

# Faculty of Engineering, Mathematics and Science

## I GENERAL FACULTY REGULATIONS<sup>1</sup>

### Degrees

1 The faculty provides courses leading to the following degrees:

(a) COMPUTER SCIENCE AND STATISTICS

Bachelor in Arts (Moderatorships in Computer Science and Business, in Computer Science and Language, and in Management Science and Information Systems Studies (B.A. with honors)), Bachelor in Arts (Moderatorship in Computer Science) (B.A. with honors) and Master in Computer Science (M.C.S.), Bachelor in Science (Information Systems) (B.Sc. (Syst. Inf.)) (evening course), see II below.

(b) ENGINEERING SCIENCE

Bachelor in Arts (B.A.), see section III, §24 below, Bachelor in Engineering (B.A.I.) and Master in Engineering (Studies) (M.A.I. (St.)), Bachelor in Science (Engineering) (B.Sc. (Ing.)) and Master in Engineering (Studies) (M.A.I. (St.)) in Engineering with Management, see III below.

(c) MATHEMATICS<sup>2</sup>

Bachelor in Arts (Moderatorships in Mathematics, and in Theoretical Physics (B.A. with honors)), Bachelor in Arts (Ordinary B.A. degree), see IV below.

(d) SCIENCE<sup>2</sup>

Bachelor in Arts (Moderatorships in Science (in one of the following subjects: biochemistry, chemistry, comparative biology<sup>3</sup>, environmental sciences, genetics, geography, geology, immunology, microbiology, molecular medicine, neuroscience, physics, physics and astrophysics, physiology, plant sciences, zoology), in Earth Sciences, in Human Genetics, in Chemistry with Molecular Modelling, in Medicinal Chemistry, in Nanoscience, Physics and Chemistry of Advanced Materials, and in Political Science and Geography (B.A. with honors)), Bachelor in Arts (Ordinary B.A. degree), Bachelor in Science (Human Health and Disease) (B.Sc. (Hom. Val.)), see V below.

### Diploma

2 The following undergraduate diploma course is available: information systems, see II below.

### Admission

3 Applications for admission from E.U. applicants to the courses for these degrees (except for the evening Diploma/B.Sc. degree in Information Systems) should be made to the Central Applications Office (C.A.O.), Tower House, Eglinton Street, Galway. Applications may be submitted online at <http://www.cao.ie>. Non-E.U. applicants should apply online direct to Trinity College Dublin by 1 February of the proposed year of entry. For further information see <https://www.tcd.ie/study/non-eu/undergraduate/>.

4 Applicants must satisfy the admission requirements of the University, together with any special requirements for entry into particular courses in the faculty; see ADMISSION REQUIREMENTS.

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<sup>1</sup>These regulations should be read in conjunction with GENERAL REGULATIONS AND INFORMATION.

<sup>2</sup>For details of geography or mathematics in combination with other subjects, see TWO-SUBJECT MODERATORSHIP COURSES.

<sup>3</sup>Comparative biology will cease to be offered as a moderatorship option from 2017-18.

### *Advanced entry*

5 Where places are available students may be permitted advanced entry to their course, if, in the opinion of the appropriate head(s) of school(s), director(s) of undergraduate teaching and learning, head(s) of department(s) or the Associate Dean for Undergraduate Science Education, they are qualified by their knowledge and attainment to do so, or by passing specified examinations. Applicants must pay a fee before presenting themselves for examination (see COLLEGE CHARGES). Applications for advanced entry to any course should be made through the [Academic Registry](#) in the first instance.

### *Academic progress*

6 To gain credit for the academic year and rise with their class, students must (a) attend satisfactorily the lectures given in the subjects of their course each term as required by the University Council and the school or course committee concerned, (b) perform satisfactorily the prescribed exercises (essay, tutorial or practical work), and (c) pass, in accordance with the course regulations, the prescribed examinations, see GENERAL REGULATIONS AND INFORMATION.

Students are normally required to take modules totalling 60 ECTS credits in each year of their course.

### *Examinations*

7 Examinations are held in Trinity term, except where an indication to the contrary is given. In most courses supplemental examinations will be held in the Fresh years, and in certain courses in the Junior Sophister year, in the succeeding Michaelmas term.

In cases of failure at the annual examination session, the assessment, progression and compensation regulations are applied at the supplemental session in the same way as during the annual session, though the assessment methods may differ. In non-degree years, whilst passing marks are not capped at the supplemental session, a student's overall end of year result will be recorded as 'pass at supplemental'. However, where assessments count towards an award, any assessment component in which a student supplements will be capped at 40 per cent.

### *Repetition of year*

8 Students who in any year have failed to satisfy any one or more of the conditions defined in §6 will not, except as provided in GENERAL REGULATIONS AND INFORMATION, receive credit for the year. The relevant court of examiners may permit them to repeat the year, if they are entitled to do so (see GENERAL REGULATIONS AND INFORMATION), or may exclude them from the course. Permission to repeat the year will normally be granted only to students whom the relevant court of examiners considers to have made a serious attempt at their examinations and normally pertains to repeating the year in full. Students have the right to appeal to the relevant court of first appeal.

### *Transfer of course*

9 Students may apply through their tutor, using the standard form available, to the Senior Lecturer for permission to transfer to another course; see GENERAL REGULATIONS AND INFORMATION.

### *Foundation scholarship*

10 Students intending to present themselves for this examination should see FOUNDATION SCHOLARSHIPS.

### *Gold medals and prizes*

11 Gold medals are awarded by the Board to candidates of the first class who have shown exceptional merit at the annual degree examination in honor or professional courses (see <https://www.tcd.ie/academicregistry/exams/prizes/>).

Various studentships, scholarships, exhibitions, and other prizes are awarded to students on the results of honor and other examinations, provided that sufficient merit is shown. Monetary awards are sent direct to prize-winners unless otherwise stated under the regulations for the particular prize. For details see PRIZES AND OTHER AWARDS (see also MISCELLANEOUS AWARDS).

At the annual examinations a book prize (value under review) is awarded to each candidate obtaining an overall first class honors grade in an honor course. These prizes are not awarded in the Senior Sophister or final year.

Book prizes may be collected from the [Academic Registry](#) by the award holder in person.

## *II COURSES IN COMPUTER SCIENCE AND STATISTICS*

### *Fees*

1 See COLLEGE CHARGES.

### MODERATORSHIP IN COMPUTER SCIENCE AND BUSINESS<sup>4</sup>

#### *Admission*

2 For admission requirements see section I, §§3,4.

#### *Course*

3 The course is of four years' duration. The course aims to provide graduates with the knowledge and skills necessary for the technical field of computer science and the business management skills to understand markets and to manage business operations within organisations. The course will prepare students for challenging careers in either (or both) computer science and business. Students must take 60 ECTS in each year of study, as outlined in the syllabus below.

#### *Examinations*

4 The students are examined in the work of each year. There are supplemental examinations in Michaelmas term each year, except for the Senior Sophister year. Permission to take supplemental examinations will not normally be granted to students whom the court of examiners considers to have not made a serious attempt at the annual examinations unless an adequate explanation is furnished. Students must submit satisfactory course work in each year. Students who fail to do so may be refused permission to take all or part of the annual examinations for that year.

To pass the Fresh years and the Junior Sophister year, students must achieve an overall credit-weighted average mark of at least 40 per cent (grade III) and accumulate 60 credits by (a) passing all modules outright or (b) passing by compensation. To pass by compensation students must either pass outright modules totalling 55 credits and achieve a minimum mark of 30 per cent in the failed module, or pass outright modules totalling 50 credits and achieve a minimum mark of 35 per cent in any failed module(s). The designation of certain modules, or module components, as non-compensatable may reduce the level of compensation permitted in either year. Students, in these years, who do not pass at the annual examination session, either outright or by compensation, must complete supplemental assessments in all modules in which they did not achieve a mark of at least 40 per cent (grade III) by taking such assessment components, as specified by either school, during the supplemental examination period.

To pass the Senior Sophister year students must achieve an overall credit-weighted average mark of at least 40 per cent (grade III) and accumulate 60 credits either by (a) passing all modules outright or (b) passing by compensation or aggregation. Whether passing by compensation or aggregation students must pass outright modules totalling at least 40 credits in addition to achieving a 40 per cent (grade III) credit-weighted average, or higher, for the year. Compensation will be permitted in modules totalling a maximum of 20 credits provided that a

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<sup>4</sup>Prior to 2012-13 this course was called the Moderatorship in Business and Computing.

minimum mark of 30 per cent has been attained in any failed module(s). Further, passing by aggregation will be permitted if a mark of less than 30 per cent has been achieved in a module or modules carrying up to a maximum of 10 credits provided that a mark of at least 30 per cent has been achieved in any remaining failed module(s). As with the earlier years, the designation of certain modules, or module components, as non-compensatable may reduce the level of compensation or aggregation permitted in the Senior Sophister year. Successful candidates at the moderatorship examination are placed in the following classes: first class honors, second class honors (with two divisions, first and second), and third class honors.

Students who have not passed in its entirety any examination within eighteen months from the date on which they first became eligible for it, are reported to the University Council as unsatisfactory with a recommendation for their exclusion from the course.

#### *Ordinary degree of B.A.*

5 Students who have passed the Junior Sophister examination may have the ordinary B.A. degree conferred if they do not choose to proceed to the Senior Sophister year or if they fail to complete satisfactorily the Senior Sophister year of the course. Except by permission of the University Council, on the recommendation of the Executive Committees of the School of Computer Science and Statistics and the School of Business, the ordinary degree of B.A. may normally be conferred only on candidates who have spent at least three years in the University.

#### *Syllabus*

##### **6 Junior Freshers**

Students must take three mandatory modules:

- BU1511 Fundamentals of management and organisation (10 credits)
- EC1040 Introduction to economic policy (10 credits)
- ST1002 Statistical analysis I (5 credits)

Students will also be required to take five mandatory computer science modules:

- CS1003 Mathematics (10 credits)
- CS1010 Introduction to programming (10 credits)
- CS1013 Programming project I (5 credits)
- CS1021 Introduction to computing I (5 credits)
- CS1022 Introduction to computing II (5 credits)

##### **7 Senior Freshers**

Students are required to take the following six mandatory business modules:

- BU2510 Organisational behaviour (5 credits) (prerequisite BU1511)
- BU2520 Principles of marketing (5 credits) (prerequisite BU1511)
- BU2530 Introduction to accounting (5 credits) (prerequisite BU1511)
- BU2550 Introduction to finance (5 credits) (prerequisite BU1511)
- BU2560 Introduction to operations management (5 credits) (prerequisite BU1511)
- BU2570 Creative thinking, innovation and entrepreneurial action (5 credits) (prerequisite BU1511)

Students are required to take the following computer science modules:

- CS2010 Algorithms and data structures (10 credits)
- CS2013 Programming project II (5 credits)
- CS2014 Systems programming (5 credits)
- CS2041 Information management I (5 credits)
- CS2BC1 Systems analysis and design I (5 credits)

The availability of modules may be restricted by resource or timetable considerations.

## 8 Junior Sophisters

Students must take 60 credits in total with at least 20 credits in business and 20 credits in computer science.

### BUSINESS MODULES

- BU3520 Management accounting for business decisions (10 credits)
- BU3530 Financial and management accounting (10 credits)
- BU3571 Human resource management (5 credits)
- BU3591 Business in society (5 credits) (includes independent project or dissertation)
- BU3601 Innovation, entrepreneurship and business modelling (5 credits)
- BU3620 Introduction to fixed income securities and alternative investments (5 credits)
- BU3631 Corporate finance and equity valuation (5 credits)
- BU3640 Services management (5 credits) (includes independent project or dissertation)
- BU3650 Digital technology in operations (5 credits) (includes independent project or dissertation)
- BU3660 Organisation theory and organisational analysis (5 credits)
- BU3680 Investments (5 credits) (includes independent project or dissertation)
- BU3690 Social entrepreneurship (5 credits) (includes independent project or dissertation)
- BU3700 Contemporary marketing management (5 credits) (prerequisite BU2520) (includes independent project or dissertation)
- BU3710 Marketing for different organisational and business contexts (5 credits) (prerequisite BU2520)

### COMPUTER SCIENCE MODULES

- ST3009 Statistical methods for computer science (5 credits)
- CS2031 Telecommunications II (5 credits)
- CS3011 Symbolic programming (5 credits)
- CS3012 Software engineering (5 credits)
- CS3013 Software engineering group project (5 credits)
- CS3016 Introduction to functional programming (5 credits)
- CS3041 Information management II (5 credits)
- CS3061 Artificial intelligence I (5 credits)
- CS3071 Compiler design I (5 credits)
- CS3081 Computational mathematics (5 credits)
- CS3BC1 e-Business I (5 credits)
- CS3BC2 e-Business II (5 credits)

The availability of modules may be restricted by resource or timetable considerations.

## 9 Senior Sophisters

\*Students must take 60 credits in total with 30 credits in business and 30 credits in computer science. The computer science final year project (20 credits) is mandatory.

### BUSINESS MODULES

- BU4511 International business and the global economy (15 credits) (not offered in 2017-18)
- BU4522 Exploring organisational experiences (15 credits) (includes independent project or dissertation)
- BU4530 Financial reporting and analysis (15 credits) (includes independent project or dissertation)
- BU4640 Derivatives and international finance (prerequisite BU2550) (15 credits)
- BU4550 Advances in marketing theory and practice (15 credits)
- BU4580 Managing new product development (15 credits) (includes independent project or dissertation)
- BU4621 Social innovation and social impact (15 credits) (includes independent project or

dissertation)

BU4630 Economic policy and business history (15 credits) (includes independent project or dissertation) (not offered in 2017-18)

#### COMPUTER SCIENCE MODULES

- CS4091 Final year project (20 credits\*)
- CS3031 Advanced telecommunications (5 credits)
- CS4001 Fuzzy logic (5 credits)
- CS4004 Formal verification (5 credits)
- CS4012 Topics in functional programming (5 credits)
- CS4400 Internet applications (5 credits)
- CS4051 Human factors (5 credits)
- CS4052 Computer graphics (5 credits)
- CS4053 Computer vision (5 credits)
- CS4404 Machine learning (5 credits)
- ST4500 Strategic information systems (10 credits)

The choice of options may be restricted by resource or timetable considerations.

\*With effect from 2020-21.

### MODERATORSHIP IN COMPUTER SCIENCE AND MASTER IN COMPUTER SCIENCE (M.C.S.)

#### *Admission*

10 For admission requirements for entry into the first year see ADMISSION REQUIREMENTS.

For direct entry into the fourth year admission is competitive and is normally restricted to graduates who have received a second class honors degree result or better in a National Framework of Qualifications (NFQ) level 8 degree. Well-qualified candidates from other disciplines who have sufficient knowledge of computing (including the ability to program) may also apply.

#### *Course*

11 For students who entered the course prior to 2012, the course normally lasts for four years and leads to a B.A. (Moderatorship) degree in Computer Science. Students who entered the course prior to 2012 will also have the option to participate in the five-year course.

From 2012 the course will normally last for five years and will lead to the degrees of B.A. (Moderatorship) and Master in Computer Science.

12 The course is concerned with the study of the theoretical underpinnings and practical applications of computers. The first two years provide an introduction to fundamentals including mathematics, programming, microprocessor systems, digital logic, telecommunications, information management and the relationship between computers and society. Later years provide specialisation in a broad range of topics through core and elective modules.

Students participating in the Master in Computer Science course will be required to engage in a one semester internship in industry or in a university research laboratory in their fourth year. In the fifth year students will undertake a significant project with a substantial element of independent research leading to a dissertation.

Students completing the fourth year to exit with a B.A. (Moderatorship) undertake a significant final year project.

#### *Examinations*

13 Students are examined in the work of each year. Supplemental examinations will be held in Michaelmas term each year, except for the fourth and fifth years. 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 unless an adequate

explanation is furnished. Students must submit satisfactory course work in each year. Students who fail to do so, or whose attendance is unsatisfactory, may be refused permission to take all or part of the annual examinations for the year.

Some Junior Sophister annual examinations, all Senior Sophister annual examinations, and some Master (Year 5) annual examinations are held in January (just prior to Hilary term). Some Master (Year 5) examinations are held in April. All other annual examinations are held in the annual examination session.

Students who have not passed in its entirety any examination within eighteen months from the date on which they first became eligible for it, will be reported to the University Council as unsatisfactory with a recommendation for their exclusion from the course.

In years one to four successful candidates at the annual examinations will be awarded one of the following grades: first class honors, second class honors (with two divisions, first and second) or third class honors.

The B.A. (Moderatorship) degree result is awarded based on a combined mark from the annual sitting of the third year examinations (which count for 20 per cent of the moderatorship result) and fourth year examinations (which count for 80 per cent of the moderatorship result). Successful candidates at the fifth year examinations will be awarded a classified B.A. (Moderatorship) and a Master in Computer Science or a Master in Computer Science with distinction.

### *Progression*

14 To pass each of the first three years of the course, students must achieve an overall credit-weighted average mark of at least 40 per cent (grade III) and accumulate 60 credits by (a) passing all modules outright or (b) passing by compensation. To pass by compensation students must either pass outright modules totalling 55 credits and achieve a minimum mark of 30 per cent in the failed module, or pass outright modules totalling 50 credits and achieve a minimum mark of 35 per cent in any failed module(s). The designation of certain modules, or module components, as non-compensatable may reduce the level of compensation permitted in any year. Students, in years one to three of the course, who do not pass at the annual examination session, either outright or by compensation, must complete supplemental assessments in all modules in which they did not achieve a mark of at least 40 per cent (grade III) by taking such assessment components, as required, during the supplemental examination period. Due to the nature of group work, failed group assignments cannot be re-assessed during the supplemental period, which means that a student may be required to repeat the year.

To pass the fourth year of the course students must achieve a credit-weighted average mark of at least 40 per cent and accumulate 60 credits by (a) passing all modules outright or (b) passing by compensation or aggregation. Whether passing by compensation or aggregation students must pass outright modules totalling at least 50 credits in addition to achieving a 40 per cent (grade III) credit-weighted average, or higher, for the year. There are no supplemental examinations in the fourth year.

Students who pass their third year examinations may exit the course with an ordinary B.A. degree, or continue to the fourth year in order to achieve and exit with a B.A. (Moderatorship). To progress to the fourth year of the five year master's course, third year students must achieve an average of 60 per cent or better in the annual examinations. Third year students who pass the third year examinations but do not achieve an average of 60 per cent or better may repeat the third year in full to try and achieve the required standard.

Fourth year students who pass the fourth year examinations and achieve an average of at least 60 per cent and satisfy the requirements for the award of Moderatorship in Computer Science may progress to the fifth year or exit the course with a B.A. (Moderatorship) degree. Students who achieve a second class (second division) honors or a third class honors grade in their fourth year examinations may exit the course with a B.A. (Moderatorship) degree or may repeat the fourth year to pass the fourth year examinations and achieve an average of at least 60 per cent and satisfy the requirements for the award of Moderatorship in Computer Science in order to progress to the fifth year of the Master in Computer Science course. Students who fail to

achieve a pass grade may exit with an ordinary B.A. degree.

*Ordinary degree of B.A.*

15 Students who have passed the third year examination may have the ordinary B.A. degree conferred if they do not choose to proceed to the fourth year of the course or if they fail to complete satisfactorily the fourth year 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, the ordinary degree of B.A. may normally be conferred only on candidates who have spent at least three years in the University.

*Moderatorship degree*

16 Students who have passed their fourth year examinations may have the B.A. (Moderatorship) degree conferred if they do not choose, or are not allowed, to proceed to the fifth year of the course.

*Master in Computer Science degree*

17 Successful candidates at the fifth year examinations will be awarded the degree of Master in Computer Science or 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.

*Modules*

**18 Year 1**

- CS1003 Mathematics (10 credits)
- CS1010 Introduction to programming (10 credits)
- CS1013 Programming project I (5 credits)
- CS1026 Digital logic design (10 credits)
- CS1021 Introduction to computing I (5 credits)
- CS1022 Introduction to computing II (5 credits)
- CS1025 Electrotechnology (5 credits)
- CS1031 Telecommunications I (5 credits)
- CS1081 Computers and society (5 credits)

**19 Year 2**

- MA2C03 Discrete mathematics (10 credits)
- CS2010 Algorithms and data structures (10 credits)
- CS2013 Programming project II (5 credits)
- CS2014 Systems programming (5 credits)
- CS2016 Concurrent systems and operating systems (5 credits)
- CS2021 Microprocessor systems (5 credits)
- CS2022 Computer architecture I (5 credits)
- CS2031 Telecommunications II (5 credits)
- CS2041 Information management I (5 credits)
- CS2081 Broad Curriculum (5 credits)

**20 Year 3**

- ST3009 Statistical methods for computer science (5 credits)
- CS3011 Symbolic programming (5 credits)
- CS3012 Software engineering (5 credits)
- CS3013 Software engineering group project (5 credits)
- CS3014 Concurrent systems (5 credits)
- CS3016 Introduction to functional programming (5 credits)
- CS3021 Computer architecture II (5 credits)



- CS3041 Information management II (5 credits)
- CS3081 Computational mathematics (5 credits)
- CS3071 Compiler design I (5 credits)

and two options from the following list:<sup>5</sup>

- CS3017 Introduction to semantics of programming languages (5 credits)
- CS3031 Advanced telecommunications (5 credits)
- CS3061 Artificial intelligence I (5 credits)
- Additional topics<sup>6</sup>

#### 21 Year 4

- CS4051 Human factors (5 credits)
- CS4081 Entrepreneurship and high tech venture creation (5 credits)

Students completing the fourth year to exit with a B.A. (Moderatorship) take the following modules:

- CS4098 Group computer science project (10 credits)
- CS4099 Final year project (20 credits)

and must choose four options from the following list:<sup>5</sup>

- CS4001 Fuzzy logic (5 credits)
- CS4003 Formal methods (5 credits)
- CS4012 Topics in functional programming (5 credits)
- CS4021 Advanced computer architecture (5 credits)
- CS4031 Next generation networks (5 credits)
- CS4400 Internet applications (5 credits)
- CS4052 Computer graphics (5 credits)
- CS4053 Computer vision (5 credits)
- CS4404 Machine learning (5 credits)
- CS4LL5 Advanced computational linguistics (5 credits)
- Additional topics<sup>6</sup>

Students following the Master in Computer Science course undertake an internship:

- CS7091 Industrial/research laboratory internship (30 credits)

and must choose four options<sup>7</sup> from the following list:<sup>5</sup>

- CS4001 Fuzzy logic (5 credits)
- CS4003 Formal methods (5 credits)
- CS4012 Topics in functional programming (5 credits)
- CS4021 Advanced computer architecture (5 credits)
- CS4031 Next generation networks (5 credits)
- CS4400 Internet applications (5 credits)
- CS4052 Computer graphics (5 credits)
- CS4053 Computer vision (5 credits)
- CS4404 Machine learning (5 credits)
- CS4LL5 Advanced computational linguistics (5 credits)
- Additional topics<sup>6</sup>

#### 22 Year 5

- CS7064 Research methods (5 credits)

<sup>5</sup>It may not be possible to offer all the options each year and some modules have prerequisites.

<sup>6</sup>Additional modules covering special topics may be added to this list subject to staff availability and timetabling constraints.

<sup>7</sup>A maximum of 20 credits of CS4 level modules can be taken over year four and five.

CS7092 Master in Computer Science dissertation (30 credits)

and five options from the following list:<sup>5</sup>

- CS7NS2 Internet of things (5 credits)
- CS7IS2 Artificial intelligence (5 credits)
- CS7GV2 Mathematics of light and sound (5 credits)
- CS7NS3 Next generation networks (5 credits)
- CS7NS6 Distributed systems (5 credits)
- CS7GV1 Computer vision (5 credits)
- CS7CS4 Machine learning (5 credits)
- CS7DS1 Data mining and analytics (5 credits)
- CS7IS1 Knowledge and data engineering (5 credits)
- CS7NS4 Urban computing (5 credits)
- CS7NS1 Scalable computing (5 credits)
- CS7GV5 Real-time animation (5 credits)
- CS7IS5 Adaptive applications (5 credits)
- CS7NS5 Security and privacy (5 credits)
- CS7GV4 Augmented reality (5 credits)
- CS7GV3 Real-time rendering (5 credits)
- CS7GV6 Computer graphics (5 credits)
- CS7DS2 Optimisation algorithms for data analysis (5 credits)
- CS7DS3 Applied statistical modelling (5 credits)
- CS7DS4 Data visualisation (5 credits)
- CS7IS3 Information retrieval and web search (5 credits)
- CS7IS4 Text analytics (5 credits)

#### MODERATORSHIP IN COMPUTER SCIENCE AND LANGUAGE

23 For details see FACULTY OF ARTS, HUMANITIES AND SOCIAL SCIENCES.

#### MODERATORSHIP IN MANAGEMENT SCIENCE AND INFORMATION SYSTEMS STUDIES

24 This course is concerned with the application of computers, mathematical techniques and information systems to problem-solving, decision-making and planning in the management of business and industry. Its aim is to provide a practical training founded on a solid theoretical base, which will enable its graduates to be immediately effective while remaining adaptable to new developments in business and information technology.

##### *Modules*

#### 25 Junior Freshers

Students take mandatory modules in business and management, computer science, economics, management science, mathematics and statistics amounting to 60 credits.

- BU1511 Fundamentals of management and organisation (10 credits)
- CS1010 Introduction to programming (10 credits)
- EC1010 Introduction to economics (10 credits)
- MA1E01 Engineering mathematics I (5 credits)
- MA1E02 Engineering mathematics II (5 credits)
- ST1001 Software applications I (5 credits)
- ST1002 Statistical analysis I (5 credits)
- ST1004 Introduction to management science (10 credits)

## 26 Senior Freshers

Students take mandatory modules in business and management, computer science, economics, management science, mathematics, probability and statistics amounting to 60 credits.

- BU2530 Introduction to accounting (5 credits)
- BU2550 Introduction to finance (5 credits)
- CS2010 Algorithms and data structures (10 credits)
- MA2E01 Engineering mathematics III (5 credits)
- MA2E02 Engineering mathematics IV (5 credits)
- ST2001 Software applications II (10 credits)
- ST2004 Applied probability I (5 credits)
- ST2005 Applied probability II (5 credits)
- ST2006 Management science methods (10 credits)

The MSISS course is currently under review and there may be changes to the above list of modules.

## 27 Junior Sophisters

Mandatory modules must be taken in a number of areas including information systems, management science and statistics. Students take modules amounting to 60 credits.

- ST3001 Software applications III (10 credits)
- ST3002 Statistical analysis III (5 credits)
- ST3004 Research methods (5 credits)
- ST3005 Information systems (5 credits)
- ST3010 Applied forecasting (5 credits)
- ST3011 Multivariate linear analysis (MLA) (5 credits)
- ST3008 Management science case studies (10 credits)
- CS3012 Software engineering (5 credits)  
Option (10 credits)

The MSISS course is currently under review and there may be changes to the above list of modules.

In their Junior Sophister year students take an option from a list of modules in business, computer science, economics, mathematics and statistics. The choice of options may be restricted by timetable considerations.

## 28 Senior Sophisters

In the Senior Sophister year all students carry out a project based on a real industrial or organisational problem and take mandatory modules in information systems, management science and statistics. Students take modules amounting to 60 credits.

- ST4500 Strategic information systems (10 credits)
- ST4003 Data analytics (10 credits)
- ST4005 Decision analysis (5 credits)
- ST4001 MSISS final year project (20 credits)  
Option (10 credits)

The MSISS course is currently under review and there may be changes to the above list of modules.

In their Senior Sophister year students take an option from a list of modules in business, computer science, economics, mathematics and statistics. The choice of options may be restricted by timetable considerations. Each student's choice of elective modules and final year project must be approved by the Course Director.

### *Assessment*

29 In all years students are assessed by assignments and tests during the year and/or by formal examinations. There are supplemental written examinations in Michaelmas term each year, except for the Senior Sophister year.

To pass each year of the course, students must achieve an overall credit-weighted average mark of at least 40 per cent (grade III) and accumulate 60 credits by (a) passing all modules outright or (b) passing by compensation. To pass by compensation students must either pass outright modules totalling 55 credits and achieve a minimum mark of 30 per cent in the failed module, or pass outright modules totalling 50 credits and achieve a minimum mark of 35 per cent in any failed module(s). The designation of certain modules, or module components, as non-compensatable may reduce the level of compensation permitted in either year. Students, in the Fresh and Junior Sophister years, who do not pass at the annual examination session, either outright or by compensation, must complete supplemental assessments in all modules in which they did not achieve a mark of at least 40 per cent (grade III) by taking such assessment components, as required, during the supplemental examination period or by re-submitting required course work during the summer.

The Junior and Senior Sophister examinations together constitute the moderatorship examination to which they contribute 35 per cent and 65 per cent of the marks respectively.

Successful candidates at the final degree examination (moderatorship) are placed in the following classes: first class honors, second class honors (with two divisions, first and second), and third class honors. The final degree result is based on a student's overall performance within the Sophister years.

### *Ordinary degree of B.A.*

30 Students who have passed the Junior Sophister examination may have the ordinary B.A. degree conferred if they do not choose to proceed to the Senior Sophister year, or if they fail to complete satisfactorily the Senior Sophister year 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, the ordinary degree of B.A. may normally be conferred only on candidates who have spent at least three years in the University.

### **DIPLOMA IN INFORMATION SYSTEMS (EVENING COURSE)**

31 There will be no admission to the first year of this programme in 2017/18.

### *Course*

32 This course is of two years' duration. Examinations are held each year. Suitably qualified students may be exempted from specified modules or admitted to the second year of the course.

### *Examinations*

33 Annual examinations are held each year with supplemental examinations in the Michaelmas term. Students who have not passed in its entirety any examination within eighteen months from the date on which they first became eligible for it are reported to the University Council as unsatisfactory with a recommendation for their exclusion from the course. To pass each year of the diploma course, students must achieve an overall credit-weighted average mark of at least 40 per cent (grade P3) and accumulate 60 credits by (a) passing all modules outright or (b) passing by compensation. To pass by compensation students must either pass outright modules totalling 55 credits and achieve a minimum mark of 30 per cent in the failed module, or pass outright modules totalling 50 credits and achieve a minimum mark of 35 per cent in any failed module(s). The designation of certain modules, or module components, as non-compensatable may reduce the level of compensation permitted in either year. Students, in these years, who do not pass at the annual examination session, either outright or by compensation, must complete supplemental assessments in all modules in which they did not achieve a mark of

at least 40 per cent (grade P3) by taking such assessment components, as required, during the supplemental examination period.

### *Syllabus*

#### **34 Year 1**

- CS1101 Information systems (10 credits)
- CS1102 Internet systems (10 credits)
- CS1103 Organisation and management (10 credits)
- CS1104 Information systems development I (10 credits)
- CS1105 Business methods (10 credits)
- CS1106 Information systems practice I (10 credits)

#### **35 Year 2**

- CS2101 Information and communications technology (10 credits)
- CS2102 Enterprise architecture and solution definition (10 credits)
- CS2103 Project management (10 credits)
- CS2104 Database and information management (10 credits)
- CS2105 Information systems development project (20 credits)

### **B.Sc. DEGREE IN INFORMATION SYSTEMS (EVENING COURSE)**

#### *Admission*

36 Applications for admission to the evening Bachelor in Science in Information Systems degree course should be made to Trinity College Dublin by 31 July. Recipients of the Diploma in Information Systems (see above) are automatically transferred to the Bachelor in Science course and do not need to reapply.

37 Applicants must normally have completed the Diploma in Information Systems (see above) at a satisfactory level or have equivalent, recognised qualifications, experience and skills.

#### *Examinations*

38 Annual examinations are held each year with supplemental examinations in Michaelmas term of the third year. There are no supplemental examinations in the fourth year. Students who have not passed in its entirety any examination within eighteen months from the date on which they first became eligible for it are reported to the University Council as unsatisfactory with a recommendation for their exclusion from the course. To pass each year of the degree course, students must achieve an overall credit-weighted average mark of at least 40 per cent (grade III) and accumulate 60 credits by (a) passing all modules outright or (b) passing by compensation. To pass by compensation students must pass outright modules totalling 50 credits and achieve a minimum mark of 35 per cent in any failed module(s). The designation of certain modules, or module components, as non-compensatable may reduce the level of compensation permitted in either year. Students in the third year who do not pass at the annual examination session, either outright or by compensation, must complete supplemental assessments in all modules in which they did not achieve a mark of at least 40 per cent (grade III) by taking such assessment components, as required, during the supplemental examination period.

#### *Degree award*

39 Successful candidates at the annual degree examination are placed in the following classes: first class honors, second class honors (with two divisions, first and second), and third class honors.

#### *Choice of options*

40 In both years of the B.Sc. (Honors) Information Systems degree the choice of options may be restricted due to resource or timetable considerations. Modules with insufficient student

numbers will not be offered. Information concerning elective modules may be obtained from the Programme Director, Information Systems Programme. Each student's choice of elective modules must be approved by the Programme Director.

#### *Ordinary degree of B.A.*

41 Students who have passed the Junior Sophister examination may have the ordinary B.A. degree conferred if they choose not to proceed to the Senior Sophister year or if they fail to complete satisfactorily the Senior Sophister year 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, the ordinary degree of B.A. may normally be conferred only on candidates who have spent at least three years in the University.

#### *Syllabus*

##### **42 Year 3**

- CS3101 e-Business (10 credits)
- CS3102 Information systems development II (10 credits)
- CS3103 Business, management and IT (10 credits)
- CS3104 Information systems strategy (10 credits)
- CS3105 Law and IT (10 credits)
- CS3106 Information systems practice II (10 credits)
- CS3107 Social computing (10 credits)

##### **43 Year 4**

- CS4101 Information security (10 credits)
- CS4102 Innovation (10 credits)
- CS4103 Information systems management (10 credits)
- CS4104 Advanced information systems (10 credits)
- CS4105 Final-year project (20 credits)
- CS4106 Information systems development III (10 credits)

In the fourth year CS4105 is mandatory. In addition, students choose modules worth 40 credits from the list above.<sup>8</sup>

### **III COURSES IN ENGINEERING SCIENCE**

#### *Fees*

1 See COLLEGE CHARGES.

#### **DEGREES OF BACHELOR IN ENGINEERING AND MASTER IN ENGINEERING (STUDIES) (B.A., B.A.I.) or (B.A., M.A.I. (St.))**

2 Students complete a four-year course and may elect to complete an additional year of study leading to a M.A.I. (St.) degree, see §16. There is provision for an abridgement of the course to three years, see section I, §5.

3 During the first two years a programme of basic modules in engineering is provided. Following completion of the first two years of the course, students elect to study specialised programmes in one of the following strands:

- civil, structural and environmental engineering
- mechanical and manufacturing engineering
- biomedical engineering
- electronic engineering
- computer engineering

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<sup>8</sup>It may not be possible to offer all the options each year. Additional modules covering special topics may be added to this list subject to staff availability and timetabling constraints.

electronic/computer engineering (combined programme)

Following completion of the fourth year of the engineering degree course, eligible students may elect to complete one further year of study in their chosen strand leading to a M.A.I. (St.) degree, §16.

4 While every effort is made to allow students to study the strand/specialism they choose, the Engineering School Curriculum Committee reserves the right to allocate the available places. In some departments the number of places for students of any one year may be limited. Timetable constraints may also reduce the number of module options available.

5 Students who successfully complete the third year of their engineering course in Trinity College Dublin and meet the selection criteria may enrol on the 'double diploma' programme run jointly with the Institut National des Sciences Appliquées (I.N.S.A.) de Lyon. Selected candidates are admitted to the third year of the engineering course in I.N.S.A. de Lyon and take modules amounting to 60 credits from the third and fourth year curricula offered by the department corresponding to their chosen engineering specialty. This academic year is recognised as being equivalent to the fourth/B.A.I. year and, on its successful completion, students return to Trinity College Dublin to satisfactorily complete the fifth year of the M.A.I. degree course. Such students are eligible to be awarded with the B.A. and M.A.I. (St.) degrees. Subsequent to this students proceed directly to the fifth year of the engineering course in I.N.S.A. de Lyon returning to the department of their option to take a set of approved modules amounting to 60 credits. Upon successful completion of this additional year, students are eligible to be conferred with the Diplôme d'Ingénieur de l'I.N.S.A. de Lyon.

A similar arrangement exists for engineering students of the I.N.S.A. de Lyon whereby suitably qualified candidates are admitted to the third year of the Trinity College Dublin engineering course and complete two years here taking modules from the engineering department corresponding to their chosen option in I.N.S.A. de Lyon. Following successful completion of these two years in Trinity College Dublin students are eligible to be awarded the B.A.I. degree. Such students return to the department of their option in I.N.S.A. de Lyon to satisfactorily complete the fifth year of their home course and to receive the Diplôme d'Ingénieur de l'I.N.S.A. de Lyon.

6 A number of additional options to study abroad with approved partner institutions are available as an integrated part of the teaching programme for students following the M.A.I. course. These options may be taken in the fourth year and include Erasmus, UNITECH (as a paid industrial partnership) and CLUSTER. Full details of available options are available from the Engineering School Office and on the [website](#).

7 Students are encouraged to gain relevant industrial experience during the vacation periods. Formal industrial partnerships/internships with approved industry partners are also available as an integrated part of the teaching programme for students following the M.A.I. course. This option may be taken in the fourth year.

### *Syllabus*

#### **8 Year 1**

Students take mandatory modules amounting to 60 credits.

1E1	Engineering mathematics I (5 credits)
1E2	Engineering mathematics II (5 credits)
1E3	Computer engineering I (5 credits)
1E4	Physics (5 credits)
1E5	Chemistry (5 credits)
1E6	Electrical engineering (5 credits)
1E7	Mechanics (5 credits)
1E8	Introduction to professional engineering (5 credits)
1E9	Engineering design I: graphics and computer aided engineering (5 credits)
1E10	Engineering design II: project (10 credits)

1E11 Experimental methods (5 credits)

Associated laboratory work, design projects and fieldwork, appropriate to the modules selected, will be provided.

## 9 Year 2

Students take mandatory modules amounting to 60 credits.

2E1 Engineering mathematics III (5 credits)  
2E2 Engineering mathematics IV (5 credits)  
2E3 Computer engineering II (5 credits)  
2E4 Solids and structures (5 credits)  
2E5 Thermo-fluids (5 credits)  
2E6 Electronics (5 credits)  
2E7 Engineering and the environment (5 credits)  
2E8 Materials (5 credits)  
2E9 Engineering design III: project (5 credits)  
2E10 Engineering design IV: project (10 credits)  
2E11 Computational engineering (5 credits)

Associated laboratory work, design projects and fieldwork, appropriate to the modules selected, will be provided.

## 10 Year 3

Students take admissible combinations of modules amounting to 60 credits, including the following mandatory modules:

3E1 Engineering mathematics V (5 credits) or  
3E1a Engineering analysis (5 credits)  
3E3 Probability and statistics (5 credits)  
3E4 Innovation and entrepreneurship for engineers) (5 credits)

and admissible combinations from the following:<sup>9</sup>

3A1 Engineering surveying (5 credits)  
3A2 Structural design (5 credits)  
3A3 Hydraulics (5 credits)  
3A4 Structural analysis (5 credits)  
3A5 Soil mechanics (5 credits)  
3A6 Construction technology (5 credits)  
3A7 Transportation and highway engineering (5 credits)  
3A8 Geology for engineers (5 credits)  
3A9 Group design project (10 credits)  
3B1 Thermodynamics (5 credits)  
3B2 Fluid mechanics 1 (5 credits)  
3B3 Mechanics of solids (5 credits)  
3B4 Mechanical engineering materials (5 credits)  
3B5 Mechanics of machines (5 credits)  
3B6 Mechatronics (instrumentation and control) (5 credits)  
3B7 Manufacturing technology and systems (5 credits)  
3B8 Universal design innovation (10 credits)  
3C1 Signals and systems (5 credits)  
3C2 Digital circuits (5 credits)  
3C3 Analogue circuits (5 credits)

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<sup>9</sup>Admissible combinations vary by engineering strand. It may not be possible to offer all the options every year.



3C4	Applied electromagnetism (5 credits)
3C5	Telecommunications (5 credits)
3C7	Digital systems design (5 credits) (for electronic and electronic/computer engineering strands)
3C8	Digital circuits design (5 credits) (for electronic and electronic/computer engineering strands)
3C9	Analogue circuits design (5 credits) (for electronic engineering strand only)
3D1	Microprocessor systems 1 (5 credits)
3D2	Microprocessor systems 2 (5 credits)
3D3	Computer networks (5 credits)
3D4	Operating systems and concurrent systems (5 credits)
3D5A	Data structures and algorithms (5 credits) (for all electronic/computer engineering strands)
3D5B	Software design and implementation (5 credits) (for computer engineering strand only)
CS2022	Computer architecture I (5 credits)
3BIO1	Anatomy and physiology (5 credits)
3BIO2	Biomedical design project (5 credits)
3BIO3	Quantitative physiology (5 credits)

Associated laboratory work, design projects and fieldwork, appropriate to the modules selected, will be provided.

#### 11 Year 4

Students take admissible combinations of modules amounting to 60 credits by following one of three modes of study involving modules and project work in College (mode 1), a project-based engineering internship (mode 2), or an international academic exchange (mode 3), comprising admissible combinations of the following:<sup>10</sup>

4E1	Management for engineers (5 credits)
4E2	Engineering project (15 credits)
4E2B	Engineering design group project: part 1 (5 credits)
4E2C	Engineering design group project: part 2 (10 credits)
4E4	Engineering project internship (30 credits)
4E5	Innovation in product development (20 credits)
4E6	Robotic design (10 credits)
4A1	Civil engineering materials (5 credits)
4A2	Hydrogeology and engineering geology (5 credits)
4A3(1)	Environmental engineering I (5 credits)
4A3(2)	Environmental engineering II (5 credits)
4A4	Hydraulics (5 credits)
4A5(1)	Geotechnical engineering I (5 credits)
4A5(2)	Geotechnical engineering II (5 credits)
4A6(1)	Structures I (5 credits)
4A6(2)	Structures II (5 credits)
4A6(3)	Structures III (5 credits)
4A7	Design and the built environment (5 credits)
4A8	Transportation (5 credits)
4B1	Mechanics of solids (5 credits)
4B2	Forensic materials engineering (5 credits)
4B3	Thermodynamics (5 credits)
4B4	Heat transfer (5 credits)

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<sup>10</sup>The general regulations with respect to the timing of academic exchanges in final year apply.

4B5	Manufacturing technology (5 credits)
4B6	Manufacturing systems and project management (5 credits)
4B7	Computer aided design (5 credits)
4B9	Control engineering 1 (5 credits)
4B10	Instrumentation and experimental techniques (5 credits)
4B11	Engineering vibrations and noise (5 credits)
4B12	Acoustics (5 credits)
4B13	Fluid mechanics 2 (5 credits)
4B15	Introduction to bioengineering (5 credits)
4B16	Biomechanics of tissues and plants (5 credits)
4B17	Multibody dynamics (5 credits)
4BIO1	Cell and molecular biology (5 credits)
4BIO2	Telemedicine (5 credits)
4BIO3	Physical and physiological measurement (5 credits)
4BIO4	Experimental and research methods in biomedical engineering (5 credits)
4BIO5	Biomechanics (5 credits)
4BIO6	Biomaterials (5 credits)
4C1	Integrated systems design (5 credits)
4C2	Microelectronic circuits (5 credits)
4C3	Digital control systems (5 credits)
4C4	Next generation networks (5 credits)
4C5	Digital signal processing (5 credits)
4C6	Microelectronic technology (5 credits)
4C7	Information and communication theory (5 credits)
4C8	Digital media processing (5 credits)
4C10	Digital communications (5 credits)
4C11	Optoelectronics (5 credits)
4C12	Applied signal processing (5 credits)
4C14	Introduction to bioengineering (5 credits)
4C15	Analogue signal processing (5 credits)
4C16	Machine learning (5 credits)
4C17	Electromagnetic fields and waves (5 credits)
4MEMS8	Research methods (5 credits)
4MEMS9	User centred design innovation (5 credits)
CS3421	Computer architecture II (5 credits)
CS4D2A	Information management II (5 credits)
CS4D2B	Knowledge engineering (5 credits)
CS4031	Next generation networks (5 credits)
CS4052	Computer graphics (5 credits)
CS4404	Machine learning (5 credits)
CS4053	Computer vision (5 credits)
CS4403	Advanced software engineering (5 credits)
CS4405	Optimisation algorithms for data analysis (5 credits)
CS4406	Data visualisation (5 credits)
CS4400	Internet applications (5 credits)
CS7434	Augmented reality (5 credits)
CS4407	Security and privacy (5 credits)

Associated laboratory work, design projects and fieldwork, appropriate to the modules selected, will be provided.

## 12 Year 5

In the fifth year of the course all students complete mandatory and optional modules (35 credits) and a mandatory engineering research project (25 credits).

5E1	Engineering research project (25 credits)
5E2	Research methods (5 credits)
5E3	Innovation in product development (15 credits)
5E4	Introduction to computational fluid mechanics (5 credits)
C1	Renewable energy I (5 credits)
C2	Renewable energy II (5 credits)
C3	Modelling of engineering systems (5 credits)
C4	Façade engineering (5 credits)
C5	Advanced spatial analysis using GIS (5 credits)
C6	Construction innovation and research (5 credits)
E2	Spatial environmental analysis and impact assessment using GIS (5 credits)
E3	Air quality and noise pollution (5 credits)
E4	Waste management and energy recovery (5 credits)
E5	Water quality and hydrological modelling (5 credits)
E7	Sustainable water supply and sanitation (5 credits)
J1	Wind energy (5 credits)
J2	Solar energy conversion and applications (5 credits)
J3	Building energy physics and control (5 credits)
J4	Energy policy and demand (5 credits)
J5	Renewable heat (5 credits)
J6	Wave and hydro energy (5 credits)
S1	Geotechnical engineering (5 credits)
S2	Advanced computation for structures (5 credits)
S3	Wind and earthquake engineering (5 credits)
S4	Bridge engineering (5 credits)
S5	Advanced concrete technology (5 credits)
S6	Soil-structure interaction (5 credits)
S8	Concrete durability and sustainability (5 credits)
S9	Advanced theory of structures (5 credits)
T1	Transportation policy (5 credits)
T2	Transport modelling and planning (5 credits)
T3	Highway engineering (5 credits)
T4	Transportation data and evaluation (5 credits)
T5	Transport design (5 credits)
5B1	Flow induced vibration and fluid structure interaction (5 credits)
5B2	Advanced materials (5 credits)
5B3	Advanced thermal fluid sciences (5 credits)
5B4	Engineering vibration and noise (5 credits)
5B5	Human factors (5 credits)
5B9	Control engineering 2 (5 credits)
5B10	Instrumentation and experimental techniques (5 credits)
5M1	Mechanics of solids (5 credits)
5M2	Forensic materials engineering (5 credits)
5M3	Thermodynamics (5 credits)
5M4	Heat transfer (5 credits)
5M5	Manufacturing technology (5 credits)
5M6	Manufacturing systems and project management (5 credits)
5M7	Computer aided design (5 credits)
5M9	Control engineering 1 (5 credits)
5M12	Acoustics (5 credits)
5M13	Fluid mechanics (5 credits)
5M15	Introduction to bioengineering (5 credits)
5M16	Biomechanics of tissues and implants (5 credits)

5M17	Multibody dynamics (5 credits)
5BIO1	Medical devices (10 credits)
5BIO2	Advanced tissue mechanics and mechanobiology (5 credits)
5BIO3	Tissue engineering (5 credits)
5BIO4	Finite element analysis (5 credits)
5BIO5	Injury biomechanics and musculoskeletal dynamics (5 credits)
5BIO6	Neural signal analysis (5 credits)
5BIO7	Advanced medical imaging (5 credits)
5C1	Digital media systems (5 credits)
5C2	Wireless networks and communications (5 credits)
5C3	Statistical signal processing (5 credits)
5C4	Speech and audio engineering (5 credits)
5C5	Optical fibre communications (5 credits)
5C6	Digital control systems (5 credits)
5C7	Complex systems science (5 credits)
CS4501	Fuzzy logic (5 credits)
CS4521	Advanced computer architecture (5 credits)
CS4504	Formal verification (5 credits)
CS7NS6	Distributed systems (5 credits)
CS7NS2	Internet of things (5 credits)
CS7IS2	Artificial intelligence (5 credits)
CS7GV5	Real time animation (5 credits)
CS7IS5	Adaptive applications (5 credits)
CS7DS1	Data mining and analytics (5 credits)
CS7IS1	Knowledge and data engineering (5 credits)
CS7GV2	Mathematics of light and sound (5 credits)
CS7CS3	Advanced software engineering (5 credits)
CS7DS2	Optimisation algorithms for data analysis (5 credits)
CS7DS3	Applied statistical modelling (5 credits)
CS7DS4	Data visualisation (5 credits)
CS7IS3	Information retrieval and web search (5 credits)
CS7IS4	Text analytics (5 credits)
CS7GV3	Real-time rendering (5 credits)
CS7NS1	Scalable computing (5 credits)
CS7NS4	Urban computing (5 credits)
5MEMS1	Micro and precision manufacturing (5 credits)
5MEMS2	Advanced manufacturing I (5 credits)
5MEMS3	Supply chain management (5 credits)
5MEMS4	Operations strategy (5 credits)
5MEMS7	Risk management and safety assessment systems (5 credits)
7B09	Neural engineering (5 credits)
7B10	Implanted devices and systems (5 credits)
7B11	Neural signal analysis (5 credits)

Associated laboratory work, design projects and fieldwork, appropriate to the modules selected, will be provided.

#### *Examinations*

13 Students are examined in the work of each year. Students whose attendance or work is unsatisfactory in any year may be refused permission to take all or part of the annual examinations for that year. To gain a pass in the annual examinations of any year students must normally pass in all modules.

14 Supplemental examinations, where appropriate, are held each year at the beginning of Michaelmas term. During the first three years of the course, students who have failed the annual

examination may be permitted to take a supplemental examination.

15 To rise with their year, students must successfully complete the prescribed number of credits, subject to the variations as provided for by compensation requirements. To pass each of the first three years of the course, students must achieve an overall credit-weighted average mark of at least 40 per cent (grade III) and accumulate 60 credits by (a) passing all modules outright or (b) passing by compensation. To pass by compensation students must either pass outright modules totalling 55 credits and achieve a minimum mark of 30 per cent in the failed module, or pass outright modules totalling 50 credits and achieve a minimum mark of 35 per cent in any failed module(s). The designation of certain modules, or module components, as non-compensatable may reduce the level of compensation permitted in any year. Students, in years one to three of the course, who do not pass at the annual examination session, either outright or by compensation, must complete supplemental examinations in all modules in which they did not achieve a mark of at least 40 per cent (grade III) by taking assessment components, as required, during the supplemental examination period. Due to the nature of group work, failed group assignments cannot be re-assessed during the supplemental period, which means that a student may be required to repeat the year.

To pass the fourth year of the course students must achieve a credit-weighted average mark of at least 40 per cent and accumulate 60 credits by (a) passing all modules outright or (b) passing by compensation or aggregation. Whether passing by compensation or aggregation students must pass outright modules totalling at least 50 credits in addition to achieving a 40 per cent (grade III) credit-weighted average, or higher, for the year. There are no supplemental examinations in the fourth year.

16 Only students who are awarded a second class (second division) grade or better in their B.A.I. examinations along with an overall combined result of at least second class (second division) grade or better in both their third and fourth year annual examinations are eligible to proceed to the fifth year of the course. For the purposes of calculating eligibility to progress to the MAI and for calculating the contribution towards the BAI degree award, in the event that supplemental examinations are taken in the Junior Sophister year, all components contributing towards the overall supplemental mark will be capped at 40 per cent. Students are permitted one repeat of the fourth year to achieve the grade required to proceed to the fifth year of the course.

17 Students who do not obtain credit for the year owing to their failure to comply with the requirements under section I, §6 above, are not permitted to repeat the year except at the discretion of the Court of First Appeal. Students repeating any year do not retain credits gained in the previous year.

18 Students who have not passed in its entirety any examination within eighteen months from the date on which they first became eligible for it are reported to the University Council as unsatisfactory students, with a recommendation for their exclusion from the course.

19 Students are required to make a serious attempt at their examinations. Students who have not made a serious attempt at the examinations will normally be refused permission to take supplemental examinations or to repeat the year and will be recommended for exclusion.

20 Students who are absent from an examination, or examinations, must furnish the Senior Lecturer, through their tutor, with an acceptable reason for their absence. Students who have been absent from an examination and have not presented the Senior Lecturer with an appropriate explanation will normally be refused permission to take supplemental examinations or to repeat the year.

21 Successful candidates at the fourth year examinations are placed within three classes: first class honors, second class honors (with two divisions, first and second) and third class honors. Except by special recommendation of the court of examiners, honors are awarded on the results of a weighted combination of a student's annual third year examinations and their first attempt at the fourth year examinations, taken together but with the third year examinations not contributing more than 20 per cent to the combined mark.

Students who fail to pass their fourth year examination may present themselves for re-examination at the examination in the following year. Those students wishing to leave after successful completion of the fourth year must undertake a project or equivalent during the fourth year to be eligible for an honors B.A.I. degree.

22 Successful candidates at the M.A.I. examinations are awarded the degree of M.A.I. (St.) or of M.A.I. (St.) with distinction. Except by special recommendation of the court of examiners, the M.A.I. (St.) degree is awarded on the results of a student's annual fifth year M.A.I. examinations only. A distinction shall require at least 70 per cent in both the examinations and the dissertation and at least 70 per cent in the final credit-weighted average mark.

Students who fail to pass the M.A.I. degree examination of their year may present themselves for re-examination at the examination in the following year.

23 Exemption from these requirements may be granted in exceptional circumstances after written application has been made by the student to the Court of First Appeal.

#### *Conferring of degrees*

24 Students who exit the course having obtained credit for years one to four are entitled to the degrees of B.A. and B.A.I. Students admitted in 2016-17 onwards and who have obtained credit for all five years of the course are entitled to the degrees of B.A. and M.A.I. (St.). Students admitted prior to 2016-17 who have obtained credit for all five years of the course are entitled to be conferred with the degrees B.A., B.A.I. and M.A.I. (St.). The degrees in each instance must be conferred at the same Commencements.

Students who complete the third year by examination and who choose not to proceed to or fail to complete satisfactorily the fourth year of the engineering course may elect to be conferred with the ordinary degree of B.A.

Except by special permission of the University Council, on the recommendation of the Executive Committee of the School of Engineering, the ordinary degree of B.A. may normally be conferred only on candidates who have spent at least three years in the University.

#### DEGREES IN ENGINEERING WITH MANAGEMENT (B.Sc. (Ing.) and M.A.I. (St.))

25 Students complete a four-year course leading to a B.Sc. (Ing.) degree, and may elect to complete an additional year of study leading to a M.A.I. (St.) degree, see §16. There is provision for an abridgement of the course to three years, see section I, §5.

26 Following completion of the fourth year of the engineering with management degree course, eligible students may elect to complete one further year of study leading to a M.A.I. (St.) degree, see §16.

27 Students who successfully complete the third year of their engineering with management course in Trinity College Dublin and meet the selection criteria may enrol on the 'double diploma' programme run jointly with the Institut National des Sciences Appliquées (I.N.S.A.) de Lyon. Selected candidates are admitted to the third year of the engineering course in I.N.S.A. de Lyon and take modules amounting to 60 credits from relevant third and fourth year curricula. This academic year is recognised as being equivalent to the fourth/B.Sc. (Ing.) year and, on its successful completion, students return to Trinity College Dublin to satisfactorily complete the fifth year of the M.A.I. degree course. Such students are eligible to be awarded with the B.Sc. (Ing.) and M.A.I. (St.) degrees. Subsequent to this students proceed directly to the fifth year of the engineering course in I.N.S.A. de Lyon returning to the department of their option to take a set of approved modules amounting to 60 credits. Upon successful completion of this additional year, students are eligible to be conferred with the Diplôme d'Ingénieur de l'I.N.S.A. de Lyon.

A similar arrangement exists for engineering students of the I.N.S.A. de Lyon whereby suitably qualified candidates are admitted to the third year of the Trinity College Dublin engineering course and complete two years here taking modules from the engineering with management course. Following successful completion of these two years in Trinity College Dublin students are

eligible to be awarded the B.Sc. (Ing.) degree. Such students return to the department of their option in I.N.S.A. de Lyon to satisfactorily complete the fifth year of their home course and to receive the Diplôme d'Ingénieur de l'I.N.S.A. de Lyon.

28 A number of additional options to study abroad with approved partner institutions are available as an integrated part of the teaching programme for students following the M.A.I. course. These options may be taken in the fourth year and include Erasmus, UNITECH (as a paid industrial partnership) and CLUSTER. Full details of available options are available from the Course Director and the website.

29 Students are encouraged to gain relevant industrial experience during vacation periods. Formal project internships with approved industry partners may also be available as an integrated part of the teaching programme for students following the M.A.I. course. This option may be taken in the fourth year.

### *Syllabus*

#### **30 Year 1**

Students take mandatory modules amounting to 60 credits.

1MEMS1	Introduction to manufacturing (5 credits)
1MEMS4	Introduction to computing (5 credits)
ST1004	Introduction to management science (10 credits)
1E1	Engineering mathematics I (5 credits)
1E2	Engineering mathematics II (5 credits)
1E4	Physics (5 credits)
1E5	Chemistry (5 credits)
1E6	Electrical engineering (5 credits)
1E7	Mechanics (5 credits)
1E10	Engineering design II: project (10 credits)

Associated laboratory work and design projects, appropriate to the modules selected, will be provided.

#### **31 Year 2**

Students take mandatory modules amounting to 60 credits.

2MEMS2	Finance (5 credits)
2MEMS3	Design I (5 credits)
2MEMS4	Materials (5 credits)
2MEMS7	Manufacturing technology (5 credits)
2MEMS10	Manufacturing engineering design (10 credits)
2E1	Engineering mathematics III (5 credits)
2E2	Engineering mathematics IV (5 credits)
2E4	Solids and structures (5 credits)
2E5	Thermo-fluids (5 credits)
2E6	Electronics (5 credits)
2E11	Numerical methods (5 credits)

Associated laboratory work and design projects, appropriate to the modules selected, will be provided.

#### **32 Year 3**

Students take admissible combinations of modules amounting to 60 credits, including the following mandatory modules:

3B3	Mechanics of solids (5 credits)
3B4	Mechanical engineering materials (5 credits)
3E3	Probability and statistics (5 credits)

- 3MEMS1 Manufacturing technology II (5 credits)
- 3MEMS3 Design II (10 credits)
- ST3005 Information systems (5 credits)

and admissible combinations from the following:

- 3MEMS5 Operations and project management (5 credits)
- 3MEMS6 Communications and people management (5 credits)
- 3B1 Thermodynamics (5 credits)
- 3B2 Fluid mechanics (5 credits)
- 3B5 Mechanics of machines (5 credits)
- 3B6 Mechatronics (instrumentation and control) (5 credits)
- 3C1 Signals and systems (5 credits)
- 3BIO1 Anatomy and physiology (5 credits)
- 3BIO2 Biomedical design project (10 credits)
- ST3010 Applied forecasting (5 credits)

Associated laboratory work and design projects, appropriate to the modules selected, will be provided.

### 33 Year 4

Students take admissible combinations of modules amounting to 60 credits. Students follow one of three modes of study involving courses and project work in College (mode 1), a project-based internship (mode 2), or an international academic exchange (mode 3), comprising admissible combinations of the following:<sup>11</sup>

- 4MEMS1 Engineering project (15 credits)
- 4MEMS2 Advanced manufacturing (5 credits)
- 4MEMS3 Supply chain management (5 credits)
- 4MEMS4 Operations strategy (5 credits)
- 4MEMS5 Micro and precision manufacturing (5 credits)
- 4MEMS8 Research methods (5 credits)
- 4MEMS9 User centred design innovation (5 credits)
- 4E4 Engineering with management project internship (30 credits)
- 4E5 Innovation in product development (20 credits)
- 4E6 Robotic design (10 credits)
- 4A8 Transportation (5 credits)
- 4B1 Mechanics of solids (5 credits)
- 4B2 Forensic materials engineering (5 credits)
- 4B3 Thermodynamics (5 credits)
- 4B4 Heat transfer (5 credits)
- 4B7 Computer aided design (5 credits)
- 4B9 Control engineering 1 (5 credits)
- 4B10 Instrumentation and experimental techniques (5 credits)
- 4B11 Engineering vibrations (5 credits)
- 4B12 Acoustics (5 credits)
- 4B13 Fluid mechanics 2 (5 credits)
- 4B17 Multibody dynamics (5 credits)
- 4BIO1 Cell and molecular biology (5 credits)
- 4BIO5 Biomechanics (5 credits)
- 4BIO6 Biomaterials (5 credits)
- CS4052 Computer graphics (5 credits)
- CS4053 Computer vision (5 credits)
- ST2351 Probability and theoretical statistics I (10 credits)

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<sup>11</sup>The general regulations with respect to the timing of academic exchanges in final year apply.



ST2352	Probability and theoretical statistics II (10 credits)
ST3001	Software applications 3 (10 credits)
ST3011	Multivariate linear analysis (MLA) (5 credits)
ST4004	Management science in practice (10 credits)
ST4500	Strategic information systems (10 credits)
BU4580A	Managing new product development (10 credits)

Associated laboratory work and design projects, appropriate to the modules selected, will be provided.

### 34 Year 5

In the fifth year of the course all students complete mandatory and optional modules (35 credits) and a mandatory engineering research project (25 credits).

5E1	Engineering research project (25 credits)
5E2	Research methods (5 credits)
5E3	Innovation in product development (15 credits)
5E4	Introduction to computational fluid mechanics (5 credits)
5MEMS1	Micro and precision manufacturing (5 credits)
5MEMS3	Supply chain management (5 credits)
5MEMS7	Risk management and safety assessment systems (5 credits)
C1	Renewable energy I (5 credits)
C2	Renewable energy II (5 credits)
T1	Transportation (5 credits)
5B1	Flow induced vibration and fluid structure interaction (5 credits)
5B2	Advanced materials (5 credits)
5B3	Advanced thermal fluid sciences (5 credits)
5B4	Engineering vibration and noise (5 credits)
5B5	Human factors (5 credits)
5B9	Control engineering 2 (5 credits)
5B10	Instrumentation and experimental techniques (5 credits)
5BIO1	Medical devices (10 credits)
5BIO2	Advanced tissue mechanics and mechanobiology (5 credits)
5BIO3	Tissue engineering (5 credits)
5BIO4	Finite element analysis (5 credits)
5BIO5	Injury biomechanics and musculoskeletal dynamics (5 credits)
5BIO6	Neural signal analysis (5 credits)
5M1	Mechanics of solids (5 credits)
5M2	Forensic materials engineering (5 credits)
5M3	Thermodynamics (5 credits)
5M4	Heat transfer (5 credits)
5M5	Manufacturing technology (5 credits)
5M6	Manufacturing systems and project management (5 credits)
5M7	Computer aided design (5 credits)
5M9	Control engineering 1 (5 credits)
5M12	Acoustics (5 credits)
5M13	Fluid mechanics (5 credits)
5M15	Introduction to bioengineering (5 credits)
5M16	Biomechanics of tissues and implants (5 credits)
5M17	Multibody dynamics (5 credits)
CS7004	Embedded systems (5 credits)
CS7032	Artificial intelligence (5 credits)
ST3451	Applied linear statistical models I (5 credits)
ST3452	Applied linear statistical models II (5 credits)

ST3453	Stochastic models in space and time I (5 credits)
ST3454	Stochastic models in space and time II (5 credits)
ST3455	Modern statistical methods I (5 credits)
ST3456	Modern statistical methods II (5 credits)
ST3457	Statistical inference I (5 credits)
ST3458	Statistical inference II (5 credits)
ST4003	Data analytics (5 credits)

Associated laboratory work and design projects, appropriate to the modules selected, will be provided.

### *Examinations*

35 As §§13-20 above but with specific reference to the B.Sc. (Ing.) instead of the B.A.I. degree in §16.

36 Successful candidates at the B.Sc. (Ing.) degree examinations are placed within three classes: first class honors, second class honors (with two divisions, first and second) and third class honors. Except by special recommendation of the court of examiners, honors are awarded on the results of a weighted combination of a student's annual third year examinations and subsequent annual B.Sc. (Ing.) examinations, taken together but with the third year examinations not contributing more than 20 per cent to the combined mark.

Students who fail to pass the B.Sc. (Ing.) degree examination of their year may present themselves for re-examination at the examination in the following year. Students who successfully complete these examinations receive a result of pass.

37 Successful candidates at the M.A.I. examinations are awarded the degree of M.A.I. (St.) or of M.A.I. (St.) with distinction. Except by special recommendation of the court of examiners, the M.A.I. (St.) degree is awarded on the results of a student's annual fifth year M.A.I. examinations only. A distinction shall require at least 70 per cent in both the examinations and the dissertation and at least 70 per cent in the final credit-weighted average mark.

Students who fail to pass the M.A.I. degree examination of their year may present themselves for re-examination at the examination in the following year.

38 Exemption from these requirements may be granted in exceptional circumstances after written application has been made by the student to the Court of First Appeal.

### *Conferring of degrees*

39 Students who have obtained credit for years one to four are entitled to the degree of B.Sc. (Ing.). Students who have obtained credit for the fifth year are additionally entitled to the degree of M.A.I. (St.). All degrees must be conferred at the same Commencements.

Students who complete the third year by examination and who choose not to proceed to or fail to complete satisfactorily the fourth year of the engineering with management course may elect to be conferred with the ordinary degree of B.A.

Except by special permission of the University Council, on the recommendation of the Executive Committee of the School of Engineering, the ordinary degree of B.A. may normally be conferred only on candidates who have spent at least three years in the University.

## *IV SCHOOL OF MATHEMATICS*

1 The School of Mathematics offers a degree course in mathematics in which students can select, particularly in the Sophister years, combinations of modules chosen from various areas; these include pure mathematics, applied mathematics, theoretical physics, computing and statistics.

2 The School of Mathematics in conjunction with the [School of Physics](#) offers a degree course in theoretical physics. This is an integrated programme of study consisting of lectures and tutorials in mathematics and physics together with experimental work in physics.

3 Mathematics may also be studied as a component of a two-subject moderatorship course in combination with one of several other subjects.

#### *Fees*

4 See COLLEGE CHARGES.

#### *Rowe Fund Library*

5 Members of the Dublin University Mathematical Society have the use of a mathematical library in the society's rooms in addition to the College library.

### MODERATORSHIP IN MATHEMATICS

6 In each of the Fresh years students take modules providing a total of 60 credits with modules providing 30 credits taken in each teaching term in accordance with regulations published prior to the commencement of the academic year in the course handbook and on the website of the School of Mathematics. The majority of modules in the Fresh curriculum are mandatory.

In the Junior Fresh year students take mandatory modules in areas of calculus, real analysis, linear algebra, group theory, mechanics, statistics and computer programming. In the Senior Fresh year students take mandatory modules in areas of real and complex analysis, metric spaces, abstract algebra, differential equations and mathematical methods, together with optional modules provided in areas of pure mathematics, mechanics, probability and statistics. In each of the two teaching terms of the Senior Fresh year students may include in their choice of modules a module with 5 credits, subject to agreement, available from any school in College.

Modules offered by other schools are subject to the agreement of the school concerned and the course director for the moderatorship in mathematics. This understanding applies to the availability of modules offered by other schools to students in any year of the course.

Each of these modules is assessed by means of continuous assessment and/or papers set at the annual examination held in the Trinity term.

7 In the Junior Sophister year, students take modules providing a total of 60 credits. At most 10 credits should be accounted for by modules at the intermediate level (5 credits per term), with the remainder at advanced level. In addition to modules in statistics listed in §17 below, students may apply to the course director to take other modules provided by schools in College other than the School of Mathematics. Subject to the agreement of both schools concerned and prerequisites, modules with an appropriate mathematical content or significant relation to applications of mathematics may be taken (up to at most 20 credits, 10 per term). Modules which are not related to mathematics, Broad Curriculum or language modules, may also be taken (up to at most 10 credits, 5 per term) subject to agreement.

In the Senior Sophister year, students take modules at the advanced level providing a total of 60 credits, which must include a 10 credit project (module MA4492). In addition to modules in statistics listed in §17 below, and subject to the agreement of both schools concerned and prerequisites, students may take modules provided by schools in College other than the School of Mathematics with an appropriate mathematical content or significant relation to applications of mathematics (up to at most 20 credits, 10 per term). Projects in the Senior Sophister year (module MA4492) must be approved and undertaken in accordance with regulations established by the School of Mathematics. Projects should be completed and submitted three weeks before the end of Hilary term and subject to a subsequent poster presentation held before the end of Hilary term.

In all years students should make their choice of modules in accordance with the course requirements published by the School of Mathematics before the commencement of the

academic year. The Director of Teaching and Learning (Undergraduate) may permit certain module combinations that are not expressly provided for in these published course requirements, provided that the resulting choice of modules accords with the objectives of the moderatorship course. Certain combinations of modules may not be available due to timetabling constraints.

8 Results for examinations and assessments are published according to the following grades: I = 70-100, II<sub>1</sub> = 60-69, II<sub>2</sub> = 50-59, III = 40-49, F<sub>1</sub> = 30-39, F<sub>2</sub> = 0-29. In order to pass, a mark of at least 40 per cent is required.

To pass each of the Fresh years, students must achieve an overall credit-weighted average mark of at least 40 per cent (grade III) and accumulate 60 credits by (a) passing all modules outright or (b) passing by compensation. To pass by compensation students must either pass outright modules totalling 55 credits and achieve a minimum mark of 30 per cent in the failed module, or pass outright modules totalling 50 credits and achieve a minimum mark of 35 per cent in any failed module(s). Junior and Senior Fresh students who do not pass at the annual examination session, either outright or by compensation, must complete supplemental assessments in all modules in which they did not achieve a mark of at least 40 per cent (grade III) by taking such assessment components as required by the School of Mathematics during the supplemental examination period at the beginning of Michaelmas term.

To pass each of the Sophister years, students must achieve an overall credit-weighted average mark of at least 40 per cent (grade III) and accumulate 60 credits either by (a) passing all modules outright or (b) passing by compensation or aggregation. Whether passing by compensation or aggregation students must pass outright modules totalling at least 40 credits in addition to achieving a 40 per cent (grade III) credit-weighted average, or higher, for the year. Compensation will be permitted in modules totalling a maximum of 20 credits provided that a minimum mark of 30 per cent has been attained in any failed module(s). Further, passing by aggregation will be permitted if a mark of less than 30 per cent has been achieved in a module or modules carrying up to a maximum of 10 credits provided that a mark of at least 30 per cent has been achieved in any remaining failed module(s).

Students who pass the Junior Sophister annual examinations may have the ordinary B.A. degree conferred if they do not choose to proceed to the Senior Sophister year. Except by special permission of the University Council, the ordinary degree of B.A. may normally be conferred only on candidates who have spent three years in the University.

The examinations of the two Sophister years count equally towards the overall mark for moderatorship.

Students who fail to reach moderatorship standard in their Senior Sophister year will be awarded an ordinary B.A. degree.

#### *Mathematics, statistics and computing*

9 Students with a strong interest in studying statistics or computing from a mathematical point of view may do so within the moderatorship course in mathematics. In addition to modules in statistics provided expressly for the mathematics moderatorship, and also available to students of mathematics in the two-subject moderatorship, several other modules provided by the [School of Computer Science and Statistics](#) are open to mathematics students. Thus, students of mathematics have the option of choosing modules on a broad range of mathematical topics.

#### *Repetition of year in mathematics*

10 Students may apply for permission, or may be required, to repeat an academic year as provided under general College regulations. Students are not allowed to repeat a year if they have obtained an overall mark of 29 per cent or lower for the year.

### MODERATORSHIP IN THEORETICAL PHYSICS

11 In each of the Fresh years students must take modules providing a total of 60 credits in accordance with regulations published prior to the commencement of the academic year in the

course handbook and on the websites of the Schools of Mathematics and Physics. Modules are assessed by means of continuous assessment, laboratory work, and/or papers set at the annual examination held in the Trinity term.

In the Junior Fresh year students take 20 credits of physics modules covering material on waves and optics, special relativity, astronomy and astrophysics, statistics, electricity and magnetism, and quantum physics. Students also attend experimental/computational laboratory sessions and tutorials. In mathematics students take 40 credits of modules covering material in calculus, real analysis, linear algebra, mechanics, and computer programming.

In the Senior Fresh year students take physics modules for 20 credits involving lectures on thermodynamics, electricity and magnetism, materials, nuclear and particle physics, oscillations, chaos and complexity, and astronomy. Each of these modules includes practicals with set experiments, computational exercises and group study projects. In mathematics, students take modules for 40 credits on analytical mechanics, group theory, real and complex analysis, and mathematical methods.

12 In the Junior Sophister year, students take advanced level mathematics modules, including mandatory modules in quantum mechanics, classical electrodynamics and statistical physics, that together provide a total of 30 credits. In physics, students take modules totalling 30 credits including lectures on condensed matter physics, atomic and nuclear physics, a choice of either astrophysics or computational physics and a practical module of 10 credits including advanced experiments and a component covering communication skills and career development.

In the Senior Sophister year, students follow a similar course choosing from a range of advanced mathematics modules. In physics, students take mandatory modules on high energy physics, condensed matter theory, electron and photon physics, and problem solving, and can choose from optional modules covering nanoscience, cosmology, computer simulation and advanced topics in physics. Students must take at least 20 credits of modules in both physics and mathematics. The remaining 20 credits of modules consist of a 10 credit research project in either physics or mathematics and 10 credits which may be chosen from either or both subjects.

13 Results for examinations and assessments are published according to the following grades: I = 70-100, II<sub>1</sub> = 60-69, II<sub>2</sub> = 50-59, III = 40-49, F<sub>1</sub> = 30-39, F<sub>2</sub> = 0-29. In order to pass, a mark of at least 40 per cent is required.

To pass each of the Fresh years, students must achieve an overall credit-weighted average mark of at least 40 per cent (grade III) and accumulate 60 credits by (a) passing all modules outright or (b) passing by compensation. To pass by compensation students must either pass outright modules totalling 55 credits and achieve a minimum mark of 30 per cent in the failed module, or pass outright modules totalling 50 credits and achieve a minimum mark of 35 per cent in any failed module(s). Junior and Senior Fresh students who do not pass at the annual examination session, either outright or by compensation, must complete supplemental assessments in all modules in which they did not achieve a mark of at least 40 per cent (grade III) by taking such assessment components as required by the School of Mathematics and the School of Physics during the supplemental examination period at the beginning of Michaelmas term.

To pass each of the Sophister years, students must achieve an overall credit-weighted average mark of at least 40 per cent (grade III) and accumulate 60 credits either by (a) passing all modules outright or (b) passing by compensation or aggregation. Whether passing by compensation or aggregation students must pass outright modules totalling at least 40 credits in addition to achieving a 40 per cent (grade III) credit-weighted average for the year. Compensation will be permitted in modules totalling a maximum of 20 credits provided that a minimum mark of 30 per cent has been attained in any failed module(s). Further, passing by aggregation will be permitted if a mark of less than 30 per cent has been achieved in a module or modules carrying up to a maximum of 10 credits provided that a mark of at least 30 per cent has been achieved in any remaining failed module(s). There are no supplemental examinations in the Sophister years.

To qualify to proceed to moderatorship, Junior Sophister students must achieve an overall credit-weighted average mark of at least 45 per cent for the year. Students who achieve an overall mark of 35 per cent or higher, and do not qualify to proceed to moderatorship, can, as provided under general College regulations, repeat the Junior Sophister year in order to improve their performance.

Students who pass the Junior Sophister annual examinations may have the ordinary B.A. degree conferred if they do not choose, or are not allowed, to proceed to the Senior Sophister year. Except by special permission of the University Council, the ordinary degree of B.A. may normally be conferred only on candidates who have spent three years in the University.

The mark for moderatorship is based on the results of both Sophister years, weighted with 35 per cent allocated to the Junior Sophister modules and 65 per cent for the Senior Sophister modules.

Students who fail to reach moderatorship standard in their Senior Sophister year will be awarded an ordinary B.A. degree.

#### *Repetition of year in theoretical physics*

14 Students may apply for permission, or may be required, to repeat an academic year as provided under general College regulations. Students are not allowed to repeat a year if they have obtained an overall mark of 34 per cent or lower for the year.

#### *Transfer of course*

15 Students may apply through their tutor to transfer from the honor course in theoretical physics to the honor course in mathematics not later than the end of the Junior Sophister year.

Sophister students in theoretical physics may apply through their tutor to transfer to the honor course in physics (see COURSES IN SCIENCE, section V), not later than the beginning of the Senior Sophister year.

Each request to transfer is considered by the heads of school concerned, who then make recommendations to the Senior Lecturer. All transfers are subject to general College regulations (see GENERAL REGULATIONS AND INFORMATION).

### TWO-SUBJECT MODERATORSHIP COURSES

16 Students may combine mathematics with economics, philosophy, geography and a range of arts subjects in a two-subject moderatorship course. For details see TWO-SUBJECT MODERATORSHIP COURSES.

#### *Modules*

17 The principal prerequisites are indicated following the module names. Students lacking prerequisites for a module must obtain prior permission of the course director to take the module.

#### *Introductory level*

	PREREQUISITES
MA1111 Linear algebra I (5 credits)	
MA1212 Linear algebra II (5 credits)	MA1111
MA1213 Introduction to group theory (5 credits)	
MA1125 Single-variable calculus and introductory analysis (10 credits)	
MA1126 Introduction to set theory and general topology (5 credits)	MA1125
MA1132 Advanced calculus (5 credits)	
MA1241 Mechanics I (5 credits)	
MA1242 Mechanics II (5 credits)	MA1241
ST1251 Introduction to statistics I (5 credits)	

ST1252	Introduction to statistics II (5 credits)	ST1251
MA1264	Introduction to programming in C/C++ (5 credits)	
MA1282	Mathematical applications in economics (5 credits)	

*Intermediate level*

		PREREQUISITES
MA2314	Fields, rings and modules (5 credits)	MA1213
MA2316	Introduction to number theory (5 credits)	MA2314
MA2321	Analysis in several real variables (5 credits)	MA1212, MA1125, MA1132
MA2322	Calculus on manifolds (5 credits)	MA2321
MA2223	Metric spaces (5 credits)	MA1126
MA2224	Lebesgue integral (5 credits)	MA2223
MA2327	Ordinary differential equations (5 credits)	MA1212
MA2328	Complex analysis (5 credits)	MA1126 or MA2321
MA232A	Euclidean and non-Euclidean geometry (5 credits)	MA1132
MA2331	Equations of mathematical physics I (5 credits)	MA1132
MA2332	Equations of mathematical physics II (5 credits)	MA2331
MA2341	Advanced classical mechanics I (5 credits)	MA1242
MA2342	Advanced classical mechanics II (5 credits)	MA2341
ST2351	Probability and theoretical statistics I (5 credits)	ST1252
ST2352	Probability and theoretical statistics II (5 credits)	ST1252

*Advanced modules*

In any given year, the advanced modules available to students, and the constraints imposed on the choice of modules, are published by the [School of Mathematics](#) before the commencement of the academic year. The modules provided by the School of Mathematics will include a selection from the following list (and may also include modules not listed here):

		PREREQUISITES
MA3415	Introduction to Lie algebras (5 credits)	
MA3416	Group representations (5 credits)	
MA3419	Galois theory (5 credits)	
MA341D	Introduction to Gröbner bases (5 credits)	
MA3421	Functional analysis I (5 credits)	
MA3422	Functional analysis II (5 credits)	MA3421
MA3423	Topics in complex analysis I (5 credits)	MA2328
MA3424	Topics in complex analysis II (5 credits)	MA3423
MA3425	Partial differential equations I (5 credits)	
MA3426	Partial differential equations II (5 credits)	MA3425
MA3427	Algebraic topology I (5 credits)	
MA3428	Algebraic topology II (5 credits)	
MA3429	Differential geometry I (5 credits)	MA2322
MA342A	Harmonic analysis (5 credits)	
MA342H	Partial differential equations (methods and applications) (5 credits)	MA2327
MA342N	Ordinary differential equations (5 credits)	
MA342P	Elliptic curves (5 credits)	
MA3431	Classical field theory I (5 credits)	
MA3432	Classical field theory II (5 credits)	MA3431
MA3441	Quantum mechanics I (5 credits)	MA2342
MA3442	Quantum mechanics II (5 credits)	MA3441
MA3443	Statistical physics I (5 credits)	
MA3444	Statistical physics II (5 credits)	MA3443
MA4445	Quantum field theory I (5 credits)	MA3442, MA3444

MA4446	Quantum field theory II (5 credits)	MA4445
MA4448	General relativity (5 credits)	MA2342, MA3429, MA3432
MA444D	The standard model of elementary particle physics (5 credits)	MA3432, MA3442
MA3461	Computational geometry and computer graphics (5 credits)	
MA3463	Computation theory and logic I (5 credits)	
MA3464	Computation theory and logic II (5 credits)	MA3463
MA346F	Practical numerical simulations	
MA3484	Methods of mathematical economics (5 credits)	
MA3486	Fixed point theorems and economic equilibria (5 credits)	
MA4491	Research assignment (5 credits)	
MA4492	Project (10 credits) (This module is for Senior Sophister students only.)	

#### *Statistics modules*

The following advanced level modules are provided by the [School of Computer Science and Statistics](#).

	PREREQUISITES	
ST3451	Applied linear statistical models I (5 credits)	ST2352
ST3452	Applied linear statistical models II (5 credits)	ST3451
ST3453	Stochastic models in space and time I (5 credits)	ST2352
ST3454	Stochastic models in space and time II (5 credits)	ST3453
ST3455	Modern statistical methods I (5 credits)	ST2352
ST3456	Modern statistical methods II (5 credits)	ST3455
ST3457	Statistical inference I (5 credits)	ST2352
ST3458	Statistical inference II (5 credits)	ST3457

Additional modules on statistics and also modules on computer science provided by the School of Computer Science and Statistics are also available within the mathematics moderatorship and the mathematics component of the two-subject moderatorship.

### *V COURSES IN SCIENCE*

#### REGULATIONS<sup>12</sup>

##### *Fees*

1 See COLLEGE CHARGES.

#### MODERATORSHIP IN SCIENCE

2 The moderatorship in science is available in each of the following subjects:<sup>13</sup> biochemistry, chemistry, comparative biology<sup>14</sup>, environmental sciences, genetics, geography, geology, immunology, microbiology, molecular medicine, neuroscience, physics, physics and astrophysics, physiology, plant sciences and zoology.

3 Theoretical physics, taught jointly by the Schools of Mathematics and Physics, is available as a separate moderatorship degree course. See SCHOOL OF MATHEMATICS, section IV, §11.

4 Separate moderatorship courses are available in earth sciences (see §§27-29 below), human genetics (see §§30-35 below), chemistry with molecular modelling (see §§36-39 below), medicinal chemistry (see §§40-44 below), nanoscience, physics and chemistry of advanced

<sup>12</sup>These regulations should be read in conjunction with GENERAL FACULTY REGULATIONS and GENERAL REGULATIONS AND INFORMATION.

<sup>13</sup>For moderatorship in biochemistry, immunology, microbiology, molecular medicine, neuroscience and physiology for medical and dental students, see §10.

<sup>14</sup>Comparative biology will cease to be offered as a moderatorship option from 2017-18.



materials (see §§45-49 below) and political science and geography (see §50 below).

5 The Fresh modules are intended to provide both a training in general science and an introduction to the moderatorship subject. In the Junior Sophister year students will work primarily in the moderatorship subject but may take a selection of related modules offered by other schools or departments. All students wishing to proceed to moderatorship in any one of the subjects specified in §2 above are required to complete satisfactorily the Fresh modules in science except by decision of the Associate Dean of Undergraduate Science Education.<sup>15</sup>

The ECTS value of each year of the course is 60 credits.

6 All students admitted are given an opportunity to discuss their choice of subjects with their tutor or a member of the academic staff at the Junior Fresh orientation session and they are advised to visit their tutor before registration. Students may only proceed to the Sophister subjects for which the Junior and Senior Fresh modules selected are an adequate preparation. Junior Fresh students wishing to change their combination of modules must request the permission of the Associate Dean of Undergraduate Science Education not later than the end of the third week of Michaelmas teaching term.

7 Junior Fresh students must give notice to the Associate Dean of Undergraduate Science Education, not later than the end of Hilary term, of their choice of Senior Fresh modules for the forthcoming year.

8 Senior Fresh students must give notice to the Associate Dean of Undergraduate Science Education, not later than the end of Hilary term, of their choice of Junior Sophister subject(s) for the forthcoming year. Requests for transfer from the subjects notified after this date will only be considered in exceptional circumstances and if the necessary places are available.

9 Students should be aware that their choice of Junior and Senior Fresh subjects/modules can affect their choice of moderatorship.

#### *Moderatorship for dental and medical students*

10 Dental or medical students who have completed their Junior Sophister year may apply to the Associate Dean of Undergraduate Science Education for permission to take a moderatorship in biochemistry, immunology, microbiology, molecular medicine, neuroscience or physiology. All applications must be made by the last day of Hilary term. See SCHOOL OF DENTAL SCIENCE and SCHOOL OF MEDICINE.

#### *Attendance and course work*

11 Students must attend for appropriate academic instruction in each term of each academic year and must satisfy the head or heads of school or department concerned as to their academic progress in each term in order to proceed with their year; see GENERAL REGULATIONS AND INFORMATION. The faculty may from time to time draw up regulations determining the required attendance of students at the various forms of instruction.

#### *Field courses*

12 Students taking comparative biology, environmental sciences, geography, geology, plant sciences or zoology are required to attend field courses.

The charges for field courses are in addition to the normal annual College fees. The charges vary from year to year and between the different departments. Students intending to take a subject requiring attendance at field courses will be informed by the School concerned regarding the courses planned and the costs involved.

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<sup>15</sup>See also section I, §5 'Advanced entry'.

**Junior Freshers**

Students choose modules from the following to a total of 60 credits as appropriate (see Table I – MODERATORSHIP PREREQUISITES):

- BY1101 Molecular and cellular biology (10 credits)
- BY1102 Evolution, biodiversity and environment (10 credits)
- CH1101 General and physical chemistry (10 credits)
- CH1102 Introduction to systematic, inorganic and organic chemistry (10 credits)
- GG1024 Introduction to geography I: physical geography and earth system science (10 credits)
- GG1025 Introduction to geography II: environmental geography (10 credits)
- GL1101 Geology (10 credits)
- MA1S11 Mathematics – semester 1 (10 credits)
- MA1S12 Mathematics – semester 2 (10 credits)
- MA1M01 Mathematical methods (10 credits)
- PY1P10 Physics – semester 1 (10 credits)
- PY1P20 Physics – semester 2 (10 credits)
- PY1F01 Foundation physics for the life and earth sciences (10 credits)

**Senior Freshers**

Students choose modules from the following to a total of 60 credits as appropriate (see Table I – MODERATORSHIP PREREQUISITES):

- BY2201 Cell structure and function (5 credits)
- BY2202 Vertebrate form and function (5 credits)
- BY2203 Metabolism (5 credits)
- BY2204 Evolution (5 credits)
- BY2205 Microbiology (5 credits)
- BY2206 Ecosystem biology and global change (5 credits)
- BY2207 Behaviour (5 credits)
- BY2208 Genetics (5 credits)
- BY2209 Infection and immunity (5 credits)
- BY2210 Agriculture, environment and biotechnology (5 credits)
- CH2201 Chemistry 1 (10 credits)
- CH2202 Chemistry 2 (10 credits)
- GG2024 Physical geography – changing environments (10 credits)
- GG2025 Human geography – changing worlds (10 credits)
- GL2205 The dynamic Earth 1: rocks and evolution (10 credits)
- GL2206 The dynamic Earth 2: structure and microscopy (10 credits)
- MA22S1 Multivariable calculus for science (5 credits)
- MA22S2 Vector calculus for science (5 credits)
- MA22S3 Fourier analysis for science (5 credits)
- MA22S4 Mechanics (5 credits)
- MA22S6 Numerical and data analysis (5 credits)
- PY2P10 Classical physics (10 credits)
- PY2P20 Modern physics (10 credits)

**Junior Sophisters**

One moderatorship subject is selected from the following to a total of 60 credits:

- Biochemistry
- Chemistry
- Environmental sciences
- Genetics

Geography  
 Geology  
 Immunology  
 Microbiology  
 Molecular medicine  
 Neuroscience  
 Physics  
 Physics and astrophysics  
 Physiology  
 Plant sciences  
 Zoology

14 Each moderatorship subject requires the satisfactory completion of certain Junior Fresh and Senior Fresh modules (see Table I). The specific combinations chosen by individual students will depend upon personal subject preference, moderatorship aspirations and school academic background (see also §17).

15 **TABLE I — MODERATORSHIP PREREQUISITES**

<b>Moderatorship</b>	<b>Senior Fresh</b>	<b>Junior Fresh</b>
Biochemistry <sup>16</sup>	BY2201, BY2203, BY2205, BY2208	CH1101, CH1102, MA1S11 or MA1M01
Chemistry	CH2201, CH2202	CH1101, CH1102, MA1S11 or MA1M01
Environmental sciences	Four of the following: BY2201, BY2202, BY2203, BY2204, BY2205, BY2206, BY2207, BY2208, BY2209, BY2010	BY1101, BY1102
Genetics	BY2201, BY2203, BY2205, BY2208	BY1101, CH1101, CH1102, MA1S11 or MA1M01
Geography	GG2024, GG2025	GG1024 and/or GG1025
Geology	GL2205, GL2206	GL1101
Immunology <sup>16</sup>	BY2201, BY2203, BY2205, BY2208	CH1101, CH1102, MA1S11 or MA1M01
Microbiology	BY2201, BY2203, BY2205, BY2208	BY1101, CH1101, CH1102, MA1S11 or MA1M01
Molecular medicine <sup>16</sup>	BY2201, BY2203, BY2205, BY2208	CH1101, CH1102, MA1S11 or MA1M01
Neuroscience <sup>17</sup>	BY2201, BY2202, BY2203, BY2208	CH1101, CH1102, MA1S11 or MA1M01
Physics	PY2P10, PY2P20, MA22S1, MA22S2, MA22S3, MA22S4	PY1P10, PY1P20, MA1S11, MA1S12
Physics and astrophysics	PY2P10, PY2P20, MA22S1, MA22S2, MA22S3, MA22S4	PY1P10, PY1P20, MA1S11, MA1S12

<sup>16</sup>Junior Fresh BY1101 is advisable.

<sup>17</sup>Junior Fresh BY1101 and BY1102 are advisable.

Physiology <sup>17</sup>	BY2201, BY2202, BY2203, BY2208	MA1S11 or MA1M01
Plant sciences	Four of the following: BY2201, BY2202, BY2203, BY2204, BY2205, BY2206, BY2207, BY2208, BY2209, BY2010	BY1101 or BY1102
Zoology	BY2201, BY2202, BY2203, BY2208	BY1101, BY1102, MA1S11 or MA1M01

16 After the publication of Senior Fresh examination results each year, all successful students are offered moderatorship places. Admission to each moderatorship may be limited by a quota established annually by reference to the teaching resources available to each school or department. To be qualified for a given moderatorship, students must have completed satisfactorily both Fresh years and must have read the stated prerequisite modules as set out in Table I for any moderatorship for which they wish to be considered. Students who have not completed the prerequisites for a given moderatorship may still be considered for that moderatorship if places are available.

17 Advice on how to choose appropriate Fresh module combinations for the various moderatorships is given in the document 'Science TR071, Junior Fresh programme 2017-18' and on the [science course website](#).

#### *Annual examinations*

18 Students must sit their annual examinations, which are held in the Trinity term, and must complete all other assessment components, as required. Junior and Senior Fresh students who have failed in the annual examinations must take a supplemental examination at the beginning of Michaelmas term. An expanded form of the following regulations giving further details of compensation requirements and other matters is available on request at the [Science Course Office](#).

19 To gain a pass in each of the Fresh years, students must achieve an overall credit-weighted average mark of at least 40 per cent (grade III) and accumulate 60 credits by (a) passing all modules outright or (b) passing by compensation. To pass by compensation students must either pass outright modules totalling 55 credits and achieve a minimum mark of 30 per cent in the failed module, or pass outright modules totalling 50 credits and achieve a minimum mark of 35 per cent in any failed module(s). Junior and Senior Fresh students who do not pass at the annual examination session, either outright or by compensation, must complete supplemental assessments in all modules in which they did not achieve a mark of at least 40 per cent (grade III) by taking such assessment components, as required, during the supplemental examination period at the beginning of Michaelmas term.

Students who do not qualify to rise with their year and whose overall average mark is 35 per cent or higher, either in the annual or the supplemental examination can, as provided under general College regulations, repeat their year in order to improve their performance.

20 To pass the Sophister years, students must achieve an overall credit-weighted average mark of at least 40 per cent (grade III) and accumulate 60 credits either by (a) passing all modules outright or (b) passing by compensation or aggregation. Whether passing by compensation or aggregation students must pass outright modules totalling at least 40 credits in addition to achieving a 40 per cent (grade III) credit-weighted average, or higher, for the year. Compensation will be permitted in modules totalling a maximum of 20 credits provided that a minimum mark of 30 per cent has been attained in any failed module(s). Further, passing by aggregation will be permitted if a mark of less than 30 per cent has been achieved in a module or modules carrying up to a maximum of 10 credits provided that a mark of at least 30 per cent has

been achieved in any remaining failed module(s). The designation of certain modules, or module components, as non-compensatable may reduce the level of compensation or aggregation permitted in either Sophister year. There are no supplemental examinations in the Sophister years.

To qualify to proceed to the Senior Sophister year, students sitting the Junior Sophister examination must achieve an overall credit-weighted average mark of 45 per cent or higher in the overall examination.

Students who achieve an overall mark of 35 per cent or higher, but who do not qualify to proceed to moderatorship, can, as provided under general College regulations, repeat the Junior Sophister year in order to improve their performance.

21 Students whose overall mark is 34 per cent or lower in their annual examinations and supplemental examinations (if applicable) are not permitted to repeat their year and must withdraw from science.

#### *Ordinary degree of B.A.*

22 Students who pass the Junior Sophister annual examinations may have the ordinary B.A. degree conferred if they do not choose, or are not allowed, to proceed to the Senior Sophister year. Students who fail the Senior Sophister year will be awarded the ordinary B.A. degree. Except by special permission of the University Council, on the recommendation of the Science Course Director, the ordinary degree of B.A. may normally be conferred only on candidates who have spent at least three years in the University.

#### *Moderatorship examination*

23 The Junior and Senior Sophister examinations constitute part I and part II of the moderatorship examination. There are no supplemental examinations. Students unavoidably absent from the moderatorship examination in their final year may apply to the Senior Lecturer to present themselves for the moderatorship examination in the following year. If students are permitted by the Senior Lecturer to do so, without having to repeat lectures or classes, they must give notice by consulting with their school, department/discipline or course office before the end of Michaelmas term to confirm their examination and/or assessment requirements while off-books.

24 Various forms of teaching and learning are a feature of the Sophister years and formal lectures will not necessarily be given in every term.

25 The scheme of distribution of marks between papers and practical work at the moderatorship examination will be published by individual schools or departments/disciplines.

26 The final moderatorship result is calculated by aggregating the Junior and Senior Sophister examination results as per Table II.

**TABLE II — CALCULATION OF MODERATORSHIP RESULTS**

<b>Moderatorship</b>	
Biochemistry	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Chemistry	Junior Sophister 35 per cent, Senior Sophister 65 per cent
Comparative biology	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Environmental sciences	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Genetics	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Geography	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Geology	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Immunology	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Microbiology	Junior Sophister 20 per cent, Senior Sophister 80 per cent

Molecular medicine	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Neuroscience	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Physics	Junior Sophister 35 per cent, Senior Sophister 65 per cent
Physics and astrophysics	Junior Sophister 35 per cent, Senior Sophister 65 per cent
Physiology	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Plant sciences	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Zoology	Junior Sophister 20 per cent, Senior Sophister 80 per cent

### *Subjects/modules*

## Junior Freshers

### BIOLOGY

Two 10 credit modules are offered in biology which together provide students with a broad based training in the fundamentals of modern biology. They offer a comprehensive introduction to molecular and cellular biology; genetics; developmental biology; the biology of microorganisms; animal and plant diversity, form and function; and ecology. A practical skills programme supports both modules.

BY1101 Introduction to molecular and cellular biology

BY1102 Evolution, biodiversity and environment

### CHEMISTRY

The modules provide a general introduction to the fundamentals of modern chemistry, and form the basis for further studies, both in chemistry and in other sciences. There are two chemistry modules: CH1101 (general and physical chemistry; 10 credits) and CH1102 (introduction to systematic inorganic and organic chemistry; 10 credits). CH1101 includes stoichiometry, atomic structure, principles of bonding, the periodic table and periodicity, solid state chemistry, important chemical reactions, gas laws, thermodynamics, solutions, acid-base equilibria, kinetics and electrochemistry. CH1102 deals with aspects of main-group and coordination chemistry, and of aliphatic and aromatic functional group organic chemistry. CH1101 is a prerequisite for CH1102.

### GEOGRAPHY

Students must have taken GG1024 or GG1025 to take Senior Fresh geography. Two 10 credit modules in geography are offered in the Junior Fresh year: GG1024 introduction to geography I (physical geography and earth system science) and GG1025 introduction to geography II (environmental geography). Students may take either or both of these modules.

Introduction to geography I (physical geography and earth system science) includes a consideration of the overall setting of planet Earth within the solar system and its tectonics; global atmospheric and oceanic processes, climate change, surface processes of landscape development; Irish landscapes and soil development. The module is examined by a combination of written examination and course work.

The introduction to geography II (environmental geography) module will introduce key concepts relating to nature, culture and environment, and interactions between humans and their environment, using case studies from the fields of conservation, environmental degradation and environmental hazards. The module is examined by a combination of written examination and course work.

### GEOLOGY

The geology module involves a series of lectures which explore the origin and evolution of the Earth, the organisms that live on it and the resources that it provides. Linked to the lectures are a

series of tutorials which give 'hands-on' experience of rocks, minerals and fossils. Progress is assessed by multiple choice theory tests and tutorial assignments and by an end of year examination.

#### MATHEMATICS

The mathematics modules MA1S11 and MA1S12 provide a basic mathematical training suitable for all branches of science. Topics covered include calculus; partial derivatives; linear algebra; introduction to differential equations; introduction to computing; introduction to probability and statistics; sample applications to scientific problems.

#### MATHEMATICAL METHODS

(For students not reading mathematics as above)

This module MA1M01 consists of (a) an introduction to computing and (b) a foundation in mathematics including the following topics: simple arithmetical and algebraic manipulations; functions; graphs; differentiation, emphasising its geometric interpretation; maxima and minima; integration; simple differential equations; matrices and linear equations.

#### PHYSICS

Tuition will consist of lectures, practicals and tutorials in physics at introductory level. The semester 1 module PY1P10 includes lectures on mechanics, waves and optics, and statistics. The semester 2 module PY1P20 includes lectures on electricity and magnetism, quantum physics, and astronomy and astrophysics. Each of these 10 credit modules includes practicals with set experiments and computational exercises. This tuition may only be taken by students reading Junior Fresh mathematics modules MA1S11 and MA1S12.

#### FOUNDATION PHYSICS FOR THE LIFE AND EARTH SCIENCES

Tuition is given in a single 10 credit module, PY1F01, in semester 2 and will consist of lectures, practicals and tutorials in physics at introductory level, adapted for students wishing to progress to a moderatorship in the earth or life sciences. Lectures are given on physics of motion, biomechanics, physics of hearing and seeing, electricity and magnetism and bioelectricity, radioactivity, nuclear physics and related medical applications, heat, pressure and fluids and their biological, geological and medical applications. Practical include set experiments. This tuition may only be taken by students reading Junior Fresh mathematical methods or mathematics and may not be taken by students taking PY1P10 and PY1P20.

### Senior Freshers

#### BIOLOGY

Ten 5 credit modules are offered in biology which build on the material covered in the Junior Fresh year and provide a foundation for advanced studies in the Sophister life sciences subjects. Students may select up to eight of these modules, as appropriate.

- BY2201 Cell structure and function
- BY2202 Vertebrate form and function
- BY2203 Metabolism (prerequisite BY2201)
- BY2204 Evolution
- BY2205 Microbiology
- BY2206 Ecosystem biology and global change
- BY2207 Behaviour
- BY2208 Genetics
- BY2209 Infection and immunity (prerequisites BY2201, BY2205)
- BY2210 Agriculture, environment and biotechnology

## CHEMISTRY

The modules provide a broad intermediate level overview of modern chemistry, and form the basis for further studies at Sophister level, both in chemistry and in other sciences. There are two 10 credit chemistry modules: CH2201 and CH2202. Lectures are complemented by laboratory work. In addition, students will participate in a team-based activity that will involve a research and presentation exercise on some aspect of chemistry. The modules include core material in physical, inorganic and organic chemistry, and elements of computational, materials and biological/medicinal chemistry.

## GEOGRAPHY

Students must take two 10 credit geography modules in the Senior Fresh year. Building on knowledge acquired in the Junior Fresh year, topics covered at Senior Fresh level within the context of a changing earth include investigations of the atmosphere and oceans; earth surface form and processes; distributions of species and development, including its environmental aspects. Learning and research skills are also developed in the Senior Fresh year through a module dealing with a number of key issues within contemporary human geography which exposes them to a range of methodological approaches and research techniques. Practical and fieldwork skills are also developed during the Senior Fresh year.

## GEOLOGY

The two 10 credit Senior Fresh geology modules provide a foundation of knowledge about the Earth for further studies at Sophister level, in geology and other sciences. The modules reinforce the concept of a dynamic Earth and consist of lectures and practical work as well as field excursions. An array of expertise will be acquired, including palaeontology, mineralogy, and petrography. Students will be equipped with the skills to describe and interpret minerals and rocks, extract information from geological maps, and will get hands-on experience with polarised light microscopy. In addition, an overnight field excursion is held in first semester and a residential field course is held in second semester. These field courses are very strongly recommended for prospective geology Sophister students.

## MATHEMATICS

These modules are a continuation of the topics introduced in Junior Fresh mathematics modules MA1S11 and MA1S12. Modules MA22S1 and MA22S3 are offered in the Michaelmas term, with modules MA22S2, MA22S4 and MA22S6 in the Hilary term. MA22S4 and MA22S6 cannot be taken simultaneously.

MA22S1 Multivariable calculus for science (5 credits, prerequisites MA1S11, MA1S12)

Vector-valued functions; functions of several variables; line integrals; multiple integrals

MA22S2 Vector calculus for science (5 credits, prerequisites MA1S11, MA1S12, MA22S1, MA22S3)

Surface integrals, theorems of Green, Gauss and Stokes; partial differential equations

MA22S3 Fourier analysis for science (5 credits, prerequisites MA1S11, MA1S12)

Linear algebra; Fourier series; ordinary differential equations; special functions

MA22S4 Mechanics (5 credits, prerequisites MA1S11, MA1S12, MA22S1, MA22S3)

Motion under a central force; work and energy; rotating frames; Lagrangian mechanics

MA22S6 Numerical and data analysis (5 credits, prerequisites MA1M01 or MA1S11)

Numerical linear algebra; mathematical statistics; biological applications

## PHYSICS

Tuition will consist of lectures, practicals and tutorials in physics at intermediate level. The module PY2P10 (classical physics) includes lectures on oscillations, materials, electricity and magnetism, and thermodynamics. The module PY2P20 (modern physics) includes lectures on special relativity, nuclear and particle physics, waves and optics, and astronomy. Each of these



10 credit modules include practicals with set experiments, computational exercises and group study projects. This tuition may only be taken by students taking the mathematics modules: MA22S1, MA22S2, MA22S3 and MA22S4.

### **Sophister courses**

Sophister courses in science are organised so that students follow a continuous programme of study over two years leading to a moderatorship in a particular subject. Students will be required to take modules carrying sixty credits in each year.

A '*Sophister course programme*' is published annually and is available to students in Hilary term each year from the [Science Course Office](#).

#### BIOCHEMISTRY

Biochemistry is a moderatorship course offered by the [School of Biochemistry and Immunology](#). The focus is on understanding how living cells function at a molecular and cellular level. It encompasses a wide range of topics such as cancer biology, stem cell biology, immunology, neurobiology, developmental biology and drug discovery. The Junior Sophister year consists of a varied programme of lectures, practicals, tutorials and a literature review on a chosen topic. In the Senior Sophister year, students undertake a dissertation and spend a number of weeks in one of the research laboratories in the new Biomedical Sciences Institute where they conduct state-of-the-art research in areas such as cancer, obesity, aging, neurobiology, nutrition, parasitology and biotechnology. Modules are updated regularly and lecture content summaries are published annually. The School of Biochemistry and Immunology has formed extensive links through the ERASMUS, TEMPUS and other European Union programmes which offer opportunities for students to spend a period of their course, usually in the third year, studying in a university in the United Kingdom, Western or Eastern Europe. Assistance and advice in future careers is also offered.

#### CHEMISTRY

Junior Sophisters take modules in organic, inorganic, physical, analytical and biological/polymer chemistry. Further topics, including computational and medicinal chemistry may be provided in an option module. The modules provided cover topics such as organic mechanisms and synthetic methods, heterocyclics, organometallic C-C couplings, pericyclic reactions, organoheteroatom chemistry, physical organic chemistry, retrosynthesis, bio-organic chemistry including natural products, amino acids and peptides, organic and inorganic polymers, group theory, spectroscopy and other physical methods, quantum chemistry and statistical mechanics, advanced thermodynamics and kinetics, coordination chemistry, solid state chemistry, structural inorganic chemistry and related characterisation techniques, properties of soft matter, bio-inorganic chemistry, organometallics, catalysis and surface chemistry, electrochemistry, analytical chemistry, metal compounds in the environment, drug design and clusters. Lectures are complemented by practical classes in inorganic, organic, physical and computational chemistry; advanced preparative methods and instrumental techniques, including computer-controlled equipment are introduced.

In the Senior Sophister year the core modules take some of these topics to a more advanced level. A wide range of optional topics is provided including interdisciplinary topics. A list of topics available in any year can be provided by the school. The practical component in the Senior Sophister year is an extended research project during the Michaelmas term, which may be carried out in an advanced industrial laboratory or in an approved academic laboratory in another country. Students are also required to carry out course work, which may include one or more essays, written communications, seminars, or oral and poster presentations.

## COMPARATIVE BIOLOGY<sup>18</sup>

Comparative Biology is run jointly by staff from Botany and Zoology disciplines in the [School of Natural Sciences](#) with additional input from Genetics and Neuroscience. The course focuses on the comparative physiology of organisms in the context of their evolutionary histories. It is a research led subject integrating the research interests of staff in the School of Natural Sciences primarily within the molecular and comparative physiology interdisciplinary research activity. The course is built around specific themes including: perception, movement, energy, and structure (in the context of evolution). Modules focus on the comparative physiological mechanisms by which animals and plants have evolved and respond to both their internal and external environments. The course concentrates on comparing important physiological phenomena across both animal and plant species, thereby identifying key principles that could not be revealed by the study of individual model organisms alone. Junior Sophister modules comprise tutorials: current issues in functional biology; comparative physiology; plant physiology; plant molecular biology; developmental biology; parasitology; experimental design and analysis; neurogenetics/*Drosophila*; eukaryotic molecular biology; special essay (functional biology and society) and Broad Curriculum. Senior Sophister modules comprise the research project; research comprehension; plant molecular genetics; plant developmental genetics; neurodevelopment and *Drosophila* and a choice of advanced modules in developmental biology, parasitology, eyes and vision and plant tutorials.

## ENVIRONMENTAL SCIENCES

Environmental sciences is a multidisciplinary subject which focuses on understanding and mitigating the impact of human populations on natural systems and processes. This requires the integration of physical and life sciences, engineering, economics and social sciences. The moderatorship course at Trinity College Dublin adopts this multidisciplinary ethos. The course is delivered through the collaboration of all disciplines in the [School of Natural Sciences](#) (Botany, Geography, Geology, and Zoology), the [School of Engineering](#) and participating disciplines through the Broad Curriculum syllabus. Teaching is research led with students in the final year carrying out an extensive research project. Courses in the Junior and Senior Sophister years consist of lectures, seminars and practical classes in the broad areas of ecology, environmental governance, analytical chemistry, hydrology, conservation and wildlife management and geographical information systems. Emphasis in the moderatorship is on the student acquiring laboratory and field skills. Field study is a core component of the environmental sciences programme. The course includes two field courses in the Junior Sophister (third) year based in Ireland, with two additional optional courses on offer that take place in the Canary Islands (for Junior Sophisters) and Kenya (for Senior Sophisters).

## GENETICS

The teaching and research activities of the Genetics Department are in the areas of molecular, human, population and quantitative genetics and evolution. The Junior Sophister modules are designed to prepare for, and to introduce, advanced material from these and other related areas of genetics. Central genetics modules cover the basic processes of inheritance and gene expression, and genome structure and evolution, in man and other animals, plants, bacteria and viruses. The modules in molecular genetics depend heavily on the theory and techniques of genetic engineering while those in molecular evolution, population and quantitative genetics introduce students to computing and computer programming. The department arranges for Junior Sophister students to spend part of the long vacation working in genetics research laboratories abroad, usually in the United States, supported by the American Ireland Fund.

The Senior Sophister course allows students to choose modules relevant to their interests. All carry out a research project in association with one of the research groups in the department. There is a wide choice from molecular evolution, plant and animal development, human genetics

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<sup>18</sup>Comparative biology will cease to be offered as a moderatorship option from 2017-18.

and molecular genetics. The possible combinations and emphases are according to the aims of the students; the department believes that maximum realisation of aptitudes is primarily determined by motivation.

About 75 per cent of genetics graduates go on to study for higher degrees and careers in research. The course is designed so that a student who will not necessarily seek a research career will have attained experience in widely useful techniques which lead to interesting careers. For example those in molecular genetics would know many biochemical, bacterial, virological and genetic engineering techniques, while those in population or quantitative genetics would be competent computer programmers, familiar with a wide range of applied genetics as well as basic genetics. Students who take modules related to human genetics will have particular knowledge of medical genetics, the genetic basis of cancer (oncogenetics), diagnostic genetics and genetic counselling.

#### GEOGRAPHY

Geography in the two Sophister years constitutes a progressive course that builds on work covered in earlier years, the aim being to produce graduates who, while having a firm grounding in geography, are also equipped with a range of subject-specific and transferable skills. Sophister years students in geography may take up to 20 credits over the course of two years of non-geography modules. This may include Broad Curriculum cross-faculty modules or language modules which are worth 5 credits each. The Junior Sophister year comprises some compulsory core modules (see the current Geography Undergraduate Course Handbook for information) and optional core modules covering various aspects of human, environmental and physical geography. Students may be required to undertake fieldwork as part of the advanced research methods module. Opportunities exist for Junior Sophister students to spend all or part of the year in a European university under the ERASMUS scheme. In the Senior Sophister year students must undertake a dissertation which is assessed as part of the final examination and is an important feature of the degree. A satisfactory research proposal must be devised during the Junior Sophister year, with the final dissertation being submitted towards the end of the first semester of the Senior Sophister year. Core optional modules in the Senior Sophister year cover topics such as environmental change, environmental conflicts, historical geography, geomorphology, development, urban and economic geography. Choices in any particular year may be limited by the availability of staff and timetable constraints.

Assessment is by a combination of work carried out during the year and by end of year examinations held in Trinity term. Details of examinations in the Fresh and Sophister years are available from the Geography website and course handbook; methods and the breakdown of assessments vary from module to module. Modules are assessed through a variety of means, including essays, group and individual project work, on-line assessments, oral presentations and written examinations, subject to §20 under TWO-SUBJECT MODERATORSHIP COURSES.

#### GEOLOGY

Modern geology is a dynamic science, which, in its broadest sense, aims at understanding the solid Earth, its interaction with the oceans and the atmosphere as well as the mineral and energy resources that provide for modern, highly developed society. The moderatorship prepares students for the many career opportunities in geology and provides training in both transferable and subject specific skills.

The Junior Sophister year consists of modules involving lectures and practical work that introduce the major branches and skills of the geological sciences. This includes in-depth training with the polarising light microscope and skills to interpret a variety of geological data. Junior Sophister students attend at least two major field classes away from Dublin, during which students learn the craft of geological mapping and data acquisition.

Senior Sophister students attend a set of core modules in geology that further deepen the understanding in the most critical aspects of geological interpretation. They also choose from a range of optional modules, some of which may be delivered by other schools or departments.

Training of field skills is deepened with additional field classes. Senior Sophisters undertake an independent project which is the subject of their dissertation.

Students wishing to read geology are very strongly recommended to attend the residential field courses in Senior Fresh year.

#### IMMUNOLOGY

Students may opt to take a moderatorship in immunology offered by the [School of Biochemistry and Immunology](#). The immunology modules in the Junior Sophister year are core concepts in immunology, and immunology and disease (including bacterial, viral and parasitic diseases, autoimmune diseases, allergy and asthma, cancer and transplantation). In the Junior Sophister year there are also immunology practicals, tutorials and exercises, as well as some modules in microbiology. There is the possibility of a summer internship in research laboratories worldwide and some of our students have the opportunity to study abroad for a year as part of the ERASMUS scheme. In the Senior Sophister year, students carry out an immunology research project based in one of the independent research laboratories within the school. Modules are updated regularly and lecture content summaries are published annually. Lectures in immunology in the final year include viral evasion strategies, cytokine signalling, clinical immunology, neuroimmunology, vaccines and innate and adaptive immunity in disease. Other topics covered include apoptosis and cancer. Assistance and advice in future careers is offered.

#### MICROBIOLOGY

Microbiology is the branch of biological science that deals with microorganisms – bacteria, protozoa, fungi (moulds and yeasts), and viruses. Microbiology is central to modern biomedical science, the agri-food industry and to studies of the environment. It is also an emerging force in bioenergy and systems biology. Students are given an introduction to the microbial sciences in their Fresh microbiology modules before specialising in microbiology in the Sophister years. The Junior and Senior Sophister modules comprise lectures, laboratory practical classes, tutorials, seminars and research essays in three broad areas of microbiology over two years – (i) microbial pathogenicity, (ii) molecular and cellular microbiology, and (iii) applied and environmental microbiology. Junior Sophister students also take additional teaching in genetics, biochemistry and immunology. Many students are placed in laboratories in Ireland or abroad between Junior and Senior Sophister years in order to develop laboratory skills and give exposure to research. In the Senior Sophister year, the year's work is divided between three compulsory (core) topics under these headings and 8-9 optional specialist topics from which students normally choose four. Topics covered in depth include: prokaryotic and eukaryotic genome structure; regulation of gene expression in prokaryotes and eukaryotes; DNA and RNA structure; cell surface structure; interactions of bacterial, viral, protozoal and fungal pathogens with their hosts; virology and cancer; design and development of antimicrobial drugs; vaccinology; clinical microbiology; applied aspects of microbiology, including biotechnology; current national and international legislation and standards relating to microbiology. Senior Sophister students join one of the research groups in microbiology where they carry out their own research project. A degree in microbiology provides an outstanding education in the areas of biomedical science and molecular and cellular biology for a range of employment in hospital laboratories, public health laboratories, biotech. and pharmaceutical industries, food, dairy and brewing industries, scientific civil service, water industry, education, publishing, technical sales, services and marketing, and management. Many microbiology graduates go on to earn higher (including doctoral) degrees leading to research careers in universities, research institutes or industry.

#### MOLECULAR MEDICINE

Molecular medicine is a moderatorship run jointly by the [School of Biochemistry and Immunology](#) and the [School of Medicine](#). This option has been introduced to recognise the revolutionary advances in disease diagnosis, therapy and prevention brought about by bio-molecular research and aims to demonstrate how basic science is translated into clinical

treatment. In the Junior Sophister year students are introduced to core aspects of biochemistry (protein chemistry, membrane and cell biology, eukaryotic gene structure and expression, immunology) and varied topics related to molecular medicine (diagnostics and therapeutics, drug absorption and metabolism and clinical aspects of cancer and infection). In the Junior Sophister year there are also practicals, tutorials and a mini-review of the literature on a chosen topic. In the Senior Sophister year students will be required to choose a research project in either of the schools. Lectures in the Senior Sophister year are divided equally between St James's Hospital and the main campus. Topics include innate and adaptive immunity, immunodeficiency, autoimmunity and inflammation, neuroscience and endocrinology, microbial diseases, molecular haematology and oncology, diagnostics and therapeutics, cell cycle and cancer. Assistance and advice in future careers is offered.

#### NEUROSCIENCE

Neuroscience is a discipline devoted to the scientific study of the nervous system in health and disease, and is at the interface between neurobiology and cognitive science. It includes study of the nature and functioning of the nervous system at all levels, from the molecules that make up individual nerve cells, to the complexities of how behaviour, thoughts and emotions are produced. Neuroscience is a multidisciplinary area of investigation that makes use of a variety of methods and investigations from a wide range of traditional disciplines. Consequently the Junior and Senior Sophister neuroscience curricula are comprised of relevant modules contributed by schools in the Faculties of Health Sciences, Engineering, Mathematics and Science, and Arts, Humanities and Social Sciences. In addition to taking specialist modules in neuroscience, students will gain valuable experience in skills that are important for a general scientific training such as data handling, biostatistics, experimental design, computing, scientific writing, oral communication skills, and critical analysis of scientific papers. An important component of the Senior Sophister year is a major research project that will be carried out in one of the several neuroscience research groups across campus, including those contributing to the Trinity College Institute of Neuroscience. The research project will be preceded by a literature review and will lead to a dissertation. The goal of this degree is to provide students with a well-balanced and integrated knowledge of neuroscience, and to highlight the progress and intellectual challenges in this discipline.

#### PHYSICS

Tuition will consist of lectures, practical work, tutorials and seminars in advanced physics as follows:

Junior Sophister modules of 5 credits each include PY3P01 quantum mechanics I, PY3P02 electromagnetic interactions I, PY3P03 condensed matter I, PY3P04 condensed matter II, PY3P05 atomic and nuclear physics, PY3P06 dynamical systems, PY3P07 experimental techniques, with a choice of either PY3C01 computer simulation I or PY3A03 stellar and galactic structure. The PY3PP1 practical module of 20 credits combines set experiments of an advanced nature with a component of communication skills and career development.

Senior Sophister modules of 5 credits each include PY4P01 quantum mechanics II, PY4P02 high energy physics, PY4P03 condensed matter III, PY4P04 nanoscience, PY4P05 electromagnetic interactions II, PY4P06 modern optics, PY4P07 advanced topics in physics. The PY4PP1 practical module of 25 credits combines a component of problem-solving and an extended research project.

#### PHYSICS AND ASTROPHYSICS

Tuition will consist of lectures, practical work, tutorials and seminars in advanced physics, with emphasis on astrophysics as follows:

Junior Sophister modules of 5 credits each include PY3P01 quantum mechanics I, PY3P02 electromagnetic interactions I, PY3P03 condensed matter I, PY3P05 atomic and nuclear physics, PY3C01 computer simulation I, PY3A03 stellar and galactic structure, PY3A06 statistical

thermodynamics and astrophysical spectroscopy, PY3A07 experimental techniques for astrophysics. The PY3AP1 practical module of 20 credits combines general set experiments of an advanced nature, a component of communication skills and career development, and specialist computer training.

Senior Sophister modules of 5 credits each include PY4P01 quantum mechanics II, PY4P02 high energy physics, PY4P05 electromagnetic interactions II, PY4P06 modern optics, PY4C01 computer simulation III, PY4A03 planetary and space science, PY4A05 cosmology. The PY4AP1 practical module of 25 credits combines a component of problem-solving and an extended research project in physics or astrophysics.

#### PHYSIOLOGY

Physiology is the study of how cells work, how they co-operate in organs like the heart or brain and how the operation of these organs is integrated. The moderatorship in physiology provides students with an in-depth understanding of mammalian body function from the molecular level to that of the whole organism, with especial emphasis on human physiology in health and disease.

To be eligible to enter the physiology moderatorship, students must have successfully completed the prerequisite Senior Fresh modules, which provide an introduction to the nervous (brain and spinal cord), cardiovascular (blood circulation), respiratory (lungs), gastrointestinal (digestion), excretory (kidneys) and endocrine (hormones) systems, as well as fundamentals of biochemistry and genetics. The Sophister years build on this introduction to provide a detailed functional understanding of cells and of organ systems, together with training in scientific methodology, experimental design and data analysis. Areas of physiology which reflect major research interests of the department include cell physiology, neuroscience and exercise physiology.

During the second half of the Senior Sophister year, each student undertakes an individual research project preceded by a literature survey and resulting in a written dissertation. These projects may be based within the department or with an associated research group within one of the affiliated teaching hospitals. Assessment in the Sophister course is by a combination of in-course evaluation and formal examination. Final assessment at the end of the Senior Sophister year includes *viva voce* examination by an external examiner.

Further details of the structure of the Sophister years and research options and information on typical career opportunities for physiology graduates are available on the website <http://www.medicine.tcd.ie/Physiology/>.

#### PLANT SCIENCES<sup>19</sup>

Teaching in plant sciences is research led and focuses on the areas of ecology, systematics and conservation and whole plant physiology. Extensive use is made of the notable departmental herbarium and the College Botanic Garden. In the Junior Sophister year, subject to resources being available, one of the field courses will take place in the Canary Islands. The moderatorship aims to produce graduates equipped with a range of subject-specific and transferable skills. The Sophister years use a mixture of lectures, tutorials, seminars given by visiting speakers and practical classes, including fieldwork, to deliver an integrated, up-to-date course in plant biology. This includes, in the Senior Sophister year, the production of a dissertation based on a research project.

Junior Sophisters take modules in plant physiology, plant diversity and systematics, environmental dynamics, fundamentals of ecology, soil science, economic botany, statistics and experimental design, plant molecular biology, as well as attending workshops and tutorials, two field courses and ecology and evolution seminars. There is a strong practical element in most of the modules. In the Junior Sophister year students may choose a Broad Curriculum module or an entomology module.

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<sup>19</sup>Prior to 2011-12 this Sophister option was called botany.

Senior Sophisters take a mix of mandatory and optional modules in plant-environment interactions, plant community ecology, plant conservation and biodiversity, data analysis, plant-animal interactions, global environmental change and vegetation description and analysis, as well as attending workshops and tutorials and ecology and evolution seminars. A research project is carried out under the supervision of one of the academic staff and forms a key element of the honors degree. Senior Sophister students also have the opportunity to take a limited number of Sophister modules offered by other schools and disciplines, including the tropical field trip to Kenya organised by the Department of Zoology.

Normally, a mixture of continuous assessment and examinations are used to assess the modules and in most modules, practical notebooks and prescribed exercises form part of the assessment.

#### ZOOLOGY

Zoology offers Sophister students training in many areas of the biology of animal systems emphasising particularly those aspects that relate to ecology, conservation and wildlife biology, parasitology, marine biology, developmental biology and behaviour. The Junior Sophister course highlights the major concerns of modern zoology and introduces the student to the full range of zoological interests, from the evolutionary origins of biodiversity and ecological system services to the genetic basis of development in embryos. The student is introduced to a wide range of analytical and censusing techniques and to the latest data handling methods. The modules examine the relationship between the form and function of various animal groups, their cell biology, physiology, ecology, parasitology and behaviour. A module on data handling introduces students to modern analytical approaches. Residential marine and terrestrial field courses consolidate this learning in the field, allow direct experience of quantitative habitat assessment and management methods, and facilitate interaction with the living environment.

The Senior Sophister course is largely tutorial-taught. Senior Sophister students choose advanced modules from topics across the range of zoology. They can pursue personal interests by selecting a series of special subject tutorials from the fields of evolution, wildlife biology, ecology, developmental biology and parasitology. They can also elect to go on a field course in Kenya in place of one of these tutorial modules. In addition they complete a research project on a topic selected to coincide with their interests, which makes up a significant part of the Senior Sophister year.

#### MODERATORSHIP IN EARTH SCIENCES

27 The direct entry moderatorship course in earth sciences (TR077) mainly comprises modules drawn from the existing moderatorships in geography and in geology. The course also includes a number of Fresh modules from the science (TR071) course in addition to several bespoke modules tailored for earth sciences students. Students in their Senior Fresh year select one module (5 credits) from the Broad Curriculum cross-faculty modules or language modules.

28 The course differs from the moderatorships in geography and geology in its tailored combination of modules that blend the traditional disciplines of geology and physical geography with an array of other physical, chemical and biological sciences to address key issues regarding the functioning of the Earth. The degree is awarded under the regulations of the science course. Students apply specifically to the course TR077 Earth sciences on the C.A.O. form.

29 The earth sciences moderatorship aims to produce graduates with a broad and holistic knowledge of the planet Earth. It emphasises the interconnected nature of the geosphere (rocks and sediments), the hydrosphere (lakes, oceans and ice), the atmosphere (weather and climate) and the biosphere (plants and animals). It seeks to develop an understanding of the processes operating today and in the past, and how this knowledge can inform us about the future.

## *Modules*

### **Junior Freshers**

Earth sciences students take introductory modules in geography, geology, physics, chemistry and mathematical methods.

### **Senior Freshers**

Earth sciences students take a prescribed programme of foundation modules in physical and human geography, geology and physics. In addition, students undertake a module in geochemistry and participate in a field course. Students are also required to take a single 5 credit module from the Broad Curriculum/language modules.

### **Junior Sophisters**

Earth sciences students take selected modules from the geography and geology courses in addition to a dedicated research methods module.

### **Senior Sophisters**

The final earth sciences degree mark will be composed of 20 per cent from the Junior Sophister year and 80 per cent from the Senior Sophister year. Earth sciences students select 40 credits of modules from the final year courses in geography and geology. In addition, they conduct a significant individual research project (15 credits) and participate in an overseas field course (5 credits).

## **MODERATORSHIP IN HUMAN GENETICS**

30 The moderatorship course in human genetics (TR073) provides students with a strong foundation in biology, mathematics and chemistry, an introduction to major fields of genetics and specialised modules in human genetics.

31 The course differs from the moderatorship in genetics in the obligation to study a particular combination of modules in the four year course and the concentration on human genetics. The degree is awarded under the regulations of the science course. Students apply specifically to the course TR073 Human genetics on the C.A.O. form.

32 Human genetics is a rapidly growing discipline within the subject of genetics. The field has acquired a distinctive body of knowledge and theory and experimental procedures and is presenting major challenges in both research and teaching. It has been revolutionised by the techniques of recombinant DNA (genetic engineering, molecular cloning, genome sequencing, microsatellite markers, polymerase chain reaction, transgenic animals, etc.), and the data emerging from the Human Genome Project. The subject has been stimulated by the explosion in knowledge of medical genetics, especially the molecular basis of many inherited disorders; the explanation of cancer as an acquired genetic disease; the study of molecular evolution (which is telling much about the evolution of man); the study of the history and geography of human genes (linking genetics, anthropology and linguistics), and of ancient DNA (linking genetics and archaeology); the application of DNA fingerprinting to forensic science, and decisions about suitability for employment and insurance (linking genetics to law and business). Substantial problems in ethics have been raised as a result of the studies in human genetics.

33 A tutorial programme in association with relevant College schools and departments and outside authorities where appropriate, extending over the Fresh years of the course, will introduce students to consideration of the philosophical, ethical, social and psychological issues arising from human genetics as well as scientific topics.

34 A student who has taken the specified modules in biology, chemistry and mathematics in the Fresh years in the main science course (TR071) may apply to transfer at the beginning of the Junior Sophister year to the course in human genetics (TR073). Conversely, a student of human



genetics (TR073) may apply to transfer at the beginning of the Junior Sophister year to the TR071 course. Applicants will be assessed on the basis of their qualifications at entry, as well as on their academic record in College, and any transfer will be subject to the availability of places.

35 Students must meet the general requirements of the science course in order to rise with their year.

#### *Modules*

##### **Junior Freshers**

Specified modules in biology, chemistry, mathematics, human genetics tutorials

##### **Senior Freshers**

Specified modules from biology, mathematics (introducing students to mathematical problems in biology), chemistry, human genetics tutorials.

##### **Junior Sophisters**

Foundation modules on recombinant DNA, molecular evolution, population genetics, quantitative genetics, bioinformatics, computer programming for genetics, statistics, mutation, DNA replication, gene expression etc. plus a series of modules in other subjects (e.g. neuroscience and development) related to genetics.

##### **Senior Sophisters**

Students take a set of modules in specific aspects of human genetics (e.g. genetics of neural development, neuropsychiatric genetics, cancer genetics, developmental genetics, human evolutionary genetics, genetics of transgenic animals and gene therapy, immunogenetics, genetic diversity, gene expression in higher organisms, prions), carry out a research project and write a review on topics in human genetics. The final human genetics degree mark will be composed of 20 per cent from the Junior Sophister year and 80 per cent from the Senior Sophister year.

#### **MODERATORSHIP IN CHEMISTRY WITH MOLECULAR MODELLING**

36 The moderatorship in chemistry with molecular modelling (TR074) allows students to obtain a core chemistry degree while specialising in the theoretical and applied aspects of molecular modelling, from materials chemistry to computational drug design.

37 The degree is awarded under the regulations of the science course, and prospective students will normally apply specifically to the course TR074 Chemistry with molecular modelling on the C.A.O. form.

38 A student taking the main course in science (TR071) may apply to transfer to the course in chemistry with molecular modelling (TR074). Conversely, a student of chemistry with molecular modelling (TR074) may apply to transfer to the science (TR071) course. Applications will be assessed on the basis of students' qualifications at entry, as well as their academic record in College, and any transfer will be subject to the availability of places.

39 Students must meet the general requirements of the science course in order to rise with their year.

#### *Modules*

##### **Junior Freshers**

Chemistry modules CH1101 and CH1102, mathematics modules MA1S11 and MA1S12 and either physics modules PY1P10 and PY1P20 or biology modules BY1101 and BY1102.

In addition, special lectures will be given on molecular modelling.

## Senior Freshers

Chemistry modules CH2201 and CH2202, mathematics modules MA22S1, MA22S2 and MA22S3 and either physics modules PY2P10, PY2P20 and mathematics module MA22S4 or biology modules BY2201, BY2203, BY2205, BY2208 and mathematics module MA22S6.

In addition, there will be special lectures on molecular modelling as well as laboratories on computational molecular modelling.

## Junior Sophisters

The core chemistry modules will be taken along with specialist molecular modelling modules and laboratory work. These latter elements will include topics such as computer programming, numerical methods (optimisation and molecular dynamics) and applications, including solid state chemistry and protein structure. In each case lectures will be accompanied by tutorials and molecular-modelling practical classes.

## Senior Sophisters

In addition to core chemistry moderatorship modules, specialist molecular-modelling modules that expand upon topics introduced in the Junior Sophister year will be taken. These will include advanced modules in molecular dynamics, and optimisation and applications including computational drug design and materials chemistry. The practical element of the Senior Sophister year is an extended research project during the Michaelmas term, which may be carried out within the [School of Chemistry](#) or in an industrial laboratory or an approved academic laboratory in another country. This project must be related to molecular modelling. Students are also required to make presentations, which may include one or more essays, seminars and posters during the year. The final chemistry with molecular modelling degree mark will be composed of 35 per cent from the Junior Sophister year and 65 per cent from the Senior Sophister year.

## MODERATORSHIP IN MEDICINAL CHEMISTRY

40 The moderatorship in medicinal chemistry (TR075) is especially attuned to the development of the creative talent needed by the major enterprise that is the modern pharmaceutical industry, one of the largest and fastest-growing business sectors in the modern world. The medicinal chemistry degree provides a sound general grounding in chemistry but focuses on, and extends into, topics of relevance to the design, synthesis and biological evaluation of new medicinal compounds.

41 The degree is awarded under the regulations of the science course, and prospective students will normally apply specifically to the course TR075 Medicinal chemistry on the C.A.O. form. In certain cases it may be possible for students to transfer from the TR071 science course, as detailed below.

42 A student taking the main chemistry course in science (TR071) may apply to transfer to the course in medicinal chemistry (TR075). Conversely, a student of medicinal chemistry (TR075) may apply to transfer to the TR071 course. Applicants will be assessed on the basis of their qualifications at entry, as well as on their academic record in College, and any transfer will be subject to the availability of places.

43 The medicinal chemistry course for the Fresh years will follow that of the TR071 chemistry course, although additional special sessions will be held for the medicinal chemistry group, involving an introduction to the ideas and techniques of medicinal chemistry. In the Sophister years students will study the more specialised aspects of medicinal chemistry along with modules shared with the TR071 course.

44 Students must meet the general requirements of the science course in order to rise with their year.

### Junior Freshers

Medicinal chemistry students will take TR071 chemistry modules CH1101 and CH1102, biology modules BY1101 and BY1102 and mathematics modules MA1S11 and MA1S12. In addition, they will attend special medicinal chemistry tutorials.

### Senior Freshers

Medicinal chemistry students will take TR071 chemistry modules CH2201 and CH2202, biology modules BY2201, BY2203, BY2205 and BY2208, and the remaining 20 credits from the biology modules BY2202, BY2204, BY2206, BY2207, BY2209, BY2210 or the mathematics modules MA22S1, MA22S2, MA22S3, MA22S4 and MA22S6.

### Junior Sophisters

Medicinal chemistry students will share organic chemistry modules with TR071 students, and will also share some relevant inorganic and physical, analytical and biological/polymer modules. In addition, students will take modules on the principles of medicinal chemistry, pharmacology, microbiology, biochemistry and industrial chemistry. Practical work will cover synthetic organic, inorganic, computational and physical chemistry.

### Senior Sophisters

Medicinal chemistry students will take prescribed organic chemistry units in conjunction with TR071's Senior Sophister chemistry students. In addition, they will take specialised modules in the cardiovascular system and the central nervous system, computational medicinal chemistry, case studies (including influenza treatments and selective COX inhibitors), site-specific drug delivery, combinatorial chemistry and analytical methods. Practical work will consist of a research project, which will be undertaken during Michaelmas term. This will be carried out either in the [School of Chemistry](#) in Trinity College, under the supervision of a member of staff or, alternatively, may be carried out in a university chemistry department overseas, or in the laboratories of an industrial concern. The final medicinal chemistry degree mark will be composed of 35 per cent from the Junior Sophister year and 65 per cent from the Senior Sophister year.

## MODERATORSHIP IN NANOSCIENCE, PHYSICS AND CHEMISTRY OF ADVANCED MATERIALS<sup>20</sup>

45 The moderatorship course in nanoscience, physics and chemistry of advanced materials (TR076) allows students to specialise in nanoscience at an advanced level during their undergraduate careers due to the combination of modules and practical experience offered by the Schools of Physics and Chemistry.

46 The course shares many lectures with those given for the moderatorships in chemistry and in physics, and also provides some specialist advanced nanoscience and materials modules with a specifically tailored practical module that emphasises nanoscience. The degree is awarded under the regulations of the science course. Students apply specifically to the course TR076 Nanoscience, physics and chemistry of advanced materials on the C.A.O. form.

47 Nanotechnology is being used to develop smaller and more powerful electronic devices, lasers and other photonic devices, medical diagnostics and materials with new properties. The interdisciplinary nature of the moderatorship in nanoscience, physics and chemistry of advanced materials gives graduates a broad scientific education that is ideal for careers in the nano- and information-technology sectors as well as an excellent starting point for higher degrees in nanomaterials research.

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<sup>20</sup>Prior to 2011-12 this course was called the Moderatorship in Physics and Chemistry of Advanced Materials.

48 A student who has taken mathematics, chemistry and physics in the Fresh years in science (TR071) may apply to transfer to the course in nanoscience, physics and chemistry of advanced materials (TR076). Conversely, a student on the course in nanoscience, physics and chemistry of advanced materials (TR076) may apply to transfer to the TR071 course. Applicants will be assessed on the basis of their qualifications at entry, as well as on their academic record in College, and any transfer will be subject to the availability of places.

49 Students must meet the general requirements of the science course in order to rise with their year.

### *Modules*

#### **Junior Freshers**

Chemistry modules CH1101 and CH1102, mathematics modules MA1S11 and MA1S12 and physics modules PY1N10 and PY1N20. In addition, special tutorials/seminars in nanoscience and advanced materials will be given.

#### **Senior Freshers**

Chemistry modules CH2201 and CH2202, mathematics modules MA22S1, MA22S2, MA22S3 and MA22S4 and physics modules PY2N10, PY2N20. In addition, special tutorials/seminars will be given in nanoscience and advanced materials.

#### **Junior Sophisters**

The Junior Sophister year consists of nine modules, with lectures on topics such as solid state physics and chemistry, quantum mechanics, lasers, thermodynamics, electrochemistry, macromolecules, spectroscopy, group theory, materials preparation, and microelectronic technology. The practical module in the Junior Sophister year introduces students to a wide range of characterisation methods, including those required in nanoscience, and incorporates a component of communication skills and career development.

#### **Senior Sophisters**

The Senior Sophister year comprises seven modules of 5 credits each. It concentrates on specific topics, including more advanced solid state physics and chemistry, non-linear optics, materials for electronic and optoelectronic devices, conducting and insulating polymers and metal oxides, superconductivity, surface and interface effects, computer simulation and advanced growth techniques. The practical component (25 credits) of the Senior Sophister year consists of an extended research project during the Michaelmas term, frequently carried out in an advanced industrial laboratory. In addition, the practical component includes a problem-solving module, which will develop a student's problem-solving techniques in physics and chemistry. The final physics and chemistry of advanced materials degree mark will be composed of 35 per cent from the Junior Sophister year and 65 per cent from the Senior Sophister year.

### **MODERATORSHIP IN POLITICAL SCIENCE AND GEOGRAPHY**

50 For details see FACULTY OF ARTS, HUMANITIES AND SOCIAL SCIENCES.

### **BACHELOR IN SCIENCE (HUMAN HEALTH AND DISEASE)**

51 For details see FACULTY OF HEALTH SCIENCES.

### ***VI THE STATISTICS AND OPERATIONS RESEARCH LABORATORY***

1 The Statistics and Operations Research Laboratory undertakes the analysis and execution of research projects for departments of the College and also for outside institutions. The laboratory was established to assist in the dissemination and application of statistical and operations research techniques in Ireland.

2 The statistical work of the laboratory is concerned primarily with the collection, analysis and interpretation of data. The tasks of data collection involve statistical problems of design and sampling and computer techniques of data handling. The operations research side of the laboratory's work involves the construction of mathematical models of the particular organisation under investigation. The systems studied are as diverse as breweries, hospitals, airlines and manufacturing industry.

3 The resources of the laboratory are available for use by staff and students from other College departments. It is strongly advisable to seek statistical advice at the initial stage of a project before embarking on the fieldwork.