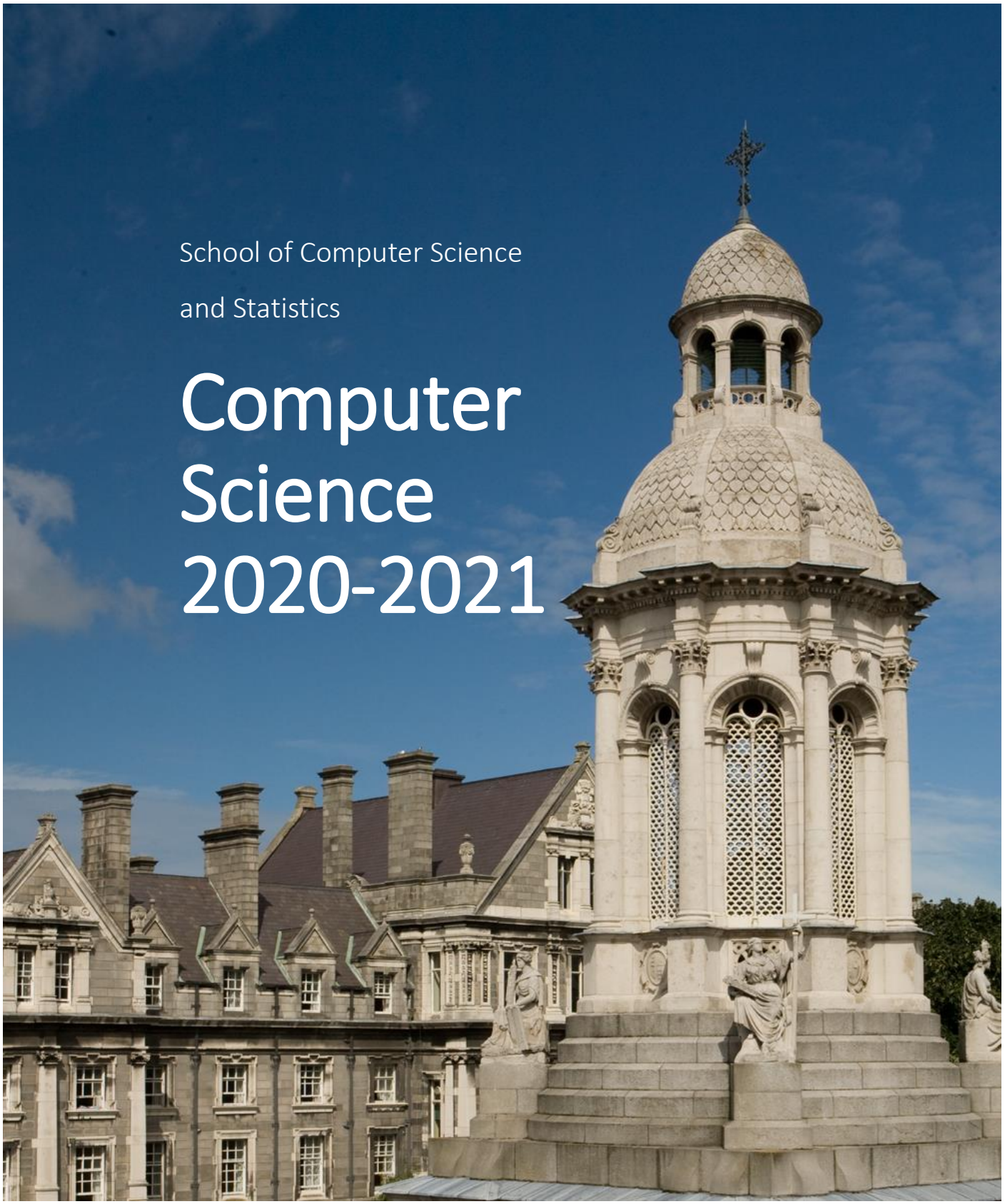

School of Computer Science

and Statistics

Computer Science 2020-2021

Contents

General Course Information

1.1 Introduction

This is the course specific handbook of the Computer Science degree programme offered by the School of Computer Science and Statistics in Trinity College Dublin. It must be read alongside the School Course Handbook which provides information and regulations relevant to all programmes taught by the School.

The integrated Computer Science degree programme leads to a BA Moderatorship in Computer Science degree after four years and a Master in Computer Science (MCS) degree after five. This handbook contains information and regulations for all Computer Science degree programme students. It provides a guide to what is expected of you on this programme, and the academic and personal support available to you. Please retain it for future reference.

Kenneth Dawson-Howe & Jonathan Dukes.
13th October 2020

1.2 Contact Details

The main contact details for the school are provided in the School handbook. Contact details for the personnel involved in running the programmes are provided below:

Staff Name	Role/Title	Contact 1	Contact 2
Jonathan Dukes	DUTL	jdukes@scss.tcd.ie	
Kenneth Dawson Howe	Course Director	kdawson@scss.tcd.ie	
Hannah Archbold	Executive Officer	archbolh@tcd.ie	01 896 1768
Hester Jackman	Internship Coordinator	internships@scss.tcd.ie	

1.3 Internships/Placements for Credit

It is possible for students to spend the third year of the programme studying abroad. Details are provided in Study Abroad/ERASMUS section of this document.
An industry/research lab placement is an integral part the fourth year of the five year MCS programme. For more information about internships, please visit https://www.scss.tcd.ie/internships/ or contact Hester Jackman (internships@scss.tcd.ie).

1.4 Scholarships & Prizes

Many of the scholarships and prizes are described in the School Handbook. In addition, students on the Computer Science programme are eligible for the following prizes:

1.4.1 Gold medals

Gold medals are awarded by the Board to candidates of the first class who have shown exceptional merit (and for this programme that mean achieving an overall average of 80% or above) at the annual degree examination in honor or professional courses (i.e. in Year 4 of our programme). See https://www.tcd.ie/academicregistry/exams/assets/local/gold-medal-criteria.pdf for more details.

1.4.2 Computer Science Prizes

The following prizes are listed in the University Calendar for the Computer Science programme.

The Professor John G. Byrne Prize

This prize was established in 2014 with funds provided by Alumni of the School in honour of Professor John G. Byrne, Chair of Computer Science 1973–2003, and Head of the Department of Computer Science from its founding in 1969 to 1987 and from 1990 to 2001. In celebration of excellence, the prize is awarded annually to the student who achieves the highest overall result in the Masters Year of the Computer Science course provided the result is at Distinction level. Value, ¤1,024.

The Victor W. Graham Prize

This prize, founded in 1986 from funds subscribed by friends and pupils to mark Mr V. W. Graham's retirement, is awarded to the Year 1 student in the moderatorship in computer science course who obtains the highest mark in the summer examination in pure mathematics. Value, ¤750.

The Ludgate Prize

This prize was instituted in 1991 in memory of Percy E. Ludgate, an Irish designer of an analytical engine. It is awarded to the student who submits the best project in Year 4 of the moderatorship in computer science. Value, ¤127.

The William Nurock Prize

This prize was founded in 1938 by a bequest from William Nurock. The conditions for the award of the prize were changed in 1984. It is now awarded annually to the best student in the final year examinations of the moderatorship in computer science, providing that such student also attains gold medal standard. Value, ¤1,000.

1.5 Registration

Registration for all other JF students for Academic Year 20/21 (Phase 1 & 2 Programmes)
Students in Year 1 of Integrated Computer Science will be invited during the Trinity term to register their preferences for Year 2 of their course, including Trinity Electives and Open Modules. Students will be advised of how to do this, and of where they will find relevant module information several weeks before they are invited to register. Timetabling may restrict the availability of modules to individual students.

Registration for SF students for Academic Year 20/21 (Phase 1 Programmes, where applicable)
Students in Year 2 of Integrated Computer Science will be invited during the Trinity term to indicate their preferences for Year 3 of their studies, including Trinity Electives and Open Modules as per their course structure.
Students will be advised of how they will do this and where they will find relevant module information several weeks before they are invited to register. Timetabling may restrict the availability of modules to individual students.

TEACHING AND LEARNING

1.6 Programme Architecture

Information on the programme's architecture and the available pathways to award. Undergraduate programmes. This information should include the following caveat: Available pathways are subject to change and may be dependent subject to capacity
The integrated Computer Science degree programme leads to a BA Moderatorship in Computer Science degree after four years and (optionally) to a Master in Computer Science (MCS) degree after five years. There are no other pathways available for students entering this degree programme.

1.7 Programme Structure and Workload

Year 1 – Junior Fresh Year

In Year 1 (referred to as the Junior Fresh (JF) year in Trinity), students take the following full year and half year modules:

Semester 1	Semester 2
CSU11001 Mathematics I	CSU12002 Mathematics II
CSU11010 Introduction to Programming	
CSU11021 Introduction to Computing I	CSU11022 Introduction to Computing II
CSU11026 Digital Logic Design	
CSU11031 Electronics and Information	STU11002 Statistical Analysis I
CSU11081 Computers and Society	CSU11013 Programming Project I

Full details, including learning outcomes, book recommendations and important evaluation and assessment criteria are available at https://teaching.scss.tcd.ie/integrated-computer-science/ics-year-1/

Year 2 – Senior Fresh Year

In Year 2 (referred to as the Senior Fresh (SF) year in Trinity), students take the following full year and half year modules:

Semester 1	Semester 2
CSU11010 Algorithms and Data Structures	
CSU22014 Systems Programming I	CSU23016 Concurrent Systems and Operating Systems
CSU22041 Information Management I	CSU23021 Microprocessor Systems
CSU22022 Computer Architecture I	CSU22013 Software Engineering Project
MAU22C00 Discrete Mathematics	
STU22004 Applied Probability I	Applied Probability II or Open Module Other Open Modules to be confirmed for Semester 2 • Gender: History, Culture, Representation (School: Histories and Humanities) • Becoming Moral: Ethical Reasoning in Theological Perspective (School: Religion) • Another World is Possible: Social and Political Ethics (School: Religion) • Spirit of Entrepreneurship (School: Business) • Ireland and the Cinema (School: Creative Arts) • Social Psychology (School: Psychology) • Personality and Individual Differences (School: Psychology) • Introduction to Psychology of Language (School: Psychology) • Introduction to Digital Media (School: Creative Arts) • Language and Mind (School: Linguistic, Speech and Communication Sciences)

Full details, including learning outcomes, book recommendations and important evaluation and assessment criteria are available at https://teaching.scss.tcd.ie/integrated-computer-science/ics-year-2/

Year 3 – Junior Sophister Year

For students in JF in 2019-20 onwards the junior sophister year is somewhat different. Please see Appendix A for details.
In Year 3 (referred to as the Junior Sophister (JS) year in Trinity), students take the following half year modules:

Semester 1	**Semester 2**
CSU34011 Symbolic	CSU33071 Compiler Design I
CSU33012 Software	CSU33013 Software Engineering
CSU34021 Computer Architecture II	CSU33014 Concurrent Systems I
CSU33081 Computational Mathematics	STU33009 Statistical methods for Computer Science
CSU34016 Introduction to Functional Programming	CSU34031 Advanced Telecommunications
CSU34041 Information Management II	CSU33061 Artificial Intelligence I

All modules have an ECTS weighting of 5 credits.

Full details, including learning outcomes, book recommendations and important evaluation and assessment criteria are available at
https://teaching.scss.tcd.ie/integrated-computer-science/ics-year-3/

Year 4 – Senior Sophister Year

For students in JF in 2019-20 onwards the senior sophister year is very slightly different. Please see Appendix A for details.
During the first few weeks of Year 4 (referred to as the Senior Sophister (SS) year in Trinity), students have to decide whether they are going to take the 5 year Masters (MCS) programme or the 4 year Bachelors (BA (Mod.)) programme. As a result, there are two possible versions of Year 4:

Semesters 1	Semester 2
Final Year Options (5*5credits) All students	CS7091 Industrial / Research Lab Internship (30 credits) *+ 5 year MCS programme
CSU44097 Project methods (5 credits) 5 Year MCS Programme	CSU44098 Group Design Project (10 credits) 4 year B.A.(Mod) programme
	CSU44099 Final Year Project (20 credits) ** 4 year B.A.(Mod) programme
	CSU44081 Entrepreneurship and HighTech Venture Creation (5 credits) 4 year B.A.(Mod) programme

* For more information about internships, please visit

https://www.scss.tcd.ie/internships/
+To take the internship students must get 60% or more in their first attempt at the Year 3 examinations.
++ Students must select five options from the Year 4 Options in the Options Table below.
** For more information about final year projects, please visit https://www.scss.tcd.ie/StudentProjects/.

The Year 4 options, all of which count for 5 ECTS credits, are as follows.

Year 4 Options
CSU44000 Scalable Computing
CSU44001 Fuzzy Logic
CSU44004 Formal Verification Techniques
CSU44012 Topics in Functional Programming
CSU44031 Next Generation Networks
CSU44051 Human Factors
CSU44052 Computer Graphics
CSU44053 Computer Vision
CSU44061 Machine Learning
CSU44062 Advanced Computational Linguistics

An Options presentation is normally held during Hilary Term for Year 3 students and students select their options by submitting a (provided) form by a deadline typically in the middle of April. Please note that not all options may run in a given year depending on demand and availability of appropriate staff to teach the options. Students may change options by informing the teaching unit up to the end of the second week of Semester 1. Late changes will not be accepted.
Full details, including learning outcomes, book recommendations and important evaluation and assessment criteria are available at
https://teaching.scss.tcd.ie/integrated-computer-science/ics-year-4/

Year 5 – MCS Year

In Year 5, in addition to one compulsory course, students select five options and a major dissertation topic:

Semester 1	**Semester 2**
CS7CS6 Research and Innovation (5 credits)	
CS7092 MCS Dissertation (30 credits) *	
Year 5 Options (25 credits) +	

* For more information, see https://www.scss.tcd.ie/StudentProjects/.
+ Students must select options totaling 25 credits from the Year 5 Options below. Please note that not all options may run in a given year and some options have prerequisites. Students should be aware that they should not take modules with significant overlap with modules which they took in year 4 (e.g. students who took CSU44061 should not take CS7CS4). Students may change options by informing the teaching unit up to the end of the second week of the semester in which the options are run. Late changes will not be accepted.

Year 5 Options
CS7CS2: Innovation
CS7CS4: Machine Learning
CS7DS1 Data Analytics
CS7DS2: Optimisation Algorithms for Data Analysis
CS7DS3: Applied Statistical Modelling
CS7DS4: Data Visualisation
CS7GV1: Computer Vision
CS7GV2: Mathematics of Light and Sound
CS7GV3: Real-time Rendering
CS7GV4: Augmented Reality
CS7GV5: Real-time Animation
CS7GV6: Computer Graphics
CS7IS1: Knowledge and Data Engineering
CS7IS2: Artificial Intelligence
CS7IS3: Information Retrieval and Web Search
CS7IS4: Text Analytics
CS7IS5: Adaptive Applications
CS7NS1: Scalable Computing
CS7NS2: Internet of Things
CS7NS3: Next Generation Networks
CS7NS4: Urban Computing
CS7NS5: Security and Privacy

CS7NS6: Distributed Systems

Full details, including learning outcomes, book recommendations and important evaluation and assessment criteria are available at https://teaching.scss.tcd.ie/integrated-computer-science/ics-year-5/

1.8 Study Abroad/ERASMUS

Students on the ICS programme can spend their third year abroad as long as they achieve an overall II.1 in their annual examinations in Junior Fresh. There are two schemes: (1) Erasmus which has a limited number of places and which is coordinated by Dr. Carl Vogel (email: Carl.Vogel@scss.tcd.ie), and (2) Trinity College Dublin also has some exchanges with universities in North America (which are not conducted with Erasmus support. Information about those exchanges may be obtained through the Academic Registry). Interested students should contact Dr. Vogel and/or the Academic Registry during the summer after they obtain the Junior Fresh results.

1.9 Module Descriptors & Compulsory Reading Lists

The School reserves the right to amend the list of available modules and, in particular to withdraw and add modules. Timetabling may restrict the availability of modules to individual students.
Brief descriptions of the modules are provided on the course website. Full details, including learning outcomes, book recommendations and important evaluation and assessment criteria are available at https://teaching.scss.tcd.ie/integrated-computer-science/

1.10 Learning Outcomes

Our programme's outcomes conform to those required by Engineers Ireland to satisfy the education standard for the professional title of Chartered Engineer. For BA(Mod) graduates those outcomes are:

1. Advanced knowledge and understanding of the mathematics, sciences, engineering sciences and technologies underpinning their branch of engineering;
2. The ability to identify, formulate, analyse and solve complex engineering problems;
3. The ability to perform the detailed design of a novel system, component process using the analysis and interpretation of relevant data;
4. The ability to design and conduct experiments and to apply a range of standard and specialised research (or equivalent) tools and techniques of enquiry;
5. An understanding of the need for high ethical standards in the practice of engineering, including the responsibilities of the engineering profession towards people and the environment;
6. The ability to work effectively as an individual, in teams and in multi-disciplinary settings together with the capacity to undertake lifelong learning;
7. The ability to communicate effectively on complex engineering activities with the engineering community and with society at large.

For ordinary BA graduates we expect similar outcomes but obviously as a lesser level, and significantly not including the development of a novel system on an individual basis. Our MCS graduates achieve all of these programme outcomes. By the time our graduates finish they are capable of dealing with complex multi-disciplinary problems and with problems that are ill-defined. They can design to professional codes of practice and can deal with novel problems, where they must proceed working cautiously from first principles relying on their knowledge of engineering science. The aim of the programme is to equip its graduates with the knowledge, skills and experience to be able to:

1. Develop and apply computer systems from a broad base of knowledge in mathematics, computer science, computer technology and human factors.
2. Identify and formulate advanced technical challenges and demonstrate judgement to design appropriate computer science solutions.
3. Design systems, components or processes to meet specified functional objectives and to measure and analyse performance against these objectives.
4. Understand and express the role of computer science in the community including the need for high standards of ethical behaviour and professional responsibility.
5. Work effectively, independently and within multidisciplinary teams, and act as a mentor in team settings and engage in lifelong learning.
6. Communicate effectively both professionally with other computing professionals and with the wider community.
7. Participate in contemporary research activity as appropriate and demonstrate the knowledge and skills needed to undertake independent research.

1.11 Capstone Project

Standard Text: The capstone project — though defined differently by different subjects — is the common element across all degree exit routes and is weighted at 20 ECTS. It requires a significant level of independent research by the student. It should be an integrative exercise that allows students to showcase skills and knowledge which they have developed across a range of subject areas and across their four years of study. It should result in the production of a significant piece of original work by the student. It should provide them with the opportunity to demonstrate their attainment of the four graduate attributes: to think independently, to communicate effectively, to develop continuously and to act responsibly.
Students should refer to School and College Policies and Procedures with regards to Research guidelines and ethical practices.

1.12 Coursework Requirements

In-course assessment and examination arrangements, grade descriptors, as well as, guidelines on presentation and submission of work for assessment purposes (including details of penalties applied for late submission, word count and declaration for plagiarism). Reference to academic support services or online modules may be relevant here.
Coursework is an integral part of Computer Science and it is essential that every student participates fully in the coursework associated with each module. If a student does not make a serious attempt at the coursework in a module this is considered in the same way as if a student does not make a serious attempt at an examination. Any student who submits less than two thirds of their coursework in a module is considered as not making a serious attempt. In such circumstances, if the student fails the module overall, they may be excluded from the degree programme at the discretion of the Examination Board. Timely submission of coursework is particularly important as this is a vital professional skill.
The penalties for late submission of coursework may be specified by the individual module lecturers, but in the absence of any such specification the following penalties will apply:

- In the case of fourth and fifth year dissertations and internship reports, late submissions are penalised by 5% per 'day', and a mark of 0% is awarded if the submission is more than 2 weeks after the deadline.
- In fourth and fifth year late submissions of coursework other than dissertations and internship reports are penalised by 10% per 'day' and a mark of 0% is awarded if the submission is more than 2 weeks after the deadline for submission.
- In all other years late submissions are penalised by 20% per 'day' and a mark of 0% is awarded if the submission is more than 1 week after the deadline for submission. In the case of electronic submission, a 'day' is taken to be a 24 hour period (or any part thereof).
- In the case where physical submission is required a 'day' is taken to be a working day or any part thereof. For coursework which must be submitted in both electronic and physical form the larger of the two penalties will be applied. In all cases a week is a calendar week.

If there are extenuating circumstances warranting late submission students must request extensions through their tutors in advance of the deadline for submission. Extenuating circumstances include only serious circumstances such as certified medical conditions and bereavements. Coursework marks are normally computed and returned as numerical values (e.g. as percentages). Guidelines for the presentation and submission of work are provided separately for each module. It is the responsibility of each student to retain a copy of any coursework that they submit.

Grade Descriptors
The requirements of each piece of coursework differ depending on the year of study as well as the nature of the problem. To give an idea of what each grade equates to in a qualitative fashion, the following is an indication of the standard expected of dissertations/projects which are done in year 4:

- I+ (80 - 100 Marks) An upper first project is one which is exceptionally good for an undergraduate and which displays: – thorough understanding of the project area – excellent knowledge of the relevant literature – comprehensive development of the technical theme including an element of originality – exemplary presentation and analysis of results – sound critical evaluation – well organised and excellently presented report
- I (70 - 79 Marks) A standard first class project is one which rates as very good for an undergraduate and which displays: – good understanding of the project area – sound knowledge of the relevant literature – complete development of the technical theme with at least some novel thinking – comprehensive presentation and full analysis of the results – clear evidence of an ability to critically evaluate – logically organised and very well presented report
- II.1 (60 - 69 Marks) An upper second class project is one which clearly rates as a good project and which displays: – reasonably good understanding of the project area – some knowledge of the relevant literature – sound development of the technical theme – clear presentation and relevant analysis of results – some critical evaluation, perhaps limited in scope – well organised and well presented report
- II.2 (50 - 59 Marks) A lower second class project is one which rates as moderately good and which displays: – some understanding of the project area – limited knowledge and appreciation of the relevant literature – limited development of the technical theme 23 – basic presentation and analysis of results – no originality or critical evaluation – insufficient attention to organisation and presentation of report
- III (40 - 49 Marks) A third class project is one which generally rates as weak and displays: – very limited understanding of the project area – scant knowledge and appreciation of the relevant literature – sparse development of the technical theme – confused presentation and incomplete analysis of results – weak level of technical discussion – poorly organised and presented report
- Fail (0 - 39 Marks) A project graded as a fail represents an unsatisfactory project containing significant errors or omissions: – flawed understanding of the project area – very superficial knowledge and appreciation of the relevant literature – lack of development in the technical theme – poor or incomplete presentation of results; inadequate or flawed analysis – discussion confused or erroneous – very poor overall presentation

1.13 Marking Scale

Grades for individual subjects and overall grades in years 1-5 are awarded based on the (rounded) percentage achieved as follows:

Years 1-4		Year 5	
Grade	**Mark**	**Grade**	**Mark**
I	70%–100%	Distinction	70%–100%
II.1	60%–69%	Pass	50%–69%
II.2	50%–59%		
III	40%–49%		

1.14 Progression Regulations

For one semester modules students are examined at the end of the semester and for one year modules they are examined at the end of the second semester. To complete an academic year (and hence progress to the next year of the programme or exit with a degree award), students must be successful at the Annual or Supplemental Examinations.
In order to be successful in the Annual or Supplemental Examinations, students must pass all modules. The pass mark in years 1-4 is 40%, and in year 5 is 50%. Alternatively, students may pass by compensation if they (i) achieve an overall weighted average pass 24 mark and (ii) pass modules totalling 50 credits, and (iii) get a 'Qualified Pass' mark (35% in years 1-4 and 45% in year 5) in the failed module(s) (either one 10-credit module or one/two 5-credit modules).
If a student is successful in the Annual Examinations his/her overall mark will be calculated as the average of each module's mark weighted by its ECTS rating and an overall grade awarded (according to the scale above). If a student is unsuccessful in the Annual Examinations, he/she is required to take a supplemental examination or assessment in all modules in which they have not achieved a pass mark, as indicated in the examination results. Permission to take supplemental examinations will not normally be granted to students whom the court of examiners considers not to have made a serious attempt at the annual examinations and coursework in each module unless an adequate explanation is furnished. The method of assessment of modules varies between annual and supplemental examinations. Supplemental examinations are held in Michaelmas term each year (i.e. towards the end of the summer break). If a student is successful in the Supplemental Examinations his/her overall mark will be calculated as the average of each module's mark (weighted by its ECTS rating) and an overall grade awarded (according to the scale above). This average is based on the marks achieved in the supplemental examinations together with the marks achieved in the annual examinations for the modules in which supplemental examinations/assessments were not required. A student who does not

feel their returned mark is correct should first ask to view their script with the examiners, and may (through their tutor) if they still believe that something is incorrect request a recheck, remark (of the full class) or lodge an appeal (See Section 3.8.3). A student who does not pass in either the Annuals or the Supplementals is required to repeat the year in full (See Section 3.8.4).**Trinity Courses**

1.15 Awards

Ordinary BA Degree (exit only)
Students who have passed their Year 3 examinations may have an ordinary BA degree conferred if they do not choose, or are not allowed, to proceed to Year 4 of the programme or if they fail to complete satisfactorily Year 4 of the course. Except by permission of the University Council, on the recommendation of the Executive Committee of the School of Computer Science and Statistics, an ordinary BA degree may be conferred only on candidates who have spent at least two years in the University.

Moderatorship Degree
The BA (Moderatorship) degree result is awarded, if a student has successfully completed Years 3 and 4, based on a combined mark from the Year 3 examinations (which count for 20% of the moderatorship result) and Year 4 examinations (which count for 80% of the moderatorship result). Where students are awarded an honors degree, the class of degree awarded is based on the weighted average mark achieved as follows: First Class Honors: 70%–100%, Second Class Honors, First Division: 60%–69%, Second Class Honours, Second Division: 50%–59%, Third Class Honors: 40%–49%. Students who have been successful in their Year 4 examinations may have the BA (Mod) degree conferred if they do not choose, or are not allowed, to proceed to the fifth year of the programme.

Master in Computer Science Degree
Successful candidates at the Year 5 examinations will be awarded a classified BA (Moderatorship) based on their results in Years 3 and 4, as set out above, and a Master in Computer Science or a Master in Computer Science with Distinction. A distinction shall require at least 70 per cent in the dissertation and at least 70 per cent in the final credit-weighted average mark.

1.16 Professional and Statutory Body Accreditation (if applicable)

The degree programme is professionally accredited by Engineers Ireland (See http://www.engineersireland.ie/Services/Accredited-Courses.aspx).

1.17 External Examiner

The external examiner for 2019-2022 is Prof. Simon Dobson, from the School of Computer Science at the University of St Andrews. He will be involved in ensuring that the examinations in fourth and fifth year are run properly (in terms of how the exam papers are set and marked, and how the results are moderated).

1.18 Student Feedback and Evaluation

The School will conduct student surveys of modules on a regular basis (at least once every three years) typically around the middle of the semester, and will provide feedback on the results of these surveys as soon as practical. It will also facilitate student fora with the class representatives towards the end of each semester.

APPENDIX A: NEW CURRICULUM

Students in JF in 2019-20 are following a revised curriculum. In years 3-4 the expected curriculum is as follows:

Year 3 Junior Sophister Year

In Year 3 (referred to as the Junior Sophister (JS) year in Trinity), students take the following half year modules:

Michaelmas Term	Hilary Term
CSU33012 Software Engineering	CSU33013 Software Engineering Project II
CSU34011 Symbolic Programming	CSU33061 Artificial Intelligence I
Telecommunication I	CSU34041 Information Management II
JS Computer Science Option	JS Computer Science Option
JS Computer Science Option or Open Module in Statistics	JS Computer Science Option or Open Module in Statistics
Trinity Elective*+	Trinity Elective*+

*All Trinity Elective modules have an ECTS weighting of 5 credits.
+See https://www.tcd.ie/trinity-electives/
JS Computer Science options are:
CSU33081 Computational Mathematics CSU34021 Computer Architecture II
CSU33071 Compiler Design I CSU33014 Concurrent Systems I
CSU34016 Introduction to Functional Programming
CSU34031 Advanced Telecommunications

Year 4 Senior Sophister Year

The new programme in the Senior Sophister year is almost the same as the existing programme. The only change as present seems to be that rather than taking the mandatory module CSU44081 (Entrepreneurship and High Tech Venture Creation), students may be allowed to choose between a module in Technology Entrepreneurship or another approved module elsewhere. This will depend on the availability of appropriate approved modules from other schools.