹If COMP335 is taken, an imbalance of 15 credits between the two semesters is allowed. 120 credits to be taken in Year 3.