UNIVERSITY OF LONDON

Programme Regulations 2019–2020

Computer Science
Computer Science (Data Science)
Computer Science (Machine Learning and Artificial Intelligence)
Computer Science (Web and Mobile Development)
Computer Science (User Experience)
Computer Science (Physical Computing and Internet of Things)
Computer Science (Games Development)
Computer Science (Virtual Reality)

BSc

Important document – please read
This document contains important information that governs your registration, assessment and programme of study

Contents

Important information regarding the Programme Regulations

About this document

Last revised 06 February 2020

As a student registered with the University of London you are governed by the current General Regulations and Programme Regulations associated with your programme of study. Goldsmiths is responsible for the academic direction of the programme.

In addition to Programme Regulations, you will have to abide by the General Regulations. These regulations apply to all students registered for a programme of study with the University of London and provide the rules governing registration and assessment on all programmes; they also indicate what you may expect on completion of your programme of study and how you may pursue a complaint, should that be necessary. Programme Regulations should be read in conjunction with the General Regulations.

The relevant General Regulations and the Programme Regulations relating to your registration with us are for the current year and not the year in which you initially registered.

On all matters where the regulations are to be interpreted, or are silent, our decision will be final.

Further information about your programme of study is outlined in the Programme Specification which is available on the relevant Courses page of the website. The Programme Specification gives a broad overview of the structure and content of the programme as well as the learning outcomes you will achieve as you progress.

To note

Throughout the Regulations, 'we' 'us' and 'our' mean the University of London; 'you' and 'your' mean the student, or where applicable, all students.

For the BSc Computer Science programmes, you should note the following terminology:

Module: Individual units of the programme are called modules. Each module is a self-contained, formally structured learning experience with a coherent and explicit set of learning outcomes and assessment criteria.

Core module: Core modules are central to the teaching and learning on the programme and may introduce concepts and ideas that appear in the compulsory and optional modules. Core modules must be passed. There is one core module on the BSc Computer Science programme and six core modules on each of the specialist Computer Science degrees.

Compulsory module: Compulsory modules introduce concepts and ideas that appear in optional modules. Students must take these modules as part of their studies.

Optional module: Optional modules are designed to extend the concepts and ideas introduced in core and compulsory modules and to introduce other relevant concepts and techniques. Students select optional modules from a list.

Significant changes made to the programme regulations 2019-2020:

From April 2020, module CM1015 will be titled *Computational Mathematics*.

Regulations 1.11 and 3.4 have been updated to note that a maximum of 30 compensated credits and a maximum of 60 credits for recognition of prior learning are permitted in the exit award of a Diploma of Higher Education in Computer Science.

Regulation 4.4 has been added noting that if you have a combined weighted average of 40% or above but you have achieved less than 35% in either element of assessment, your mark will be capped at 39% [Fail] (which will be subject to the application of rules for compensation at the point of classification).

Regulation 4.11 on word limits for coursework and project items has been updated. For coursework and project items, you should not exceed the word limits by more than 10%. If the word count is between 10% to 20% above the word limit, five marks will be deducted. If the word count exceeds the word limit by more than 20%, you will receive a mark of zero for your work.

1 Structure of the programme

See Appendix A for the full programme structure and Appendix B for module outlines.

Qualifications

1.1

The following qualifications are awarded under these regulations:

- Bachelor of Science in Computer Science
- Bachelor of Science in Computer Science (Data Science)
- Bachelor of Science in Computer Science (Machine Learning and Artificial Intelligence)
- Bachelor of Science in Computer Science (Web and Mobile Development)
- Bachelor of Science in Computer Science (User Experience)
- Bachelor of Science in Computer Science (Physical Computing and Internet of Things)
- Bachelor of Science in Computer Science (Games Development)
- Bachelor of Science in Computer Science (Virtual Reality)
- Bachelor of Science in Computer Science (unclassified/pass degree) - *Exit qualification only*
- Diploma of Higher Education in Computer Science - *Exit/Intermediate qualification only*
- Certificate of Higher Education in Computer Science - *Exit/Intermediate qualification only*

Degree structure

1.2

For the award of BSc Computer Science you must complete:

- one **core** module and seven **compulsory** modules at FHEQ Level 4 totalling 120 credits, plus
- eight **compulsory** modules at FHEQ Level 5 totalling 120 credits, plus
- six **optional** modules and a **compulsory** project at FHEQ Level 6 totalling 120 credits

1.3

For the award of BSc Computer Science with a named specialism you must complete:

- one **core** module and seven **compulsory** modules at FHEQ Level 4 totalling 120 credits, plus
- eight **compulsory** modules at FHEQ Level 5 totalling 120 credits, plus
- five specialist **core** modules, **one** optional module and a **compulsory** project at FHEQ Level 6 totalling 120 credits

1.4

There are two study sessions each year beginning in **April** and **October**. The maximum number of modules you can register for in any one session is **five** (or three plus the final project).

This can be a combination of new modules and resits (with a maximum of **four** new modules), or resits only.

Over a 22 week session, a 15 credit module will typically require 150 hours of notional study hours. Each module, excluding the final project, is organised into 10 topics, with approximately 10-12 hours of study required per topic. The remaining study time is intended for coursework and examination preparation.

Intermediate qualifications

1.5

An intermediate qualification or qualifications (i.e. a Certificate of Higher Education and/or Diploma of Higher Education in Computer Science) may be awarded if you are registered on any of the BSc programmes. You may accumulate these qualifications as you progress through your BSc studies.

1.6

You must apply to be awarded these qualifications; they will not be awarded automatically.

1.7

Providing you satisfy the requirements, you may apply for intermediate qualifications at any point between making an examination entry for examinations that, if successfully completed, would make you eligible for the qualification, and making your final examination entry on the programme on which you are registered.

1.8

If you do not apply for an intermediate qualification at, or prior to, your final examination entry for the programme on which you are registered, you will not be awarded these qualifications at a later date.

Exit qualifications

1.9

If you are registered on any of the BSc programmes and are unable to complete your studies for academic or personal reasons you may be eligible for an exit qualification.

1.10

We may award the Certificate of Higher Education in Computer Science as an exit qualification if you have successfully completed a minimum of **120 credits**. Neither Recognition of Prior Learning nor marginal compensation is permitted.

1.11

We may award the Diploma of Higher Education in Computer Science as an exit qualification if you have successfully completed a minimum of **240 credits**, with a minimum of 90 credits at Level 5. A maximum of 30 compensated credits and a maximum of 60 credits for Recognition of Prior Learning are permitted.

1.12

Exit qualifications are awarded at the discretion of the Board of Examiners. Once you have accepted a Certificate or Diploma of Higher Education in Computer Science as an exit qualification we will not permit you to register or re-register for a BSc under these regulations at a later date.

2 Registration

There are two Entry Routes into the BSc programmes: the Direct Entry Route and Performance Based Admission. See Entrance Requirements in the Programme Specification, and the Requirements tab on the programme's web-pages, for full details.

Effective date of registration

2.1

Your effective date of registration will be either:

- **1 October** if you first register before the September registration deadline,
- **1 April** if you first register before the March registration deadline.

2.2

The maximum period of registration for a BSc programme is normally six years.

2.3

If you are registered on the Performance Based Admissions route, you will have a maximum of three years to complete the two required modules. Your six year registration period will begin from the point at which you register on the full BSc programme.

2.4

You may request a one-year extension to your BSc registration. This will be granted at the discretion of the Programme Director in exceptional circumstances only and should be requested at the end of your final year of registration.

Date of first examinations

2.5

If your effective date of registration is:

- **1 October**, you will take your first examination(s) in March of the following year,
- **1 April**, you will take your first examination(s) in September of the same year.

Module availability

Not all modules will run in every study session. The core module, Introduction to Programming I will be available in both the April and October sessions.

2.6

Where we are unable to provide an appropriate learning experience to meet the learning outcomes of the module due to insufficient student registrations, we may withdraw the module from that session.

We will inform you of any such changes as early as possible and provide you with reasonable alternative arrangements

3 Recognition of prior learning and credit transfer

Recognition of prior learning

See the General Regulations (Section 3) for more rules relating to Recognition of prior learning.

3.1

If you are registered on a full BSc programme, you may apply for recognition of prior learning for up to **120 credits** at **Level 4**. We will not recognise or accredit prior learning for modules at FHEQ Level 5 or 6.

3.2

If you are registered on the Performance Based Admissions entry route, we will not recognise or accredit prior learning for either of the two required modules. These must be passed in order to progress onto the full BSc programme.

3.3

We consider applications for recognition of prior learning (RPL) on the basis of studies successfully completed at an appropriate level.

3.4

There will be no RPL for modules included in the award of a Certificate of Higher Education in Computer Science. A maximum of 60 credits for RPL are permitted in the award of a Diploma of Higher Education in Computer Science.

4 Assessment for the programme

Assessment methods

4.1

Each module, excluding the Final Project, is summatively assessed either by coursework or a combination of coursework and a two-hour unseen written examination.

4.2

The pass mark for any element of assessment is 40%.

4.3

The structure of assessment can take one of three types:

Assessment Structure	Element of assessment	Element weighting	To pass the module you must get:
Type I	Coursework	50%	At least 35% in each element of summative assessment and a combined weighted average of at least 40%, subject to the application of rules for compensation (regulations 4.25 to 4.31)
	Written examination	50%	

Assessment Structure	Element of assessment	Element weighting	To pass the module you must get:
Type II	Coursework I	50%	At least 35% in each element of summative assessment and a combined weighted average of at least 40%, subject to the application of rules for compensation (regulations 4.25 to 4.31)
	Coursework II	50%	
Type III	Coursework I: Initial Report	30%	At least 35% in each element of summative assessment and a combined weighted average of at least 40%, subject to the application of rules for compensation (regulations 4.25 to 4.31)
	Coursework II: Final Report	70%	

Refer to Appendix B for the assessment structure for each module.

4.4

If you have a combined weighted average of 40% or above but you have achieved less than 35% in either element of assessment, your mark will be capped at 39% Fail (which will be subject to the application of rules for compensation at the point of classification).

4.5

Each coursework element may consist of multiple items of assessment.

Final Project

4.6

The summative assessment for the Final Project consists of both coursework and a written examination, weighted in the ratio 80:20. The examination will be a two-hour written exam consisting of questions relating to your project.

4.7

The coursework will consist of multiple items which you should submit according to the prescribed deadlines set out on the VLE.

4.8

Each item of coursework, totalling 80% of the overall mark for the Final Project, is weighted as follows:

Summative Assessment	Percentage of Overall Module
Project proposal	Pass/ Fail
Progress logs	5%
Preliminary Project Report	10%
Project presentation video	5%
Final project report and code	60%

Taking assessments

Refer to the rules on assessment and assessment offences in the General Regulations.

See the website for the list of examination centres.

4.9

Examinations take place in March and September, at the end of each study session, with retakes in the next available session.

4.10

When you register for a module, you must take the assessments at the first available opportunity.

4.11

For coursework and project items, you should not exceed the word limits by more than 10%. If the word count is between 10% to 20% above the word limit, five marks will be deducted. If the word count exceeds the word limit by more than 20%, you will receive a mark of zero for your work.

The content within the main body of text comprises the overall word count, including in-text citations, references, quotes, heading and sub-headings. The cover page, reference list and any appendices do not count towards the overall word count.

Plagiarism

This section should be read in conjunction with Section 8 of the General Regulations.

4.12

Some items of assessment for this programme will require group work and, in some cases, a joint submission.

4.13

Where group work is required, and an allegation of plagiarism has been made, the work submitted will be subject to consideration as set out in the General Regulations and on the website.

4.14

Following an investigation, any penalty imposed may be applied to all members of the group on behalf of whom the work was submitted.

4.15

All other work submitted for assessment must be entirely your own.

Resitting an element of assessment

If you retake one or more elements of assessment for a module you will have to pay a module continuation fee when you register for the module to retake the assessment. You may only register for a retake once your results have been ratified.

4.16

The maximum number of attempts permitted at any element of assessment is **three.**

4.17

If your overall result for a module is a fail, you may resit any element of assessment for which you achieved less than 40%, provided that you do not exceed the maximum number of attempts.

4.18

You will not be permitted to resit any element which you have passed.

4.19

If you retake an element of assessment, your most recent mark will be used for classification.

4.20

If you fail a **core** module at the third attempt, your registration on the degree will cease. If this is a core Level 6 module, you may be permitted to transfer to another BSc degree under these regulations, subject to the rules in section 6.

4.21

If you fail a **compulsory** module at the third attempt or an **optional** module which you cannot or do not choose to swap, you will no longer be eligible for the degree with honours. You may continue your studies to obtain a pass degree (unclassified) only.

See section 7 for the full scheme of award.

Swapping an optional module

4.22

You will be permitted to swap up to **two optional modules** for an alternative, where possible, providing you are still within the maximum period of registration. If you do so;

- You must inform us that you wish to withdraw from your current module
- You may commence the new module(s) at the next available opportunity
- You will have the full three attempts to pass the new module(s)

4.23

If you fail an **optional** module at the third attempt, you may register for an alternative module. Your mark for the new module will be used for the purposes of classification.

4.24

You will not be permitted to swap any module which you have already passed.

You are permitted to withdraw from a module within **14 days of the module start date,** with no financial penalty. After this point, you will need to pay a new module fee should you decide to swap for an available alternative.

Marginal compensation

4.25

If you fail a module with a mark of between 35% and 39%, you may be compensated, and have credit awarded in the same way as for passed modules, providing the mean average mark for the Level is 45% or above.

4.26

We will **not** permit marginal compensation for core modules or the Final project. They must be passed in order to be awarded a BSc qualification.

4.27

Compensation may be applied by the Board of Examiners at the point of classification only.

4.28

Where you obtain a mark in the compensatable range, you may choose to resit up until you become eligible for the final award, subject to the maximum number of attempts.

4.29

If, at the first attempt, you achieve a compensatable fail mark for a module and, in subsequent attempts to redeem the failure, achieve further compensatable fail marks, the highest mark obtained will be used for the purposes of classification.

4.30

A maximum of 30 credits may be compensated at any given Level.

4.31

The total credit value for which marginal compensation can be permitted may not exceed the amount specified for the programme as follows:

Qualification	Maximum credit value of marginal compensation
Certificate of Higher Education (Exit award)	0
Diploma of Higher Education (Exit award)	30
BSc	60 (no more than 30 at any one level)

Deferring an assessment

You will be notified of the deadlines for deferring a module during the study session. If you defer taking a written examination you have to pay a module continuation fee when you register for the session in which you wish to take the examination.

4.32

Following the mid-term assessment, you may defer taking the final examination of a module if you notify us by the deadline. You may only do so once per module.

4.33

You are only allowed to defer written examinations. You will not be permitted to defer a coursework element. If you miss the deadline for submission, you will be given a mark of zero for the assessment element and it **will** count as an attempt.

4.34

If you defer the final examination, but you obtained a mark of 40% or above in the coursework element, that mark will be carried forward.

4.35

If you defer the final examination, but you obtained a mark below 40% in the coursework, you must resit that element of assessment. This **will** be deemed a second attempt.

4.36

If you defer the final examination, you will not be deemed to have made an attempt at that element of assessment.

4.37

When you resume study of a deferred module, this will count towards the maximum number of credits you are permitted to study in any one session.

4.38

If you do not notify us of your deferral and do not attend the final examination, you will be given a mark of zero for that assessment element and it **will** count as an attempt.

Mitigating circumstances

4.39

If you have provided evidence of mitigating circumstances you may request to continue your studies for a module in an alternative session.

4.40

This will be granted at the discretion of the Board of Examiners and in such cases we will allow you to defer all outstanding elements of assessment.

5 Progression within the programme

Performance based admissions

5.1

To enter the BSc via the Performance based admission route, you must first register for and pass Introduction to Programming I and **either** Discrete Mathematics **or** Computational Mathematics.

5.2

If you achieve a mark of 50% or above in the mid-term assessments for both modules, you will be permitted to register for modules on the BSc programme in the next study session, subject to any relevant progression rules.

5.3

If you achieve a mark of 49% or below in the mid-term assessments for one or both modules, you may continue to the final assessment. If you achieve an overall mark of **40% or above** in both modules, **with at least 35% in each element of assessment**, you will be permitted to continue your studies in the next available session, subject to any relevant progression rules.

5.4

Where you pass **one** of the two required modules, you must resit the failed module, providing you have not exhausted all attempts and you are still within the maximum period of registration. You will not be permitted to register on the full BSc until you achieve a pass in **both** modules.

5.5

You will be permitted **three** attempts at each module. If you fail **either** module at the third attempt, your registration will cease and you will not be permitted on to the full BSc programme. Marginal compensation will not be applicable to these modules.

Requirements to progress through the BSc

5.6

To progress to FHEQ Level 5 modules, you must have:

- passed, or been awarded credit through recognition of prior learning, for at least 45 credits at Level 4, including Introduction to Programming I and either Discrete **or** Computational Mathematics; and
- made an attempt at a further 45 credits at Level 4, including both Introduction to Programming II and the remaining Level 4 maths module; and
- registered for any Level 4 modules not yet attempted alongside your Level 5 modules, excluding any for which you have been awarded credit through recognition of prior learning.

5.7

To progress to FHEQ Level 6 modules, you must have:

- passed at least 45 credits at Level 5 including Object Oriented Programming **or** Software Design and Development; and
- made an attempt at a further 45 credits at Level 5 including Object Oriented Programming **or** Software Design and Development; and
- registered for any Level 4 or Level 5 modules not yet attempted alongside your Level 6 modules.

The Final Project

5.8

In order to register for the Final Project, you must have:

- passed, or exhausted all permitted attempts, at all modules at Levels 4 and 5, notwithstanding any RPL; and
- made an attempt at a minimum of 60 credits at Level 6

5.9

Where you have failed a compulsory module at the third attempt, you will be permitted to take the Final Project, and continue studies towards achieving a pass degree (unclassified) only. You will not be eligible for the BSc degree with honours.

Refer to Regulations 4.36 to 4.38 for information on what will be deemed an attempt.

Order in which to take the modules

5.10

You must attempt all elements of assessment for Introduction to Programming I before you register for Introduction to Programming II.

5.11

All other modules **within a given level**, excluding the final project, may be attempted in any order.

6 Transfer of Registration

Transfer between BSc programmes within the Computer Science suite of awards

6.1

You may apply to transfer between BSc programmes offered under these regulations provided that

- you have selected, or are still able to select, the core modules on the degree to which you wish to transfer;
- you are still within your maximum period of registration;
- you have not failed at the final attempt, a module that is core on the degree to which you wish to transfer;
- you have not passed more than one Level 6 module which does not fit on the degree to which you wish to transfer;
- you are not yet eligible for the BSc award upon which you are currently registered.

6.2

Upon transfer, you will be permitted to discard one passed module only which is not available on the degree to which you wish to transfer.

6.3

If your passed modules do not fit on to an alternative specialist degree, you may apply to transfer to the BSc in Computer Science only.

6.4

If you transfer between degree programmes we will transfer credit for:

- any modules that you have already passed provided they fit onto your new degree; and
- credit awarded for recognition of prior learning provided this remains applicable to your new degree.

6.5

The marks obtained in modules you have already passed, excluding any discarded module, will be taken into consideration for classification purposes. If you have been awarded credit for a module, we will not allow you to resit it upon transfer.

6.6

Any failed attempts made will be carried forward and will be counted towards the number of attempts permitted for the same modules following transfer.

6.7

If you are permitted to transfer between BSc programmes offered under these regulations, all modules studied will be listed on your final transcript when you receive your award. This includes modules which are discarded upon transfer.

6.8

If you transfer from one programme to another, you will not be granted a new period of registration.

7 Scheme of award

7.1

To be considered for the qualification of a BSc degree with honours you are required to have passed, modules to the value of **360 credits**. This may include recognition of prior learning for Level 4 modules and/or compensated fails where permitted.

7.2

A BSc will be classified according to the following scale:

Final average	Classification
70% or above	First Class Honours
60% - 69%	Second Class Honours (Upper Division)
50% - 59%	Second Class Honours (Lower Division)
40% - 49%	Third Class Honours
0 - 39%	Fail

7.3

Each module is worth 15 credits and the Final Project is worth 30 credits. To calculate the final grade for the degree, the marks for the modules are weighted according to credit value.

7.4

The final weighted average will be based on the marks obtained from **all** modules, including those eligible for inclusion through the marginal compensation rules.

7.5

When calculating a candidate's final degree classification, a relative weighting of 1:3:5 will be applied to modules at Levels 4, 5 and 6 respectively.

7.6

If you have credit for any module through RPL, the examiners will assess your class of Honours only upon the grades received for the modules you have undertaken with us for this programme.

Exit qualifications

7.7

If you are registered on a BSc and are unable to complete your studies, or you have passed modules to a total value of less than 360 credits, you may be eligible for an exit qualification of either a Certificate of Higher Education in Computer Science or a Diploma of Higher Education in Computer Science.

7.8

The scale used for classification of any exit qualification is:

Final average	Classification
40% or above	Pass
0 - 39%	Fail

Pass degree (unclassified)

7.9

If you are registered on any of the BSc programmes, where you have attempted all 22 modules and the Final Project and have successfully completed at least **300 credits**, but less than 360, including Introduction to Programming I, you may be considered for a pass (unclassified) degree in Computer Science. You will not be eligible for any of the specialist degree qualifications.

Diploma of Higher Education in Computer Science

7.10

If you have successfully completed at least **240 credits**, with a minimum of 90 credits at Level 5, you may be considered for the **Diploma of Higher Education in Computer Science** qualification.

7.11

The final mark is determined by an average of the marks obtained from each of the 16 modules studied; it will not include any module where credit was awarded for RPL.

Certificate of Higher Education in Computer Science

7.12

If you have successfully completed at least **120 credits**, with a minimum of 90 credits at Level 4, you may be considered for the **Certificate of Higher Education in Computer Science** qualification. There will be no marginal compensation for modules included in this qualification.

7.13

The final mark is determined by an average of the marks obtained from each of the eight modules studied. Prior learning will not be recognised or accredited.

Appendix A – Structure of the programme

The BSc programmes each comprise modules to the value of 360 credits.

Refer to Appendix B for full module descriptions.

It is expected that students who are registered on a specialist degree programme will complete a final project in line with the specialist subject area.

Some modules have additional hardware and software requirements. Refer to the Programme Specification for further information.

BSc Computer Science

Level 4

One core module:

- Introduction to programming I [CM1005]

+

Seven compulsory modules:

- Introduction to programming II [CM1010]
- Computational mathematics [CM1015]
- Discrete mathematics [CM1020]
- Fundamentals of computer science [CM1025]
- How computers work [CM1030]
- Algorithms and data structures I [CM1035]
- Web development [CM1040]

Level 5

Eight compulsory modules:

- Object oriented programming [CM2005]
- Software design and development [CM2010]
- Programming with data [CM2015]
- Agile software projects [CM2020]
- Computer security [CM2025]
- Graphics programming [CM2030]
- Algorithms and data structures II [CM2035]
- Databases, networks and the web [CM2040]

Level 6

Six optional modules chosen from the list:

- Data science [CM3005]
- Databases and advanced data techniques [CM3010]
- Machine learning and neural networks [CM3015]
- Artificial intelligence [CM3020]
- Virtual reality [CM3025]
- Games development [CM3030]
- Advanced web development [CM3035]
- Physical computing and internet of things [CM3040]
- 3D graphics and animation [CM3045]
- Mobile development [CM3050]
- Interaction design [CM3055]
- Natural language processing [CM3060]
- Intelligent signal processing [CM3065]

+

One 30 credit project:

- Final project [CM3070]

BSc Computer Science (Data Science)

Level 4

One core module:

- Introduction to programming I [CM1005]

+

Seven compulsory modules:

- Introduction to programming II [CM1010]
- Computational mathematics [CM1015]
- Discrete mathematics [CM1020]
- Fundamentals of computer science [CM1025]
- How computers work [CM1030]
- Algorithms and data structures I [CM1035]
- Web development [CM1040]

Level 5

Eight compulsory modules:

- Object oriented programming [CM2005]

- Software design and development [CM2010]
- Programming with data [CM2015]
- Agile software projects [CM2020]
- Computer security [CM2025]
- Graphics programming [CM2030]
- Algorithms and data structures II [CM2035]
- Databases, networks and the web [CM2040]

Level 6

Five specialist core modules:

- Data science [CM3005]
- Databases and advanced data techniques [CM3010]
- Machine learning and neural networks [CM3015]
- Advanced web development [CM3035]
- Natural language processing [CM3060]

+

One optional module chosen from the list:

- Artificial intelligence [CM3020]
- Virtual reality [CM3025]
- Games development [CM3030]
- Physical computing and internet of things [CM3040]
- 3D graphics and animation [CM3045]
- Mobile development [CM3050]
- Interaction design [CM3055]
- Intelligent signal processing [CM3065]

+

One 30 credit project:

- Final project [CM3070]

BSc Computer Science (Machine Learning and Artificial Intelligence)

Level 4

One core module:

- Introduction to programming I [CM1005]

+

Seven compulsory modules:

- Introduction to programming II [CM1010]
- Computational mathematics [CM1015]
- Discrete mathematics [CM1020]
- Fundamentals of computer science [CM1025]
- How computers work [CM1030]
- Algorithms and data structures I [CM1035]
- Web development [CM1040]

Level 5

Eight compulsory modules:

- Object oriented programming [CM2005]
- Software design and development [CM2010]
- Programming with data [CM2015]
- Agile software projects [CM2020]
- Computer security [CM2025]
- Graphics programming [CM2030]
- Algorithms and data structures II [CM2035]
- Databases, networks and the web [CM2040]

Level 6

Five specialist core modules:

- Databases and advanced data techniques [CM3010]
- Machine learning and neural networks [CM3015]
- Natural language processing [CM3060]
- Artificial intelligence [CM3020]
- Intelligent signal processing [CM3065]

+

One optional module chosen from the list:

- Data science [CM3005]
- Virtual reality [CM3025]
- Games development [CM3030]
- Advanced web development [CM3035]
- Physical computing and internet of things [CM3040]

- 3D graphics and animation [CM3045]
- Mobile development [CM3050]
- Interaction design [CM3055]

+

One 30 credit project:

- Final project [CM3070]

BSc Computer Science (User Experience)

Level 4

One core module:

- Introduction to programming I [CM1005]

+

Seven compulsory modules:

- Introduction to programming II [CM1010]
- Computational mathematics [CM1015]
- Discrete mathematics [CM1020]
- Fundamentals of computer science [CM1025]
- How computers work [CM1030]
- Algorithms and data structures I [CM1035]
- Web development [CM1040]

Level 5

Eight compulsory modules:

- Object oriented programming [CM2005]
- Software design and development [CM2010]
- Programming with data [CM2015]
- Agile software projects [CM2020]
- Computer security [CM2025]
- Graphics programming [CM2030]
- Algorithms and data structures II [CM2035]
- Databases, networks and the web [CM2040]

Level 6

Five specialist core modules:

- Virtual reality [CM3025]

- Advanced web development [CM3035]
- Physical computing and internet of things [CM3040]
- Mobile development [CM3050]
- Interaction design [CM3055]

+

One optional module chosen from the list:

- Databases and advanced data techniques [CM3010]
- Machine learning and neural networks [CM3015]
- Artificial intelligence [CM3020]
- Data science [CM3005]
- Games development [CM3030]
- 3D graphics and animation [CM3045]
- Natural language processing [CM3060]
- Intelligent signal processing [CM3065]

+

One 30 credit project:

- Final project [CM3070]

BSc Computer Science (Web and Mobile Development)

Level 4

One core module:

- Introduction to programming I [CM1005]

+

Seven compulsory modules:

- Introduction to programming II [CM1010]
- Computational mathematics [CM1015]
- Discrete mathematics [CM1020]
- Fundamentals of computer science [CM1025]
- How computers work [CM1030]
- Algorithms and data structures I [CM1035]
- Web development [CM1040]

Level 5

Eight compulsory modules:

- Object oriented programming [CM2005]
- Software design and development [CM2010]
- Programming with data [CM2015]
- Agile Software Projects [CM2020]
- Computer security [CM2025]
- Graphics programming [CM2030]
- Algorithms and data structures II [CM2035]
- Databases, networks and the web [CM2040]

Level 6

Five specialist core modules:

- Databases and advanced data techniques [CM3010]
- Advanced web development [CM3035]
- 3D graphics and animation [CM3045]
- Mobile development [CM3050]
- Interaction design [CM3055]

+

One optional module chosen from the list:

- Data science [CM3005]
- Machine learning and neural networks [CM3015]
- Artificial intelligence [CM3020]
- Virtual reality [CM3025]
- Games development [CM3030]
- Physical computing and internet of things [CM3040]
- Natural language processing [CM3060]
- Intelligent signal processing [CM3065]

+

One 30 credit project:

- Final project [CM3070]

BSc Computer Science (Physical Computing and Internet of Things)

Level 4

One core module:

- Introduction to programming I [CM1005]

+

Seven compulsory modules:

- Introduction to programming II [CM1010]
- Computational mathematics [CM1015]
- Discrete mathematics [CM1020]
- Fundamentals of computer science [CM1025]
- How computers work [CM1030]
- Algorithms and data structures I [CM1035]
- Web development [CM1040]

Level 5

Eight compulsory modules:

- Object oriented programming [CM2005]
- Software design and development [CM2010]
- Programming with data [CM2015]
- Agile software projects [CM2020]
- Computer security [CM2025]
- Graphics programming [CM2030]
- Algorithms and data structures II [CM2035]
- Databases, networks and the web [CM2040]

Level 6

Five specialist core modules:

- Databases and advanced data techniques [CM3010]
- Advanced web development [CM3035]
- Physical computing and internet of things [CM3040]
- Interaction design [CM3055]
- Intelligent signal processing [CM3065]

+

One optional module chosen from the list:

- Data science [CM3005]
- Machine learning and neural networks [CM3015]
- Artificial intelligence [CM3020]
- Virtual reality [CM3025]
- Games development [CM3030]

- 3D graphics and animation [CM3045]
- Mobile development [CM3050]
- Natural language processing [CM3060]

+

One 30 credit project:

- Final project [CM3070]

BSc Computer Science (Games Development)

Level 4

One core module:

- Introduction to programming I [CM1005]

+

Seven compulsory modules:

- Introduction to programming II [CM1010]
- Computational mathematics [CM1015]
- Discrete mathematics [CM1020]
- Fundamentals of computer science [CM1025]
- How computers work [CM1030]
- Algorithms and data structures I [CM1035]
- Web development [CM1040]

Level 5

Eight compulsory modules:

- Object oriented programming [CM2005]
- Software design and development [CM2010]
- Programming with data [CM2015]
- Agile software projects [CM2020]
- Computer security [CM2025]
- Graphics programming [CM2030]
- Algorithms and data structures II [CM2035]
- Databases, networks and the web [CM2040]

Level 6

Five specialist core modules:

- Artificial intelligence [CM3020]

- Virtual reality [CM3025]
- Games development [CM3030]
- 3D graphics and animation [CM3045]
- Interaction design [CM3055]

+

One optional module chosen from the list:

- Data science [CM3005]
- Databases and advanced data techniques [CM3010]
- Machine learning and neural networks [CM3015]
- Advanced web development [CM3035]
- Physical computing and internet of things [CM3040]
- Mobile development [CM3050]
- Natural language processing [CM3060]
- Intelligent signal processing [CM3065]

+

One 30 credit project:

- Final project [CM3070]

BSc Computer Science (Virtual Reality)

Level 4

One core module:

- Introduction to programming I [CM1005]

+

Seven compulsory modules:

- Introduction to programming II [CM1010]
- Computational mathematics [CM1015]
- Discrete mathematics [CM1020]
- Fundamentals of computer science [CM1025]
- How computers work [CM1030]
- Algorithms and data structures I [CM1035]
- Web development [CM1040]

Level 5

Eight compulsory modules:

- Object oriented programming [CM2005]
- Software design and development [CM2010]
- Programming with data [CM2015]
- Agile software projects [CM2020]
- Computer security [CM2025]
- Graphics programming [CM2030]
- Algorithms and data structures II [CM2035]
- Databases, networks and the web [CM2040]

Level 6

Five specialist core modules:

- Virtual reality [CM3025]
- Games development [CM3030]
- 3D graphics and animation [CM3045]
- Mobile development [CM3050]
- Interaction design [CM3055]

+

One optional module chosen from the list:

- Data science [CM3005]
- Databases and advanced data techniques [CM3010]
- Machine learning and neural networks [CM3015]
- Artificial intelligence [CM3020]
- Advanced web development [CM3035]
- Physical computing and internet of things [CM3040]
- Natural language processing [CM3060]
- Intelligent signal processing [CM3065]

+

One 30 credit project:

- Final project [CM3070]

Appendix B – Module Outlines

Topics covered in each module may be revised to ensure currency and relevance. Students will be advised of any changes in advance of their study. See module descriptors under the Structure tab on the website for further information and any updates.

Level 4

Introduction to programming I [CM1005]

This module is focused on basic programming techniques. By taking this module, you will learn how to use the basic elements of computer programming such as variables, conditionals, functions and loops. You will also learn how to create interactive, graphical computer programs. You will also be introduced to basic object-oriented programming techniques.

Topics covered:

- Your development environment
- Drawing in 2D
- Variables, Objects and Interaction
- Conditional Statements
- Basic loops and arrays
- Traversing with for loops
- Functions
- Advanced loops and arrays
- Extending Objects
- Constructor functions

Assessment: Coursework only (Type II)

Introduction to programming II [CM1010]

This module is focused on adding to the basic programming skill set you developed in Introduction to Programming I and giving you experience working with existing code and third-party libraries. By taking this module, you will learn how to customise existing code, to implement basic object orientation and to work with a range of third-party libraries.

Topics covered:

- Introduction to the project,
- Case study 1: Click & Point Adventure
- Case study 2: Interactive data visualisation
- Case study 3: Mobile Drawing App
- Planning your project: an iterative approach
- Libraries and APIs
- Structuring large programmes

- Maintainable code
- Testing and debugging
- Completing your project

Assessment: Coursework only (Type III)

Computational mathematics [CM1015]

This module helps you hone your skills in thinking abstractly. It also introduces you to many of the standard continuous models used to help understand and design computational systems. Through this module, you will develop the fundamental computational mathematical tools that will support you throughout the BSc programme. Particular attention is paid to notions of experimentation, reasoning, and generalisation. By taking this module, you will learn a wide range of the computational mathematical concepts and techniques that underpin Computer Science. In particular, you will study number systems, special functions, graphing and linear algebra.

Topics covered:

- Number bases and modular arithmetic.
- Sequences and Series
- Graph Sketching and Kinematics
- Angles, Triangles and Trigonometry
- Trigonometric functions
- Exponential and logarithmic functions
- Calculus: Limits and differentiation
- Vectors and Matrices
- Linear Transformations
- Introduction to Combinatorics and Probability

Assessment: One two hour unseen written examination and coursework (Type I)

Discrete mathematics [CM1020]

This module helps you to hone your skills in thinking abstractly. It also introduces you to many of the standard discrete models used to help understand and design computational systems. Through this module, you will develop the fundamental discrete mathematical tools that will support you throughout the BSc programme. Particular attention is paid to notions of experimentation, reasoning, and generalisation.

Topics covered:

- Sets
- Boolean Algebra
- Propositional Logic
- Predicate Logic
- Functions
- Recursion and Mathematical Induction

- Relations
- Graphs
- Trees
- Counting

Assessment: One two hour unseen written examination and coursework (Type I)

Fundamentals of computer science [CM1025]

By taking this module, you will gain a broad understanding of many of the key topic areas in computer science and the fundamental concepts that underpin them. In the area of fundamental concepts, you will study binary representations and logic, complexity theory and theories of computation, finite state machines and Turing machines. Building on this, you will then study key areas of interest in computer science including databases, artificial intelligence, and machine learning. These will be presented in the light of practical examples to illustrate how they are implemented in modern computer systems.

Topics covered:

- Boolean logic
- Algorithms
- Searching and sorting algorithms
- Theory of Computation and complexity
- Turing machines and universal machines
- Basic combinatorial principles
- Proof techniques
- Finite automata
- Regular languages
- Context-free grammar

Assessment: One two hour unseen written examination and coursework (Type I)

How computers work [CM1030]

This module aims to help you understand, and to interact with, computer systems. You will learn how to use knowledge about computational processes to analyse and explain the behaviour of computer systems. The module will use the concept of a Notional Machine, an abstract representation of the functioning of a computer system, to help you to reason about computer systems and to predict their behaviour. You will also learn about typical computer system architectures, basic networking and network services such as databases.

Topics covered:

- Introduction to Computer Science and Notional Machines
- Notional machines of web applications
- Data representations, data storage, compression
- Computer Architecture and Machine Language

- Operating Systems
- Operating System processes
- Networks
- The internet
- Data and Databases
- Machine Learning

Assessment: One two hour unseen written examination and coursework (Type I)

Algorithms and data structures I [CM1035]

This module aims to help you to develop your analytical and problem-solving skills, particularly concerning thinking algorithmically. The module will encourage you to start thinking about how to use computers to solve problems. You will develop skills in thinking algorithmically and learn the central concepts of algorithms and data structures. You will learn about linear data structures such as arrays, vectors and lists, and a unifying framework for considering such data structures as collections. You will learn how algorithms can be expressed as flowcharts and pseudocode, and how to convert these expressions into running programs. You will learn specific algorithms used for sorting and searching, and how to express repetition as iteration and recursion. You will learn a simple model for execution of computation, and how to describe computational problems and their solutions. The model will allow you to compare algorithms regarding their correctness and regarding their efficiency.

Topics covered:

- Introduction to algorithms, flowcharts and pseudocode
- Computations using flowcharts and psuedocode
- Pairs, vectors and dynamic arrays
- Basic searching
- Linked lists
- Basic sorting
- Advanced searching and introduction to complexity
- Recursive algorithms
- Advanced sorting
- Linear collections

Assessment: One two hour unseen written examination and coursework (Type I)

Web development [CM1040]

This module aims to provide you with a foundational web development skill set. You will learn the critical languages of the web: HTML, CSS and Javascript. Using HTML and CSS, you will learn how to markup, layout and style web content. You will learn about the document object model and how you can dynamically manipulate it with JavaScript to create interactive web pages. You will consider accessibility and usability issues, and how you can overcome them. You will learn about website deployment and how you can use it to make your websites accessible to other people. The module will also enable you to present your work online in the form of a website.

Topics covered:

- Introduction to Web Development
- Web Site Design
- Essential HTML
- Introduction to CSS
- Positioning in Styling & Design
- Responsive CSS
- Introduction to JavaScript for the Web
- Manipulating the DOM using Javascript
- JavaScript Libraries
- Web Hosting & Professional Practices

Assessment: Coursework only (Type III)

Level 5

Object oriented programming [CM2005]

This module aims to provide you with an object-oriented programming skill set. You will learn what objects and classes are and how to write your classes. You will see how objects can interact with each other, including defining and implementing interfaces to control the interaction. You will learn how to use inheritance to inherit and extend functionality from parent classes. You will learn how to write code according to style guidelines and how to write formal code documentation..

Topics covered:

- Variable and types
- Control flow: conditionals and iteration
- Functions
- Objects and classes
- Interaction between objects
- Inheritance: extending a parent class
- Inheritance: defining a class hierarchy
- Code documentation and style
- Abstraction and polymorphism: implementing an abstract class
- Abstraction and polymorphism: defining an interface

Assessment: Coursework only (Type II)

Software design and development [CM2010]

This module aims to advance your software development skills so that you can write more robust and complicated programs. You will learn how to use a range of programming techniques that will allow you to deal with unwanted or unexpected events that might happen when your application is

running. You will use defensive coding to check data before processing it, and exception handling to gracefully manage unforeseen or unwanted occurrences. You will learn how to discuss program structure concerning cohesion (how to meaningfully organise code into modules) and coupling (how to define the interactions between different parts of the program). You will learn about test-driven development, where you write tests for your code, and write the code itself, in parallel. You will also learn how to use software versioning tools to manage a software project as it develops.

Topics covered:

- Language primer 1: variables and conditionals
- Language primer 2: control flow
- Language primer 3: functions
- Version Control
- Collaboration using version control
- Module coupling and cohesion
- Unit Testing
- Test driven development
- Defensive coding
- Exception handling

Assessment: One two hour unseen written examination and coursework (Type I)

Programming with data [CM2015]

This module will show you how to work with data: getting data from a variety of sources, visualising data in compelling, informative ways, processing data to make it useful and shareable, and reasoning with data to test hypotheses and make parameterised predictions. The module will also introduce you to a new language and programming environment that is well-adapted to languages for these applications.

Topics covered:

- Setting up the programming environment
- Control structures, functions and comprehensions.
- Data-driven programming
- Visualising data
- Descriptive statistics
- Getting data
- Processing data: cleaning, normalizing, and scaling
- Classification with K-nearest neighbours
- Bayes' theorem and naïve Bayes classification
- Clustering

Assessment: One two hour unseen written examination and coursework (Type I)

Agile software projects [CM2020]

This module aims to provide insights and practice in software development using contemporary methods to produce software that meets the needs of users and supports an organisation's business function. The module will enable you to gain competence in the conceptualisation of a technology-based solution to a real-world problem, fulfilling the requirements of users and taking constraints imposed by the prevailing and foreseen market conditions and lessons learned from prototypes into account. You will then be given the opportunity to present a proposal for a technical project including a structured plan for implementing the solution using the agile development methodology and test driven development practices. During the whole process from concept to solution presentation, you will be required to work in a distributed team using online collaboration, project tracking and version control tools.

Topics covered:

- Project management & team working
- Requirements gathering & specification
- Market & solutions research
- User centred design & prototyping
- Project proposal
- Agile software development methodologies
- Test driven software development
- Software validation & user testing
- Professional practices
- Software documentation

Assessment: Coursework only (Type III)

Computer security [CM2025]

This module aims to provide you with an understanding of the need for computer security and the technologies that support it. It has both a theoretical component that will teach you mathematical underpinnings of security systems and a practical element that will help you discover the pitfalls of security design and to comprehend the mathematics underlying the protocols by programming small examples.

Topics covered:

- Security threats
- Social Issues in Computer Security
- Access Control and Authentication
- Security Models
- Operating System Security
- Network security
- Cryptography
- Cryptographic protocols and key management

- Public Key Cryptography
- Blockchain protocols

Assessment: One two hour unseen written examination and coursework (Type I)

Graphics programming [CM2030]

This module aims to show you how to work with images in a variety of ways. You will learn how to synthesise graphics and how to process visual signals. You will learn about the mathematical ideas that underpin digital representations of graphics; how digital media files represent graphics, and how to handle and manipulate them; and the basics of working with simulated physics and 3D graphics.

Topics covered:

- Introduction to graphics
- Coordinate transformations
- Number generators: noise/sine
- Images, pixels, colors
- Image processing
- Computer Vision: introduction
- Computer Vision: advanced
- Simulating physical systems
- 3D graphics
- Recap and review

Assessment: Coursework only (Type II)

Algorithms and data structures II [CM2035]

This module aims to provide you with detailed knowledge of several common algorithms and data structures. You will improve your understanding of searching and sorting and learn new algorithms to solve new problems. You will learn about a range of data structures such as trees, heaps, sets, maps, stacks, queues and graphs. You will learn how to evaluate and describe the performance of algorithms using big-O notation. You will learn: how to choose appropriate data structures for representing problems, how to define and implement algorithms for manipulating them, and how to analyse the correctness and efficiency of algorithms.

You will be expected to have mastered the material in Algorithms and Data Structures I before attempting this module.

Topics covered:

- Complexity, growth of functions and big-O notation
- Stacks and queues
- Binary trees
- Heaps and priority queues
- Implicit array algorithms
- Recursion and Iteration

- Graphs and simple pathfinding
- Shortest-path algorithms
- Sets, maps and hash tables
- Collections

Assessment: One two hour unseen written examination and coursework (Type I)

Databases, networks and the web [CM2040]

In this module, you will learn theory and practical skills focused on the modern web, internet and client-server applications. You will learn about relational database systems, mainly from a development perspective, emphasising issues related to data modelling and database implementation in SQL. You will learn how to model data in a database, retrieve data from the database and provide access to data through dynamic websites. In particular, you will learn about the Relational Model, Query processing, and socket architectures to enable communication.

Topics covered:

- Networking concepts
- Building Simple socket clients and servers
- Building an HTTP server
- Generating web pages from data using templates
- Relational Databases
- Querying a database
- Representing data in a database
- Representing data in a database pt 2
- Revision of HTML and CSS
- Building a dynamic website

Assessment: One two hour unseen written examination and coursework (Type I)

Level 6

Data science [CM3005]

By taking this module, you will gain a data science skillset. With these skills, you will be able to write computer programs that can read, process and analyse textual and numerical data. You will be able to generate plots and interactive visualisations of data. You will understand how to apply statistical methods to the interpretation of results. You will be able to use data analysis in the decision-making process. You will also learn about a range of application domains for data science.

Topics covered:

- Introduction and development environment
- Working with different types of data
- Correlation and regression
- Distributions and significance

- Processing text data
- Decision making based on data analysis: from correlation to causation
- Introduction to data visualisation
- Time-series data visualisation
- Scientific data visualisation
- Case studies: different contexts for data analysis

Assessment: One two hour unseen written examination and coursework (Type I)

Databases and advanced data techniques [CM3010]

This module aims to show you how to work with data in your computer programs. You will learn how to use SQL and NoSQL databases to store tabular data and documents. You will learn about the ethics of gathering and processing data and why it is important to consider issues around data security. You will learn about open data resources, and how you can access them from your computer programs. You will learn about audio and video data, and the challenges of working with this kind of data.

Topics covered:

- Open data sources: different data formats
- Gathering and cleaning data
- The ethics of working with data
- SQL: advanced data representation
- SQL: advanced queries and linking
- NoSQL and document stores
- NoSQL and data pipelines
- Speeding up queries with indexes
- Audio and video data
- Data security

Assessment: One two hour unseen written examination and coursework (Type I)

Machine learning and neural networks [CM3015]

This module provides a broad view of machine learning and neural networks. You will learn how to solve common machine learning problems such as regression, classification, clustering, matrix completion and pattern recognition. You will learn about neural networks and how they can be trained and optimised, including an exploration of deep neural networks. You will learn about machine learning and neural network software libraries that allow you to develop machine learning systems rapidly, and you will learn how to verify and evaluate the results.

Topics covered:

- Regression and classification
- Features and distances
- Supervised clustering

- Evaluation: accuracy, precision, recall and cross validation
- Dimensional reduction: principal component analysis
- Matrix completion
- Unsupervised clustering
- Multi-Layer Perceptrons and back progagation
- Network optimisers
- Deep and recurrent networks

Assessment: One two hour unseen written examination and coursework (Type I)

Artificial intelligence [CM3020]

This module is focused on Artificial Intelligence techniques. You will understand the historical development of Artificial Intelligence including search, vision and planning. You will become familiar with the foundations of agent-based approaches to software design, decision making and problem solving including under uncertainty. You will have an opportunity to apply Artificial Intelligence techniques to particular problems such as game playing and decision making.

Topics covered:

- Historical overview of Artificial Intelligence.
- Intelligent agents and environments (Part 1)
- Intelligent agents and environments (Part 2)
- Problem solving
- Knowledge representation, ontologies
- Uncertain knowledge and reasoning under uncertainty.
- Games and optimal decisions in games (Part 1)
- Games and optimal decisions in games (Part 2)
- Robotics
- Advanced Topics in AI

Assessment: One two hour unseen written examination and coursework (Type I)

Virtual reality [CM3025]

The module will combine the theory and psychology of VR with practical development skills. You will learn the skills needed to design compelling VR environments and the skills that apply to creative practice, science and industry.

This module aims to give you the skills needed to develop VR. These skills include understanding the basic theory of presence in VR, which underlies the basic design principles. You will also learn practical development skills, using an appropriate 3D engine to create interactive virtual environments. These skills will include creating 3D environments, designing and implementing 3D interaction for VR and building social VR experiences with interactive virtual characters.

Topics covered:

- Introduction to Virtual Reality: History of VR, VR Hardware and applications

- Presence: the three illusions of VR
- 3D graphics for VR
- Immersive Sound for VR
- Interaction Design in VR
- Navigation
- Object Interaction and physics
- Virtual Characters
- Social VR
- Developing a VR project

Assessment: One two hour unseen written examination and coursework (Type I)

Games development [CM3030]

This module will introduce you to i) industry standard tools for game development, such as game engines, and ii) the process of game development, including prototyping and playtesting. You will undertake a short series of game development projects, each lasting a set number of weeks and with a specific brief. For each project, you will propose a game that fits the brief, and then you will implement it. You are expected to deliver the proposed game and document it thoroughly. Through this process, you will develop an awareness of intended audience and the use of media for documentation.

Contemporary video game production draws on a range of techniques from artificial intelligence (AI) to perform tasks such as controlling virtual agents and generating novel game content. This module will also introduce crucial game AI concepts. Compared to mainstream AI, the emphasis is less on optimal problem solving and more on entertaining the player with limited computational resources. This module gives students practical experience of programming game AI systems and an understanding of the relevant theory.

Topics covered:

- Introduction to game development, the games industry and game engines
- Creating sprite based 2D
- Scripting game interaction
- 2D physics and collision
- Game Design
- Developing a Game project
- State Machines
- Pathfinding
- Behaviour Trees
- Recap and review

Assessment: One two hour unseen written examination and coursework (Type I)

Advanced web development [CM3035]

Through this module, you will learn how to build dynamic, data-driven websites using databases, front-end frameworks and server-side programming. This module provides the skill set required to do full stack web development work. By studying this module, you will develop a web developer skill set that enables you to understand how to build and deploy complete, data-driven websites. You will consider several different technologies for client side-web development such as HTML, CSS, Javascript and templates. You will explore methods for developing server-side web applications, by building web-accessible wrappers around databases. You will consider issues of scalability, and learn about web application configuration and deployment.

Topics covered:

- The web stack: clients, web servers and databases
- Advanced features of HTML, CSS and Templates
- Deploy a website
- Basic databases and data schemas for a website
- Build a CRUD/ RESTFul API
- Build a CRUD/ RESTFul API pt 2
- Build a websocket server
- User authentication and security
- Working with external APIs
- Scalability

Assessment: Coursework only (Type II)

Physical computing and the internet of things [CM3040]

This course provides an introduction to the development and programming of hardware devices that can sense and act in the environment. The course will explain and demonstrate how the environment, which is inherently continuous, can be monitored by analogue electrical and mechanical sensors, then captured and analysed using a computer, which is a discrete system. A focus of this course is the interface between the digital and the analogue.

This study encompasses basic physics, electronics, programming and software engineering. The practical objective of this course is the development of the skills needed for designing and building interactive physical devices.

Topics covered:

- Electricity and circuits
- Microcontrollers
- Sensors
- Physical Interaction Design
- Physical Computing Projects
- Motors and actuators
- Communications protocols

- Networked Devices
- Bodily monitoring
- Robots

Assessment: Coursework only (Type III)

3D graphics and animation [CM3045]

This module will cover advanced methods used in current state-of-the-art graphics and animation systems. It will include the mathematical foundations, computational techniques and their use in creative practice. By taking this module, you will learn how to write programs that generate animated 3D graphics. There are several distinct study areas: 3D modelling and animation, the graphics pipeline, simulation of physics and shader programming. You will study a range of examples, and through these learn how you can program computer graphics in contemporary graphical software for different applications.

Topics covered:

- Overview of 3D Graphics and mathematics for graphics
- 3D Models and Transforms
- Physics simulation
- Keyframe Animation
- Character Animation
- Rendering and the Graphics Pipeline
- Lighting, Materials and Texturing
- Shader Programming
- Vertex Shaders
- Fragment Shaders

Assessment: One two hour unseen written examination and coursework (Type I)

Mobile development [CM3050]

This module aims to give you the fundamental understanding and skills needed to develop mobile applications. By studying this module, you will learn the principles of effective mobile user interface design and how to design and build user interfaces. You will learn about data-driven mobile applications, and how you can integrate a mobile application to a data source. You will learn about the mobile development ecosystem and how you can develop, run and test your applications. You will learn how to work with various sensors available on mobile devices using built-in APIs. The style of the modules will be practical, with a focus on developing functioning applications.

Topics covered:

- The mobile app ecosystem
- Mobile user interface design
- Programming user interfaces
- Advanced user interface elements

- Developing a mobile app project
- Data sources
- Integrating Cloud and web services
- Sensor programming
- Advanced APIs
- Deployment

Assessment: Coursework only (Type III)

Interaction design [CM3055]

When taking this module, you will examine the notion of 'interaction with technology'. You will focus on the concepts behind modern user experience design and production. You will gain a solid grasp and practical experience of the process which allows the creation of interactive systems. This process involves specification, design, prototyping and evaluation. You will examine several design approaches and techniques, and consider how they enable usability engineering. You will learn how to evaluate interactive systems against criteria such as efficiency and usability. You will examine issues of accessibility from the perspective of different populations.

Topics covered:

- History of HCI.
- Usability and Principles of design.
- User-centred design techniques.
- Evaluation of interaction design.
- Evaluation of interaction design part 2
- Designing for different users.
- Design case studies.
- Design case studies part 2
- Tools and techniques that support interaction development.
- Current trends in interaction design and HCI.

Assessment: One two hour unseen written examination and coursework (Type I)

Natural language processing [CM3060]

This module will provide you with a grounding in both rule-based and statistical approaches to NLP, and it combines theoretical study with hands-on work employing widely used software packages. The module focuses on text processing, and by taking this module, you will learn about how you can work with text-based natural language in your computer programs. You will learn about grammars and how they can be used to analyse text. You will learn how statistical analysis can be used to extract information from and classify text. You will work in an appropriate programming environment for NLP, using libraries to implement NLP workflows.

Topics covered:

- History of NLP.

- Information retrieval and curation in NLP.
- Curated corpora and raw data sources.
- Formal grammars.
- Rule based NLP.
- Statistical NLP.
- NER (Named Entity Recognition).
- Readers, stemmers, taggers and parsers
- Software packages for NLP
- Applications of NLP

Assessment: One two hour unseen written examination and coursework (Type I)

Intelligent signal processing [CM3065]

This module aims to provide you with a broad experience of digital signal processing techniques and applications. You will study how audio and video signals can be captured and processed by a computer program. You will learn about time domain and frequency domain representations and processing. You will learn how you can extract information from audio signals. You will implement movement and face detection systems that work with live camera input.

Topics covered:

- Capturing representing and processing audio signals
- LTI systems and impulse responses
- Frequency domain representations
- Extracting features from signals
- Speech recognition
- Capturing, representing and processing camera input
- Computer vision: movement detection
- Computer vision: face detection
- Compressing signals

Assessment: Coursework only (Type II)

Final project [CM3070]

In this module, you will undertake a substantial independent project that will allow you to demonstrate a wide range of skills such as project planning, management, research, software implementation, and written presentation. If you are enrolled on a specialist pathway, either as part of the BSc or a graduate diploma, you will be expected to undertake a project in your specialist area. You will integrate the knowledge gained throughout the programme and use skills acquired in other modules in the implementation of your final project which will be in computer science or your specialist area. The work will consist of a combination of research and software development in various proportions. You will be expected to make use of methodologies from various components of computer science, including your specialist pathway if appropriate.

Topics covered:

- Project planning and management.
- Project-associated risk management.
- Project-specific research methodology and methods.
- Aims and objectives of your project.
- Project-specific literature review.
- Project-specific software design.
- Project-specific software development.
- Project-specific software testing.
- Evaluation of project results.
- Project-specific academic writing.

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Appendix C – Assessment Criteria

Mark	Descriptor	Specific Marking Criteria
80-100%	I: First (Exceptional)	• Represents an exceptional achievement beyond the standard requirements of a first class degree. • Students' work should demonstrate considerable creative thought and be based on a critical evaluation of prior work. Work is likely to achieve some outcomes that would be expected at a higher level degree.
70-79%	I: First (Excellent)	• Demonstration of a thorough grasp of relevant concepts, methodology and content appropriate to the subject discipline; indication of originality in application of ideas, in synthesis of material or in implementation; insight reflects depth and confidence of understanding of the material. • Students should be able to design and create computer systems that demonstrate original design considerable independent thought and are based on independent learning of prior work and existing technologies. • Students should be able to critically evaluate their own work.
60-69%	IIi: Upper Second (Very good)	• Demonstration of a sound level of understanding based on a competent grasp of relevant concepts, methodology and content; display of skill in interpreting complex material; organisation of material at a high level of competence. • Students should be able to demonstrate the ability to independently design, implement and evaluate a high quality and complex computer systems using knowledge from across the programme. • Students should be able to effectively evaluate their work using standard methodologies.
50-59%	IIii: Lower Second (Good)	• Demonstration of an adequate level of understanding of relevant concepts, methodology and content; display of sufficient skill to tackle some complex problems; appropriate organisation of material. • Students should demonstrate the ability to create moderately complex computer software, making use of prior knowledge and material taught within the program. • Students should be able to, at least partially, test their work using standard methods.
40-49%	III: Third (Pass)	• Represents the overall achievement of the appropriate learning outcomes to a threshold level (honours).

		• Demonstration of a limited level of understanding of relevant concepts, methodology and content; clear if limited attempt to tackle problems; display of some skill in organisation of material. • Students should demonstrate creation of a basic, complete and working computing system/ program.
25-39%	Fail	• Represents an overall failure to achieve the appropriate learning outcomes.
10-24%	Bad fail	• Represents a significant overall failure to achieve the appropriate learning outcomes.
1-9%	Very bad fail	• A submission that does not even attempt to address the specified learning outcomes.
0%	Non submission or plagiarised	• Work was not submitted or it was plagiarised.