

Faculty of Engineering, Mathematics and Science

I GENERAL FACULTY REGULATIONS¹

Degrees

1 The faculty provides courses leading to the following degrees:

(a) **COMPUTER SCIENCE AND STATISTICS**

Bachelor in Arts (Moderatorships in Business and Computing, in Computer Science, Linguistics and a 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.),² Bachelor in Science (Information Systems) (B.Sc. (Syst. Inf.)) (evening course), see II below; Master in Science (M.Sc.), see PART 2 OF THE CALENDAR — GRADUATE STUDIES AND HIGHER DEGREES. The degree of M.Sc. (St.) will be conferred upon students who successfully complete taught Master in Science programmes.

(b) **ENGINEERING SCIENCE**

Bachelor in Arts (B.A.), see section III, §2 below,³ Bachelor in Engineering (B.A.I.) and Master in Engineering (Studies) (M.A.I. (St.)),⁴ Bachelor in Science (Engineering) (B.Sc. (Ing.)) and Master in Engineering (Studies) (M.A.I. (St.))⁴ in Engineering with Management, see III below; Master in Engineering (Research) (M.A.I. (Ind.)),⁴ Master in Science (M.Sc.) and Master in Philosophy (M.Phil.) in Music and Media Technologies, see PART 2 OF THE CALENDAR — GRADUATE STUDIES AND HIGHER DEGREES. The degree of M.Sc. (St.) will be conferred upon students who successfully complete taught Master in Science programmes.

(c) **MATHEMATICS⁵**

Bachelor in Arts (Moderatorships in Mathematics, and in Theoretical Physics (B.A. with honors)), Bachelor in Arts (Ordinary B.A. degree), see IV below; Master in Science (M.Sc.) in High Performance Computing, see PART 2 OF THE CALENDAR — GRADUATE STUDIES AND HIGHER DEGREES. The degree of M.Sc. (St.) will be conferred upon students who successfully complete taught Master in Science programmes.

(d) **SCIENCE⁵**

Bachelor in Arts (Moderatorships in Science (in one of the following subjects: biochemistry with cell biology, biochemistry with structural biology, chemistry, environmental sciences, functional biology – the comparative physiology of organisms, 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; Master in Science (M.Sc.) in Biodiversity and Conservation, in Environment and Development, in Environmental Sciences, see PART 2 OF THE CALENDAR — GRADUATE STUDIES AND HIGHER DEGREES. The degree of M.Sc. (St.) will be conferred upon students who successfully complete taught Master in Science programmes. A master's course in development practice which is

¹These regulations should be read in conjunction with GENERAL REGULATIONS AND INFORMATION.

²The award title of Master in Computer Science (M.C.S.) is subject to the approval of the University Senate.

³The practice of awarding the concurrent degree of ordinary B.A. is under review.

⁴The award titles of Master in Engineering (Studies) (M.A.I. (St.)) and Master in Engineering (Research) (M.A.I. (Ind.)) are subject to the approval of the University Senate.

⁵For details of geography or mathematics in combination with other subjects, see TWO-SUBJECT MODERATORSHIP COURSES.

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conducted jointly with University College Dublin is also offered, see PART 2 OF THE CALENDAR — GRADUATE STUDIES AND HIGHER DEGREES.

The degrees of M.Litt., M.Sc. and Ph.D. may be awarded on the basis of research. For regulations see PART 2 OF THE CALENDAR — GRADUATE STUDIES AND HIGHER DEGREES. The degree of M.Sc. (Ind.) will be conferred upon students who successfully complete the Master in Science research programmes.

Diplomas

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

The following postgraduate diploma courses are available: applied building repair and conservation; computers for engineers; computing with advanced interdisciplinary outlook; computing (conversion) with interdisciplinary outlook; construction law and contract administration; environmental engineering; fire safety practice (buildings and other structures); health and safety in construction; highway and geotechnical engineering; music and media technologies; physical planning; project management; specialised technology; statistics, see PART 2 OF THE CALENDAR — GRADUATE STUDIES AND HIGHER DEGREES.

Admission

3 Applications for admission from E.U. applicants to the courses for these degrees (except for the evening B.Sc. degree in Information Systems and for higher degrees) should be made to the Central Applications Office (C.A.O.), Tower House, Eglinton Street, Galway. Applicants are referred to the C.A.O. handbook for details of application dates and procedures. Applications for admission from non-E.U. applicants should be made to the International Office, Trinity College, Dublin 2 by 1 February of year of proposed entry.

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.

Abridgement of course

5 Where places are available students may be permitted to abridge 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 course director, 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 permission to abridge any course should be made through the Admissions Office in the first instance.

Academic progress

6 To 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.

Repetition of year

7 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. Students have the right to appeal to the relevant court of first appeal.

Transfer of course

8 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.

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Foundation scholarship

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

Gold medals and prizes

10 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 <http://www.tcd.ie/vpcao/administration/examinations/criteria-for-gold-medal.php>).

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 (under review) is awarded to each candidate obtaining an overall first class honors grade in an honor or professional course. These prizes are not awarded in the Senior Sophister year.

These prizes, which are issued in the form of vouchers, can be exchanged by the student at designated booksellers. Book prizes are issued by the Examinations Office and are posted to recipient students at their home address.

II COURSES IN COMPUTER SCIENCE AND STATISTICS

Fees

1 See COLLEGE CHARGES.

MODERATORSHIP IN BUSINESS AND COMPUTING

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 information systems design 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.

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, or are not allowed, 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

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School of Computer Science and Statistics and the School of Business, the ordinary degree of B.A. may be conferred only on candidates who have spent at least three years in the University.

Syllabus

6 Junior Freshmen

Students must take three mandatory business modules:

- BU1510 Introduction to organisation and management (10 credits)
- EC1040 Introduction to economic policy (10 credits)
- ST1002 Statistical analysis I (5 credits)

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

- CS1001 Mathematics I (5 credits)
- CS1002 Mathematics II (5 credits)
- CS1011 Introduction to programming I (5 credits)
- CS1012 Introduction to programming II (5 credits)
- CS1013 Programming project I (5 credits)
- CS1021 Introduction to computing I (5 credits)
- CS1BC1 Business computing systems I (5 credits)

7 Senior Freshmen

Students will be required to take the following mandatory business modules:

- BU2511a Organisational behaviour (5 credits)
- BU2511b Principles of marketing (5 credits)
- BU2520a Introduction to accounting (5 credits)
- BU2520b Financial analysis (5 credits)
- BU2541a Introduction to finance (5 credits)
- BU2541b Introduction to operations management (5 credits)

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

- CS2011 Programming techniques I (5 credits)
- CS2012 Programming techniques II (5 credits)
- CS2013 Programming project II (5 credits)
- CS2041 Information management I (5 credits)

and a choice of either:

- CS2014 Systems programming I (5 credits) and
- CS2015 Systems programming II (5 credits)
- or
- CS2BC1 Systems analysis and design I (5 credits) and
- CS2BC2 Systems analysis and design II (5 credits)

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

- BU3510 Marketing management (10 credits)
- BU3530 Financial and management accounting (10 credits)
- BU3541 Applied finance (10 credits)
- BU3550 Organisation theory and change (10 credits)
- BU3560 Operations management: theory and practice (10 credits)
- BU3570 Human resource management (10 credits)
- BU3590 Business in society (10 credits)

COMPUTER SCIENCE MODULES

- ST2004 Applied probability I (5 credits)
- CS2031 Telecommunications II (5 credits)
- CS3011 Symbolic programming (5 credits)
- CS3012 Software engineering (5 credits)
- CS3013 Software engineering group project (5 credits)
- CS3014 Concurrent systems I (5 credits)
- CS3015 Concurrent systems II (5 credits)
- CS3016 Introduction to functional programming (5 credits)
- CS3017 Introduction to semantics of programming languages (5 credits)
- CS3041 Information management II (5 credits)
- CS3051 Visual computing (5 credits)
- CS3061 Artificial intelligence I (5 credits)
- CS3071 Compiler design I (5 credits)
- CS3BC1 e-Business I (5 credits)
- CS3BC2* e-Business II (5 credits)

*Students are required to have completed CS3BC1 in order to study this module.

9 Senior Sophisters

Students must take 60 credits in total with at least 15 credits in business and 15 credits in computer science. The computer science final year project is mandatory.

BUSINESS MODULES

- BU4501 Strategic management: theory and practice (15 credits)
- BU4510 International business (15 credits)
- BU4522 Exploring organisational experiences (15 credits)
- BU4530 Financial reporting and analysis (15 credits)
- BU4541 Financial markets and the corporate sector (15 credits)
- BU4550 Advances in marketing theory and practice (15 credits)
- BU4560 Managing non-profit organisations (15 credits)
- BU4600 International finance and risk management (15 credits)
- BU4610 Entrepreneurship: a commercial and social perspective (15 credits)

COMPUTER SCIENCE MODULES

- TBC Final year project (15 credits)
- CS3031 Advanced telecommunications (5 credits)
- CS4001 Fuzzy logic (5 credits)
- CS4021 Advanced computer architecture (5 credits)
- CS4032 Distributed systems (5 credits)
- CS4051 Human factors (5 credits)
- CS4052 Computer graphics (5 credits)
- CS4053 Computer vision (5 credits)
- CS4071 Compiler design II (5 credits)

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

MODERATORSHIP IN COMPUTER SCIENCE AND
MASTER IN COMPUTER SCIENCE (M.C.S.)⁶

Admission

10 For admission requirements for entry into the Junior Freshman year see ADMISSION REQUIREMENTS, section F, §3.

⁶The award title of Master in Computer Science (M.C.S.) is subject to the approval of the University Senate.

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For direct entry into the Senior Sophister 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 programme 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 programme prior to 2012 will also have the option to participate in the five-year programme.

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

12 In the Freshman years instruction is given in the theoretical underpinnings of computer science along with modules in hardware and software. In the Sophister years students may select a number of options in addition to core 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 Senior Sophister year. In the fifth year students will undertake a significant project with a substantial element of independent research leading to a dissertation. There are also laboratory classes in each year of the programme.

Examinations

13 Students are examined in the work of each year. Supplemental examinations will be held in Michaelmas term each year, except for the fifth year. Supplemental examinations in the Senior Sophister year may only be taken in order to attain the progression requirement for entry into the fifth year. Students exiting the programme after the Senior Sophister year obtain a moderatorship based on their results at the annual examination session only. 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.

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 Junior Sophister examinations (which count for 20 per cent of the moderatorship result) and Senior Sophister 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 Junior Sophister students who achieve a second class (second division) honors grade or better may progress to the fourth year of the five year master's programme. Students who achieve a third class honors grade in their Junior Sophister examinations may exit the programme with an ordinary B.A. degree, continue to the fourth year in order to achieve and exit with a B.A. (Moderatorship), or may repeat their Junior Sophister year to achieve a second class (second division) honors grade or better in order to remain on the five year integrated programme.

Senior Sophister students who achieve a second class (first division) honors grade or better in their examinations may progress to the fifth year or exit the programme with a B.A.

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(Moderatorship) degree. Students who achieve a second class (second division) honors or a third class honors grade in their Senior Sophister examinations may exit the programme with a B.A. (Moderatorship) degree or may repeat the Senior Sophister year to achieve a second class (first division) honors grade or better in order to progress to the fifth year of the Master in Computer Science programme. 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 Junior Sophister examination may have the ordinary B.A. degree conferred if they do not choose, or are not allowed, to proceed to the Senior Sophister year of the programme 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 be conferred only on candidates who have spent at least three years in the University.

Moderatorship degree

16 Students who have passed their Senior Sophister 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 programme.

Modules

17 Junior Freshmen

- CS1001 Mathematics I (5 credits)
- CS1002 Mathematics II (5 credits)
- CS1011 Introduction to programming I (5 credits)
- CS1012 Introduction to programming II (5 credits)
- CS1013 Programming project I (5 credits)
- CS1021 Introduction to computing I (5 credits)
- CS1022 Introduction to computing II (5 credits)
- CS1023 Digital logic design I (5 credits)
- CS1024 Digital logic design II (5 credits)
- CS1025 Electrotechnology (5 credits)
- CS1031 Telecommunications I (5 credits)
- CS1081 Computers and society I (5 credits)

18 Senior Freshmen

- MA2C01 Discrete mathematics I (5 credits)
- MA2C02 Discrete mathematics II (5 credits)
- CS2011 Programming techniques I (5 credits)
- CS2012 Programming techniques II (5 credits)
- CS2013 Programming project II (5 credits)
- CS2014 Systems programming I (5 credits)
- CS2015 Systems programming II (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)

19 Junior Sophisters

- ST1002 Statistical analysis I (5 credits)
- CS3011 Symbolic programming (5 credits)
- CS3012 Software engineering (5 credits)

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- CS3013 Software engineering group project (5 credits)
- CS3014 Concurrent systems I (5 credits)
- CS3015 Concurrent systems II (5 credits)
- CS3016 Introduction to functional programming (5 credits)
- CS3021 Computer architecture II (5 credits)
- CS3041 Information management II (5 credits)
- CS3071 Compiler design I (5 credits)

and two options from the following list:⁷

- CS3017 Introduction to semantics of programming languages (5 credits)
 - CS3031 Advanced telecommunications (5 credits)
 - CS3051 Visual computing (5 credits)
 - CS3061 Artificial intelligence I (5 credits)
- Additional topics⁸

20 Senior Sophisters

- CS4051 Human factors (5 credits)
- CS4081 Technology entrepreneurship (5 credits)

Students completing the Senior Sophister 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:⁷

- CS4001 Fuzzy logic (5 credits)
 - CS4003 Formal methods (5 credits)
 - CS4012 Topics in functional programming (5 credits)
 - CS4021 Advanced computer architecture (5 credits)
 - CS4031 Mobile communications (5 credits)
 - CS4032 Distributed systems (5 credits)
 - CS4052 Computer graphics (5 credits)
 - CS4053 Computer vision (5 credits)
 - CS4061 Artificial intelligence IIa (5 credits)
 - CS4062 Artificial intelligence IIb (5 credits)
 - CS4071 Compiler design II (5 credits)
- Additional topics⁸

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

- CS7091 Industrial/research laboratory internship (30 credits)

and must choose four options⁹ from the following list:⁷

- CS4001 Fuzzy logic (5 credits)
- CS4003 Formal methods (5 credits)
- CS4012 Topics in functional programming (5 credits)
- CS4021 Advanced computer architecture (5 credits)
- CS4031 Mobile communications (5 credits)
- CS4032 Distributed systems (5 credits)
- CS4052 Computer graphics (5 credits)
- CS4053 Computer vision (5 credits)

⁷It may not be possible to offer all the options each year and some modules have prerequisites.

⁸Additional modules covering special topics may be added to this list subject to staff availability and timetabling constraints.

⁹A maximum of 20 credits of CS4 level modules can be taken over year four and five.

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- CS4061 Artificial intelligence IIa (5 credits)
 - CS4062 Artificial intelligence IIb (5 credits)
 - CS4071 Compiler design II (5 credits)
 - CS7003 Middleware for distributed systems (5 credits)
 - CS7004 Embedded systems (5 credits)
 - CS7008 Vision systems (5 credits)
 - CS7009 Networked applications (5 credits)
 - CS7012 Management of networks and distributed systems (5 credits)
 - CS7030 Numerical methods and advanced mathematical modelling I (5 credits)
 - CS7031 Graphics and console hardware (5 credits)
 - CS7033 Real-time animation (5 credits)
 - CS7048 Data communications and wireless networking (5 credits)
 - CS7052 Sustainable computing (5 credits)
 - CS7058 Numerical methods and advanced mathematical modelling II (5 credits)
- Additional topics¹⁰

21 Fifth year

- CS7039 Research methods (5 credits)
- CS7092 Master in Computer Science dissertation (30 credits)

and five options¹¹ from the following list:¹²

- CS4001 Fuzzy logic (5 credits)
 - CS4003 Formal methods (5 credits)
 - CS4012 Topics in functional programming (5 credits)
 - CS4021 Advanced computer architecture (5 credits)
 - CS4031 Mobile communications (5 credits)
 - CS4032 Distributed systems (5 credits)
 - CS4052 Computer graphics (5 credits)
 - CS4053 Computer vision (5 credits)
 - CS4061 Artificial intelligence IIa (5 credits)
 - CS4062 Artificial intelligence IIb (5 credits)
 - CS4071 Compiler design II (5 credits)
 - CS7003 Middleware for distributed systems (5 credits)
 - CS7004 Embedded systems (5 credits)
 - CS7008 Vision systems (5 credits)
 - CS7009 Networked applications (5 credits)
 - CS7012 Management of networks and distributed systems (5 credits)
 - CS7030 Numerical methods and advanced mathematical modelling I (5 credits)
 - CS7031 Graphics and console hardware (5 credits)
 - CS7033 Real-time animation (5 credits)
 - CS7048 Data communications and wireless networking (5 credits)
 - CS7052 Sustainable computing (5 credits)
 - CS7058 Numerical methods and advanced mathematical modelling II (5 credits)
- Additional topics¹⁰

MODERATORSHIP IN COMPUTER SCIENCE, LINGUISTICS AND A LANGUAGE

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

¹⁰Additional modules covering special topics may be added to this list subject to staff availability and timetabling constraints.

¹¹A maximum of 20 credits of CS4 level modules can be taken over year four and five.

¹²It may not be possible to offer all the options each year and some modules have prerequisites.

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MODERATORSHIP IN MANAGEMENT SCIENCE AND INFORMATION SYSTEMS STUDIES

23 This programme 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

24 Junior Freshmen

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

- BU1510 Introduction to organisation and management (10 credits)
- CS1011 Introduction to programming I (5 credits)
- CS1012 Introduction to programming II (5 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)

25 Senior Freshmen

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

- BU2520a Introduction to accounting (5 credits)
- BU2520b Financial analysis (5 credits)
- CS2011 Programming techniques I (5 credits)
- CS2012 Programming techniques II (5 credits)
- MA2E01 Engineering mathematics III (5 credits)
- MA2E02 Engineering mathematics IV (5 credits)
- ST2001 Software applications II (5 credits)
- ST2002 Introduction to regression (5 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.

26 Junior Sophisters

Mandatory modules must be taken in a number of areas including information systems, management science and statistics.

- ST3001 Software applications III (10 credits)
- ST3002 Statistical analysis III (5 credits)
- ST3004 Research methods (5 credits)
- ST3005 Information systems (5 credits)
- ST3007 MLA and applied forecasting (10 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.

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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.

27 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.

- ST4500 Strategic information systems (10 credits)
- ST4003 Data mining (10 credits)
- ST4004 Management science practice (10 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

28 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.

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

Ordinary degree of B.A.

29 Students who have passed the Junior Sophister examination may have the ordinary B.A. degree conferred if they do not choose, or are not allowed, 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 be conferred only on candidates who have spent at least three years in the University.

DIPLOMA IN INFORMATION SYSTEMS (EVENING COURSE)

Admission

30 Applications for admission to the Diploma in Information Systems should be made to the Programme Director, Diploma/B.Sc. (Honors) in Information Systems, School of Computer Science and Statistics, Trinity College, Dublin 2 by 30 June. For non-mature students the minimum requirements for the diploma are six passes in the Leaving Certificate, or equivalent, with a minimum grade C3 at ordinary level in English and mathematics.

Course

31 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.

Syllabus

32 First year

- CS1101 Information systems (10 credits)

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- 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)

33 Second year

- 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

34 Applications for admission to the evening Bachelor in Science in Information Systems degree course should be made to the Programme Director, Diploma/B.Sc. (Honors) in Information Systems, School of Computer Science and Statistics, Trinity College, Dublin 2, by 30 June. Recipients of the Diploma in Information Systems (see above) are automatically transferred to the Bachelor in Science course and do not need to reapply.

35 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

36 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.

Degree award

37 Successful candidates at the annual degree examination are placed in order of merit in the following classes: first class honors, second class honors (with two divisions, first and second), and third class honors. Students who fail the annual degree examination may sit a supplemental examination in Michaelmas term and will be awarded a pass degree if successful.

Syllabus

38 Third year

- CS3103 Business, management and IT (10 credits)
- CS3105 Law and IT (10 credits)
- CS3101 e-Business (10 credits)
- CS3102 Information systems development II (10 credits)
- CS3104 Information systems strategy (10 credits)
- CS3106 Information systems practice II (10 credits)
- CS3107 Social computing (10 credits)
- CS3108 Systems analysis and design (10 credits)

In the Junior Sophister year CS3103 and CS3105 are mandatory. In addition, students choose modules worth 40 credits from the list above. The choice of options may be restricted due to resource or timetable considerations. Students normally take a total of 30 credits each term. 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.

39 Fourth year

- CS4101 Information security (10 credits)
- CS4102 Innovation (10 credits)
- CS4103 Information systems management (10 credits)
- CS4104 Advanced information systems (10 credits)
- CS4105 Research project (20 credits)

III COURSES IN ENGINEERING SCIENCE

Fees

1 See COLLEGE CHARGES.

**DEGREES OF BACHELOR IN ENGINEERING AND MASTER IN ENGINEERING (STUDIES)
(B.A.I., M.A.I. (St.)¹³)**

2 For students who entered the programme prior to 2009, the course normally lasts four years leading to a B.A.I. degree but there is provision for an abridgement of the course to three years for an ordinary B.A. degree, see section I, §5.

Students entering the programme prior to 2009 may supplement their four years of study in Trinity College Dublin with an additional year (60 credits) of study abroad with an approved partner institution or on an approved international programme. On successful completion of four years of study, such students are eligible for B.A. and B.A.I. degrees and, if chosen, students successfully completing the fifth year are eligible for the M.A.I. (St.) degree.¹⁴

Students entering the programme in 2009 and later complete a four-year course leading to the B.A.I. degree, and may elect to complete an additional year of study leading to a M.A.I. (St.) degree, see §15. There is provision for an abridgement of the course to three years for a B.A. degree, 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
- electronic engineering
- computer engineering
- electronic/computer engineering (combined programme)

Following completion of the fourth year of the engineering degree programme, eligible students elect to complete one further year of study in their chosen strand leading to a M.A.I. (St.) degree, §15.

4 While every effort is made to allow students to study the strand/specialism they choose, the B.A.I./M.A.I. Management 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 A number of options to study abroad with approved partner institutions and to complete industrial internships will be available as an integrated part of the teaching programme.

6 Students are encouraged to gain relevant industrial experience during vacation periods, particularly during their Junior and Senior Sophister years.

¹³The award title of Master in Engineering (Studies) (M.A.I. (St.)) is subject to the approval of the University Senate.

¹⁴The practice of awarding the concurrent degree of ordinary B.A. is under review.

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Syllabus

7 First year

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.

8 Second year

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 (10 credits)
2E10	Engineering design IV: project (10 credits)

Language options:

French for Applied Scientists, see p. M46

German for Applied Scientists, see p. M46

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

9 Third year

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)
3E2	Numerical methods (5 credits) (for civil and mechanical engineering strands)
3E3	Probability modelling (5 credits) (for electronic/computer engineering strands) or
ST2004	Applied probability (5 credits) (for electronic/computer engineering strands)
3E4	Management for engineers (5 credits)

and admissible combinations from the following:¹⁵

3A1	Engineering surveying (5 credits)
3A2	Structural design (5 credits)

¹⁵Admissible combinations vary by engineering strand. It may not be possible to offer all the options every year.

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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	Computer aided engineering and design (10 credits)
3C1	Signals and systems (5 credits)
3C2	Digital circuits (5 credits)
3C3	Analogue circuits (5 credits)
3C4	Applied electromagnetism (5 credits)
3C5	Telecommunications (5 credits)
3C6 (A&B)	Electronic engineering projects (10 credits)
3C7	Digital systems design (5 credits)
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)
3D5 (A&B)	Software design and implementation (10 credits)
CS2022	Computer architecture II (5 credits)
	Language options:
	French for Applied Scientists, see p. M46
	German for Applied Scientists, see p. M46

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

10 Fourth year

Students take admissible combinations of modules amounting to 60 credits by following one of three modes of study involving an engineering project (mode 1), a project-based industrial internship (mode 2), or an international academic exchange (mode 3), comprising admissible combinations of the following:¹⁶

4E1	Management for engineers (5 credits)
4E2	Engineering project (15 credits)
4E3	Broad Curriculum option (5 credits)
4E4	Engineering project internship (30 credits)
4A1	Civil engineering materials (5 credits)
4A3(1)	Environmental engineering I (5 credits)
4A3(2)	Environmental engineering II (5 credits)
4A4(1)	Hydraulics (5 credits)
4A5(1)	Geotechnical engineering I (5 credits)
4A5(2)	Geotechnical engineering II (5 credits)
4A6(1)	Structures I (Design of structures) (5 credits)
4A6(2)	Structures II (Advanced design of structures) (5 credits)

¹⁶The general regulations with respect to the timing of academic exchanges in final year apply.

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4A7	Design and the built environment (5 credits)
4A8	Transportation (5 credits)
4A10	Construction innovation and research (5 credits)
4B1	Mechanics of solids (5 credits)
4B2	Materials (5 credits)
4B3	Thermodynamics (5 credits)
4B4	Heat transfer (5 credits)
4B5	Manufacturing technology (5 credits)
4B6	Manufacturing systems and project management (5 credits)
4B7	Computer aided engineering (5 credits)
4B9	Mechatronics and systems (5 credits)
4B10	Instrumentation (5 credits)
4C1	Integrated systems design (5 credits)
4C2	Microelectronic circuits (5 credits)
4C3	Digital control systems (5 credits)
4C4	Telecommunications (5 credits)
4C5	Digital signal processing (5 credits)
4C6	Microelectronic technology (5 credits)
4C7	Digital communications (5 credits)
4C8	Digital media processing (5 credits)
4D1A	Distributed systems (5 credits)
4D1B	Advanced microprocessor systems (5 credits)
4D2A	Data engineering (5 credits)
4D2B	Knowledge engineering (5 credits)
4D3	Computer graphics (5 credits)
4D4	Computer vision (5 credits)
CS7034	Augmented reality (5 credits)
CS7053	Security of networks and distributed systems (5 credits)
4MEMS5	Micro and precision manufacturing (5 credits)
4MEMS6	Thermodynamics (5 credits)
4MEMS7	Fluid mechanics (5 credits)
ST3001	Software applications 3 (10 credits)
ST4004	Management science practice (10 credits)
ST4500	Strategic information systems (10 credits)
BU4580	Managing new product development (10 credits)

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

11 Fifth year

In the fifth year of the course all students complete mandatory and optional modules (30 credits), a mandatory engineering research project (25 credits) and an associated module in research methods (5 credits).

5E1	Engineering research project (25 credits)
5E2	Research methods (5 credits)
5AB1	Geotechnical engineering III (5 credits)
5AB3	Introduction to transportation engineering (5 credits)
5AB6	Environmental engineering III (5 credits)
5AB8	Advanced structural analysis (5 credits)
5AC2	Hydrogeology and engineering geology (5 credits)
5AC6	Advanced theory of structures (5 credits)
4B11	Engineering vibrations (5 credits)
4B12	Acoustics (5 credits)
4B13	Fluid mechanics (5 credits)

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4B14	Applied fluid mechanics (5 credits)
4B15	Introduction to bioengineering (5 credits)
4B16	Biomechanics of tissues and implants (5 credits)
5C1	Digital media systems (10 credits)
5C2	Wireless networks and communications (10 credits)
5C3	Statistical signal processing (10 credits)
5C4	Physiological measurement and data analysis (10 credits)
CS7004	Embedded systems (5 credits)
CS7012	Management of networks and distributed systems (5 credits)
CS7032	Artificial intelligence (5 credits)
CS7033	Real time animation (5 credits)
CS7039	Research methods (see 5E2) (5 credits)
CS7052	Sustainable computing (5 credits)
5MEMS2	Advanced manufacturing I (5 credits)
5MEMS3	Supply chain management (5 credits)
5MEMS4	Operations strategy (5 credits)

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

Examinations

12 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. However, compensation is permitted at the annual examinations but the court of examiners will not normally allow small deficiencies in more than a maximum of two modules to be compensated for by the results in the others.

13 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. Compensation is permitted at the supplemental examinations but the court of examiners will not normally allow small deficiencies in more than one module to be compensated for by the results in the other modules.

14 To rise with their year, students must successfully complete the prescribed number of credits, subject to the variations as provided for by compensation requirements.

15 Only students who are awarded a second class (first division) grade or better in their B.A.I. examinations or a second class (second division) grade or better in both their Junior and Senior Sophister annual examinations are eligible to proceed to the fifth year of the course. Students are permitted one repeat of Senior Sophister year to achieve the grade required to proceed to the fifth year of the course.

16 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.

17 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.

18 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.

19 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

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explanation will normally be refused permission to take supplemental examinations or to repeat the year.

20 Successful candidates at the B.A.I. degree examinations are placed within three classes: first class honors, second class honors (with two divisions, first and second) and third class honors and are ranked within specialism. (For candidates entering College before the 2008-09 academic year, a pass degree may be awarded.) Except by special recommendation of the court of examiners, honors are awarded on the results of a student's annual Junior Sophister examinations and their first attempt at the annual B.A.I. examinations, taken together but with the Junior Sophister examinations not contributing more than 20 per cent to the combined mark.

Students who fail to pass the B.A.I. degree examination of their year may present themselves for re-examination at the examination in the following year when they may compete for the degree at pass level only.

21 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.

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.

22 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

23 Students who have obtained credit for years one to four are entitled to the degrees of B.A. and B.A.I.¹⁷ Students who have obtained credit for the fifth year are entitled to the degree of M.A.I. (St.). All degrees must be conferred at the same Commencements.

Students who complete the Junior Sophister year by examination and who choose not to proceed to or fail to complete satisfactorily the Senior Sophister 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 appropriate school executive committee, the ordinary degree of B.A. may 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.)¹⁸)

24 For students who entered the programme prior to 2009, the course normally lasts four years leading to a B.Sc. (Ing.) degree but there is provision for an abridgement of the course to three years for an ordinary B.A. degree, see section I, §5.

Students entering the programme prior to 2009 may supplement their four years of study in Trinity College Dublin with an additional year (60 credits) of study abroad with an approved partner institution or on an approved international programme. On successful completion of five years of study, such students are eligible for both B.Sc. (Ing.) and M.A.I. (St.) degrees.

Students entering the programme in 2009 and later 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 §15. There is provision for an abridgement of the course to three years for a B.A. degree, see section I, §5.

25 Following completion of the fourth year of the engineering with management degree programme, eligible students elect to complete one further year of study leading to a M.A.I. (St.) degree, §15.

¹⁷The practice of awarding the concurrent degree of ordinary B.A. is under review, see also §2 above.

¹⁸The award title of Master in Engineering (Studies) (M.A.I. (St.)) is subject to the approval of the University Senate.

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26 A number of options to study abroad with approved partner institutions and to complete industrial internships will be available as an integrated part of the teaching programme.

27 Students are encouraged to gain relevant industrial experience during vacation periods, particularly during their Junior and Senior Sophister years.

Syllabus

28 First year

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.

29 Second year

Students take mandatory modules amounting to 60 credits.

2MEMS2	Finance (5 credits)
2MEMS3	Design I (10 credits)
2MEMS4	Materials (5 credits)
2MEMS10	Manufacturing engineering design (10 credits)
ST1002	Statistical analysis (5 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)

Language options:

French for Applied Scientists, see p. M46

German for Applied Scientists, see p. M46

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

30 Third year

3MEMS1	Manufacturing technology II (5 credits)
3MEMS3	Design II (10 credits)
3MEMS5	Operations and project management (5 credits)
3MEMS6	Communications and people management (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)
3E2	Numerical methods (5 credits)
ST3005	Information systems (5 credits)
ST3007a	MLA applied forecasting (5 credits)

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Language options:

French for Applied Scientists, see p. M46

German for Applied Scientists, see p. M46

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

31 Fourth year

Students take admissible combinations of modules amounting to 60 credits. Students follow one of three modes of study involving an engineering project (mode 1), a project-based industrial internship (mode 2), or an international academic exchange (mode 3), comprising admissible combinations of the following:¹⁹

4E1	Management for engineers (5 credits)
4E2	Engineering project (15 credits)
4B1	Mechanics of solids (5 credits)
4B2	Materials (5 credits)
4B3	Thermodynamics (5 credits)
4B4	Heat transfer (5 credits)
4B7	Computer aided engineering (5 credits)
4B9	Mechatronics and systems (5 credits)
4B10	Instrumentation (5 credits)
4MEMS5	Micro and precision manufacturing (5 credits)
4MEMS6	Thermodynamics (5 credits)
4MEMS7	Fluid mechanics (5 credits)
ST3001	Software applications 3 (10 credits)
ST4004	Management science practice (10 credits)
ST4500	Strategic information systems (10 credits)
BU4580	Managing new product development (10 credits)

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

32 Fifth year

In the fifth year of the course all students complete mandatory and optional modules (30 credits), a mandatory engineering research project (25 credits) and an associated module in research methods (5 credits).

5E1	Engineering research project (25 credits)
5E2	Research methods (5 credits)
4B11	Engineering vibrations (5 credits)
4B12	Acoustics (5 credits)
4B13	Fluid mechanics (5 credits)
4B14	Applied fluid mechanics (5 credits)
4B15	Introduction to bioengineering (5 credits)
4B16	Biomechanics of tissues and implants (5 credits)
5MEMS2	Advanced manufacturing I (5 credits)
5MEMS3	Supply chain management (5 credits)
5MEMS4	Operations strategy (5 credits)

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

Examinations

33 As §§12-19 above.

¹⁹The general regulations with respect to the timing of academic exchanges in final year apply.

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34 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 and are ranked. (For candidates entering College before the 2008-09 academic year, a pass degree may be awarded.) Except by special recommendation of the court of examiners, honors are awarded on the results of a student's annual Junior Sophister examinations and subsequent annual B.Sc. (Ing.) examinations, taken together but with the Junior Sophister 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 when they may compete for the degree at pass level only.

35 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.

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.

36 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

37 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 entitled to the degree of M.A.I. (St.). All degrees must be conferred at the same Commencements.

Students who complete the Junior Sophister year by examination and who choose not to proceed to or fail to complete satisfactorily the Senior Sophister 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 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 the Michaelmas term of the Junior Freshman year students take modules MA1111, MA1121, MA1131, MA1241, ST1251 and MA1261. In the Hilary term of the Junior Freshman year, students take modules MA1212, MA1214, MA1122 and two modules chosen from MA1242, ST1252, MA1262 or a module with 5 credits available from other schools in College.

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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.

In the Michaelmas term of the Senior Freshman year students take modules MA2215, MA2321, MA2223, MA2325, MA2331 and one module from MA2317, MA2341, ST2351, or a module with 5 credits available from other schools in College. In the Hilary term of the Senior Freshman year students take modules MA2322, MA2224, MA2326, MA2332, and two modules from MA2318, MA2342, ST2352, or a module with 5 credits, subject to agreement, available from any school in College.

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 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 and economics 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 60 credits, which should normally include a project (module MA4492). In addition to modules in statistics and economics 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 *viva voce* presentation held before the end of Hilary term.

In all years students should make their choice of modules in accordance with the programme requirements published by the School of Mathematics before the commencement of the academic year. The director of teaching and learning (undergraduate) may permit programmes of study that are not expressly provided for in these published programme 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, II₁ = 60-69, II₂ = 50-59, III = 40-49, F₁ = 30-39, F₂ = 0-29. In order to pass, a mark of at least 40 per cent is required.

To gain a pass in the examinations of the Freshman years, students must (a) attain a mark of at least 35 per cent in each module, (b) attain a mark of at least 40 per cent in modules totalling at least 40 credits, and (c) must also attain an overall mark of at least 40 per cent. Junior and Senior Freshman students who do not qualify to proceed at the annual examination must take a supplemental examination, resitting papers which they have failed and papers for modules examined by continuous assessment. These supplemental examinations are held at the beginning of Michaelmas term. There are no supplemental examinations in the Sophister years. To proceed to the Senior Sophister year, a student must pass in modules that together provide at least 40 credits, and must also achieve an overall average of at least 40 per cent at the Junior Sophister examination.

Junior Sophister students whose annual examination results average 40 per cent or more may be permitted to graduate with an ordinary degree if they do not choose, or are not qualified, to proceed into the Senior Sophister year. Students who are not qualified to proceed may apply to repeat their year in accordance with §10 below. Except by special permission of the University

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Council, the ordinary degree of B.A. may be conferred only on candidates who have spent at least 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 the Junior Freshman year students take Junior Freshman physics modules PY1T10 (physics for theoretical physics) (10 credits) and PY1T20 (physics for theoretical physics) (10 credits) which include lectures, practical work and tutorials together with mathematics modules MA1111, MA1121, MA1131, MA1241 (in Michaelmas term), MA1212, MA1122 and MA1242 (Hilary term). In the Senior Freshman year students take Senior Freshman physics modules PY2T10 (classical physics for theoretical physics) (10 credits) and PY2T20 (modern physics for theoretical physics) (10 credits) which include lectures, practical work and tutorials together with modules MA2321, MA2325, MA2331, MA2341 (in Michaelmas term), MA1214, MA2322, MA2332 and MA2342 (Hilary term). Each of these modules is assessed by means of continuous assessment, laboratory work, and/or papers set at the annual examination held in the Trinity term.

12 In the Junior Sophister year, students take advanced level mathematics modules that together provide 30 credits, chosen in accordance with the programme requirements published by the School of Mathematics before the commencement of the academic year, together with 30 credits of specified lectures and practical work in physics.

In the Senior Sophister year, students follow a similar programme but with 25 core credits in both physics and mathematics. The balance of 10 credits is chosen from within physics or mathematics or both. In determining the moderatorship mark, credits in excess of 30 in one school will be assigned to the other school. These must be specified in advance.

13 To gain a pass in the examinations of the Freshman years, students must pass in both mathematics and physics. The overall result for the year will be an appropriately weighted average of the grades in mathematics and physics.

Results for examinations and assessments are published according to the following grades: I = 70-100, II₁ = 60-69, II₂ = 50-59, III = 40-49, F₁ = 30-39, F₂ = 0-29. In order to pass, a mark of at least 40 per cent is required.

To gain a pass in mathematics in the examinations of the Freshman years, students must attain a mark of at least 35 per cent in each mathematics module, and must also attain an overall mathematics mark of at least 40 per cent. Junior and Senior Freshman students who have failed in mathematics at the annual examination must take a supplemental examination in mathematics, sitting papers set on each of the mathematics modules in which they have failed. To gain a pass in physics in the examinations of the Freshman years, students must attain a mark of at least 35 per cent in each physics module, and must also attain an overall physics mark of at least 40 per

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cent. Junior and Senior Freshman students who have failed in physics at the annual examination must take a supplemental examination in physics, sitting papers set on each of the physics modules in which they have failed. These supplemental examinations are held at the beginning of Michaelmas term. There are no supplemental examinations in the Sophister years.

To qualify to proceed to moderatorship, Junior Sophister students sitting the examination for the first time must pass in mathematics and obtain at least 45 per cent in physics. Students sitting the Junior Sophister examinations for the second time must pass in mathematics and obtain at least a II₂ grade in physics to qualify to proceed to moderatorship. The overall result for the Junior Sophister year will be determined by the average of the marks for mathematics and physics. Junior Sophister students whose annual examination results average 40 per cent or more may be permitted to graduate with an ordinary degree or may apply to repeat their year in accordance with §14 below. Except by special permission of the University Council, the ordinary degree of B.A. may be conferred only on candidates who have spent at least three years in the University.

The mark for moderatorship is divided equally between mathematics and physics. The mathematics examinations of the two Sophister years count equally towards the overall mark for moderatorship. The Junior Sophister physics examination counts for 10 per cent of 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.

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.

TWO-SUBJECT MODERATORSHIP COURSES

15 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.

Transfer of course

16 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).

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 – Michaelmas term

- MA1111 Linear algebra I (5 credits)
- MA1121 Concepts of analysis (5 credits)
- MA1131 Advanced calculus (5 credits)
- MA1241 Mechanics I (5 credits)
- ST1251 Introduction to statistics I (5 credits)
- MA1261 Mathematical computation I (5 credits)

Introductory level – Hilary term

- MA1212 Linear algebra II (5 credits)

PREREQUISITES
MA1111

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MA1214	Introduction to group theory (5 credits)	MA1111
MA1122	Analysis on the real line (10 credits)	MA1121
MA1242	Mechanics II (5 credits)	MA1241
ST1252	Introduction to statistics II (5 credits)	ST1251
MA1262	Mathematical computation II (5 credits)	MA1261

Intermediate level – Michaelmas term

		PREREQUISITES
MA2215	Fields, rings and modules (5 credits)	MA1214
MA2317	Introduction to number theory (5 credits)	
MA2321	Analysis in several real variables (5 credits)	MA1112, MA1122, MA1131
MA2223	Metric spaces (5 credits)	MA1122
MA2325	Complex analysis I (5 credits)	MA1122
MA2331	Equations of mathematical physics I (5 credits)	MA1131
MA2341	Advanced classical mechanics I (5 credits)	MA1242
ST2351	Probability and theoretical statistics I (5 credits)	ST1252

Intermediate level – Hilary term

		PREREQUISITES
MA2322	Calculus on manifolds (5 credits)	MA2321
MA2318	Elementary projective and algebraic geometry (5 credits)	
MA2224	Lebesgue integral (5 credits)	MA2215
MA2326	Ordinary differential equations (5 credits)	MA2223
MA2332	Equations of mathematical physics II (5 credits)	MA1122
MA2342	Advanced classical mechanics II (5 credits)	MA2331
ST2352	Probability and theoretical statistics II (5 credits)	MA2341
		ST2352

Advanced modules

In any given year, the advanced modules available to students, and the constraints imposed on the choice of courses, 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):

Michaelmas term

		PREREQUISITES
MA3411	Abstract algebra I (5 credits)	
MA3413	Group representations I (5 credits)	
MA3421	Functional analysis I (5 credits)	
MA3423	Topics in complex analysis I (5 credits)	
MA3425	Partial differential equations I (5 credits)	
MA3427	Algebraic topology I (5 credits)	
MA3429	Differential geometry I (5 credits)	MA2322
MA3431	Classical field theory I (5 credits)	
MA3441	Quantum mechanics I (5 credits)	MA2342
MA3443	Statistical physics I (5 credits)	
MA4445	Quantum field theory I (5 credits)	MA3442, MA3444
MA3461	Numerical simulation of physical systems I (5 credits)	
MA3463	Computation theory and logic I (5 credits)	
MA3471	Mathematical neuroscience I (5 credits)	

Hilary term

		PREREQUISITES
MA3412	Abstract algebra II (5 credits)	MA3411

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MA3414	Group representations II (5 credits)	MA3413
MA3422	Functional analysis II (5 credits)	MA3422
MA3424	Topics in complex analysis I (5 credits)	MA3423
MA3426	Partial differential equations II (5 credits)	MA3425
MA3428	Algebraic topology II (5 credits)	MA3427
MA3432	Classical field theory II (5 credits)	MA3431
MA3442	Quantum mechanics II (5 credits)	MA3441
MA3444	Statistical physics II (5 credits)	MA3445
MA4446	Quantum field theory II (5 credits)	MA4445
MA4448	General relativity (5 credits)	MA2342, MA3429, MA3432
MA3462	Numerical simulation of physical systems I (5 credits)	MA3461
MA3464	Computation theory and logic II (5 credits)	MA3463
MA3466	Information theory (5 credits)	
MA3472	Programming for mathematical neuroscience (5 credits)	MA3471

Michaelmas and Hilary terms

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.

Michaelmas term

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

Hilary term

		PREREQUISITES
ST3452	Applied linear statistical models II (5 credits)	ST3451
ST3454	Stochastic models in space and time II (5 credits)	ST3453
ST3456	Modern statistical methods II (5 credits)	ST3455
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.

Economics modules

The following modules are provided by the Department of Economics:

Michaelmas term

MA3481	Mathematical economics I (5 credits)
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Hilary term

		PREREQUISITE
MA3482	Mathematical economics II (5 credits)	MA3481

Additional modules provided by the Department of Economics may also be available within the mathematics moderatorship and the mathematics component of the two-subject moderatorship.

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V COURSES IN SCIENCE

REGULATIONS²⁰

Fees

1 See COLLEGE CHARGES.

MODERATORSHIP IN SCIENCE

2 The moderatorship in science is available in each of the following subjects:²¹ biochemistry with cell biology, biochemistry with structural biology, chemistry, environmental sciences, functional biology – the comparative physiology of organisms, 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 §§26-28 below), human genetics (see §§29-34 below), chemistry with molecular modelling (see §§35-38 below), medicinal chemistry (see §§39-43 below), nanoscience, physics and chemistry of advanced materials (see §§44-48 below) and political science and geography (see §49 below).

5 The Freshman 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 Freshman modules in science except by decision of the Science Course Director.²²

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 Freshman 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 Freshman modules selected are an adequate preparation. Junior Freshman students wishing to change their combination of modules must request the permission of the Science Course Director not later than the end of the third week of Michaelmas teaching term.

7 Junior Freshman students must give notice to the Science Course Director, not later than the end of Hilary term, of their choice of Senior Freshman modules for the forthcoming year.

8 Senior Freshman students must give notice to the Science Course Director, 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 Freshman 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 Science Course Director for permission to take a moderatorship in biochemistry with cell

²⁰These regulations should be read in conjunction with GENERAL FACULTY REGULATIONS and GENERAL REGULATIONS AND INFORMATION.

²¹For moderatorship in biochemistry with cell biology, biochemistry with structural biology, immunology, microbiology, molecular medicine, neuroscience and physiology for medical and dental students, see §10.

²²See also section I, §5 'Abridgement of course'.

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biology, biochemistry with structural biology, 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 environmental sciences, functional biology, 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 head of department concerned regarding the courses planned and the costs involved.

13

Modules

Junior Freshmen

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)
- GG1021 Introduction to geography I: physical (10 credits)
- GG1022 Introduction to geography II: human environment (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)

Senior Freshmen

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 Plant and animal bioresources (5 credits)
- CH2201 Chemistry 1 (10 credits)
- CH2202 Chemistry 2 (10 credits)
- GG2021 Changing worlds (10 credits)
- GG2022 Collection and analysis of geographical data (10 credits)

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- GL2201 Mineralogy (5 credits)
- GL2202 Palaeontology and stratigraphy (5 credits)
- GL2203 Petrology (5 credits)
- GL2204 Structural geology, kitchen physics and map work (5 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 with cell biology
- Biochemistry with structural biology
- Chemistry
- Environmental sciences
- Functional biology
- 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 Freshman and Senior Freshman 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**

Moderatorship	Senior Freshman	Junior Freshman
Biochemistry with cell biology ²³	BY2201, BY2203, BY2205, BY2208	CH1101, CH1102, MA1S11 or MA1M01
Biochemistry with structural Biology ²³	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

²³Junior Freshman BY1101 is advisable.

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Functional biology	BY2201, BY2202, BY2203, BY2208	BY1101, BY1102, MA1S11 or MA1M01
Genetics	BY2201, BY2203, BY2205, BY2208	BY1101, CH1101, CH1102, MA1S11 or MA1M01
Geography	GG2021, GG2022	GG1021 or GG1022
Geology	GL2201, GL2202, GL2203, GL2204	GL1101
Immunology ²⁴	BY2201, BY2203, BY2205, BY2208	CH1101, CH1102, MA1S11 or MA1M01
Microbiology	BY2201, BY2203, BY2205, BY2208	BY1101, CH1101, CH1102, MA1S11 or MA1M01
Molecular medicine ²⁴	BY2201, BY2203, BY2205, BY2208	CH1101, CH1102, MA1S11 or MA1M01
Neuroscience ²⁵	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
Physiology ²⁵	BY2201, BY2202, BY2203, BY2208	MA1S11 or MA1M01
Plant sciences	Four of the following: BY2201, BY2202, BY2203, BY2204, BY2205, BY2206, BY2207, BY2208, BY2209, BY2010	BY1101 and/or BY1102
Zoology	BY2201, BY2202, BY2203, BY2208	BY1101, BY1102, MA1S11 or MA1M01

16 After the publication of Senior Freshman 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 Freshman 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 Freshman module combinations for the various moderatorships is given in the document 'Science TR071, Junior Freshman programme 2011-12' or on the science course website: <http://www.tcd.ie/Science/undergraduate/>.

Annual examinations

18 Annual examinations in all modules are held in Trinity term in the Junior Freshman, Senior Freshman and Junior Sophister years. Junior and Senior Freshman students who have failed in

²⁴Junior Freshman BY1101 is advisable.

²⁵Junior Freshman BY1101 and BY1102 are advisable.

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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 the Junior Freshman examination, students must either pass in each module or, in the case of the annual examination only, compensate for marks of 35-39 per cent in module(s) not exceeding a total of 20 credits by their level of performance in the others. In the supplemental examinations, Junior Freshman students may compensate for marks of 35-39 per cent in module(s) not exceeding a total of 10 credits by their level of performance in the others.

To gain a pass in the Senior Freshman annual examination, students must obtain an overall pass to include pass grades in individual modules which account in total for at least 50 credits. Regulations regarding compensation are documented on the science course website: <http://www.tcd.ie/Science/undergraduate/>. In the supplemental examinations, Senior Freshman students may compensate for marks of 35-39 per cent in module(s) not exceeding a total of 10 credits by their level of performance in the others. 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 Junior Sophister examinations students must achieve a mark of 40 per cent or higher in the examination of their main subject, and in the overall examination result.

However, to qualify to proceed to moderatorship, students sitting the Junior Sophister examination for the first time must achieve a mark of 45 per cent or higher in their main subject and in the overall examination. Students sitting the Junior Sophister examination for the second time must achieve marks of 50 per cent or higher in the examination in the main subject and 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.

Moderatorship examination

22 The moderatorship examination is held in Trinity term of the Senior Sophister year. The examination is held on only one occasion annually. There are no supplemental examinations. Students unavoidably absent from the moderatorship examination 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 or course office before the end of Michaelmas term to confirm their examination and/or assessment requirements while off-books.

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

24 The scheme of distribution of marks between papers and practical work at the moderatorship examination will be published by individual schools or departments at the beginning of the Michaelmas term of the Senior Sophister year.

Ordinary degree of B.A.

25 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, on the recommendation of the Science Course Director, the ordinary degree of B.A. may be conferred only on candidates who have spent at least three years in the school or department concerned.

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Subjects/modules

Junior Freshmen

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 Introduction to organism and environmental biology

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, solid state, 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

Two 10 credit modules in geography are offered in the Junior Freshman year: GG1021 introduction to geography 1 (physical geography) and GG1022 introduction to geography 2 (human-environment). Students may take either or both of these modules.

Introduction to geography 1 (physical geography) includes: global geotectonics, global atmospheric and oceanic processes, climate change, surface processes of landscape development and global geocology. The module is examined by a combination of written examination and course work.

The introduction to geography 2 (human-environment) 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 and two half-day field trips 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;

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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, optics and astronomy. The semester 2 module PY1P20 includes lectures on properties of matter, heat, electricity and magnetism and modern physics. Each of these 10 credit modules includes practicals with set experiments and computational exercises. This tuition may only be taken by students reading Junior Freshman 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 Freshman mathematical methods or mathematics.

Senior Freshmen

BIOLOGY

Ten 5 credit modules are offered in biology which build on the material covered in the Junior Freshman 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 Plant and animal bioresources

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 chemistry modules: CH2201 and CH2202, each of 10 credits. Lectures are complemented by laboratory work. In addition, students will participate in a team based activity which will involve a research and presentation exercise on some aspect of everyday 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 Freshman year. Building on knowledge acquired in the Junior Freshman year, topics covered at Senior Freshman 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 and an understanding of key concepts in geography are also developed in the Senior Freshman year through a module dealing with the collection and analysis of geographical information, including remotely sensed satellite data that

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are in digital form. Practical and fieldwork skills are also developed during the Senior Freshman year.

GEOLOGY

The modules include lectures and practical work on Earth materials (elementary crystallography, polarised light microscopy, mineralogy, and petrography) and invertebrate palaeontology. They also include the interpretation of geological maps, introductory geophysics, large-scale and small-scale geological structures, and Ireland's geology and geological resources. In addition, two half-day field excursions are held in the Dublin area, and a residential field course is held during Hilary term. This latter field course is very strongly recommended for prospective geology Sophister students.

MATHEMATICS

These modules are a continuation of the topics introduced in Junior Freshman 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, prerequisite MA1S12)

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

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

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

MA22S3 Fourier analysis for science (5 credits, prerequisite MA1S12)

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

MA22S4 Mechanics (5 credits, prerequisites MA22S1, MA22S3)

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

MA22S6 Numerical and data analysis (5 credits, prerequisite MA1S12)

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, optics, current electricity and thermodynamics. The module PY2P20 (modern physics) includes lectures on special relativity, nuclear physics, quantum physics, 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 WITH CELL BIOLOGY

Biochemistry with cell biology is a moderatorship course offered by the School of Biochemistry and Immunology. The emphasis in this course is on understanding how living cells perform their vital functions at both the cellular and molecular levels of organisation. The course deals with both recent discoveries in biochemistry and cell biology and with the core material in these disciplines in order to provide the basis for understanding the mechanisms that make life possible. The Junior Sophister year consists of a varied programme of lectures, practicals, tutorials and a mini-review of the literature on a chosen topic. In the Senior Sophister year, students carry out an extended research project in the area of cell biology and its biochemical basis in one of the independent research laboratories in the school. Lecture topics covered

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include neurobiology, developmental biology, cell signalling, cancer and the cell cycle. 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. If biochemistry with cell biology is studied in the Senior Sophister year, 10 per cent of the total available marks in the moderatorship are awarded at the Junior Sophister examination.

BIOCHEMISTRY WITH STRUCTURAL BIOLOGY

Biochemistry with structural biology is a moderatorship course offered by the School of Biochemistry and Immunology. The emphasis in this course is on understanding how biological systems perform their vital functions at the molecular level, in scales ranging from cellular organelles to atomic resolution of proteins, DNA and RNA. The curriculum will include current techniques in structural biology, and will draw expertise from the protein X-ray Crystallography Group as well as the newly established Molecular Design Group. The overall aim is to reveal how proteomics, bioinformatics and structural biology converge to provide a structural perspective on biological processes occurring in living cells. The Junior Sophister year consists of a varied programme of lectures, practicals, tutorials and a mini-review of the literature on a chosen topic. In the Senior Sophister year, students carry out an extended research project based on structural approaches to biological problems in one of the independent research laboratories in the school. Lecture topics covered include bioinformatics, proteomics, drug design, nanomachines, diseases of protein conformation, neurobiology and developmental biology. 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. If biochemistry with structural biology is studied in the Senior Sophister year, 10 per cent of the total available marks in the moderatorship are awarded at the Junior Sophister examination.

CHEMISTRY

Junior Sophisters take modules in organic, inorganic, physical, environmental and medicinal chemistry covering topics such as organic mechanisms and synthetic methods, heterocyclics, natural products, amino acids and peptides, organic and inorganic polymers, group theory, spectroscopy and other physical methods, quantum chemistry and statistical mechanics, advanced thermodynamics, coordination chemistry, organometallics, catalysis and surface chemistry, electrochemistry, chemistry of the atmosphere, 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, and also include homogeneous catalysis, physical organic chemistry, reaction dynamics, photochemistry and solid state chemistry. A wide range of optional topics is provided including interdisciplinary topics such as environmental chemistry and medicinal chemistry. 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 make presentations which may include one or more essays, written communications, seminars and posters during the year. The final chemistry degree mark is composed of 20 per cent from the Junior Sophister year and 80 per cent from the Senior Sophister year.

ENVIRONMENTAL SCIENCES

Environmental sciences is a multidisciplinary subject which focuses on understanding and

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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 Chemistry 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, analytical chemistry, hydrology, ground water quality and water treatment, geographical information systems, and the use of stable isotopes. Emphasis in the moderatorship is on the student acquiring laboratory and field skills, to reflect this there are a number of field excursions that students may choose in the Junior Sophister year. An introductory autumn field trip begins the Junior Sophister year and is based in and around Dublin and Wicklow where the student is introduced to skills in data collection and analysis. During the second semester students may attend the Botany Mediterranean expedition or a terrestrial wildlife ecology field trip run by Zoology.

FUNCTIONAL BIOLOGY – THE COMPARATIVE PHYSIOLOGY OF ORGANISMS

This course 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 both plants and animals in the context of their evolutionary histories. It is a research led course integrating with 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). Functional biology is an emerging field describing the comparative physiology of plants and animals. 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 structure, anatomy, metabolism; applied laboratory techniques; plant molecular biology; developmental biology; parasitology; experimental design and analysis; neurogenetics; plant molecular genetics I; gene expression and Broad Curriculum. Senior Sophister modules comprise of a research project; neurodevelopment and *Drosophila* developmental genetics; special essay; tutorials focus on specialist topics in functional biology; plant-animal interactions; environmental physiology; plant molecular genetics II; plant developmental genetics.

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. A field course is organised in Hilary term. 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.

The Senior Sophister programme 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 breeding, human genetics 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.

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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. If genetics is studied in the Senior Sophister year, 10 per cent of the total available marks in the moderatorship are awarded on the basis of the Junior Sophister examinations.

GEOGRAPHY

Geography in the two Sophister years constitutes a progressive programme 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 compulsory core modules in geographical information, the history and philosophy of geography and advanced research methods, and optional core modules covering various aspects of human, environmental and physical geography. Students are 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. In the geography moderatorship, 20 per cent of the total available marks in the moderatorship are awarded at the Junior Sophister examination.

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 Freshman and Sophister years are available from the Geography website and programme 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

The Junior Sophister year consists of a range of modules involving lectures and practical work in the main branches of the geological sciences. A series of transferable as well as subject specific skills are developed during this year. Junior Sophister students attend at least two major field classes away from Dublin.

In the Senior Sophister year, students attend a set of core modules in geology and choose from a range of optional modules, some of which are provided by other schools or departments. Senior Sophisters undertake an independent project which is the subject of a dissertation and also attend field classes.

Students wishing to read geology are very strongly advised to attend the residential field course in their Senior Freshman year.

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IMMUNOLOGY²⁶

Students may opt to take a moderatorship in immunology offered by the School of Biochemistry and Immunology. Much of the content is shared with those taking biochemistry with cell biology and biochemistry with structural biology, but there are specialised modules in immunology in both Sophister years. 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. 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 final year include viral evasion strategies, cytokine signalling, clinical immunology, neuroimmunology and innate and adaptive immunity in disease. Other topics covered include apoptosis, cancer and invasion, proteomics and cytoskeleton. Assistance and advice in future careers is offered. If immunology is studied in the Senior Sophister year, 10 per cent of the total available marks in the moderatorship are awarded at the Junior Sophister examination.

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 Freshman 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 are also required to take additional modules in immunology and genetics. 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 7-8 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. In the microbiology moderatorship, 10 per cent of the total available marks in the moderatorship are awarded at the Junior Sophister examination in microbiology.

MOLECULAR MEDICINE

Molecular medicine is a moderatorship run jointly by the School of Biochemistry and

²⁶Prior to 2011-12 this Sophister option was called biochemistry with immunology.

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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 (stem cells and gene therapy, 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. If molecular medicine is studied in the Senior Sophister year, 10 per cent of the total available marks in the moderatorship are awarded at the Junior Sophister examination.

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, PY3A01 astrophysics I. The PY3PP1 practical module of 20 credits combines set experiments of an advanced nature and 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. If physics is studied in the Senior Sophister year, the marks awarded at the Junior Sophister examination count as 20 per cent of the total available marks in moderatorship.

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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, PY4A04 interstellar medium and cosmology. The PY4AP1 practical module of 25 credits combines a component of problem-solving and an extended research project in physics or astrophysics. If physics and astrophysics is studied in the Senior Sophister year, the marks awarded at the Junior Sophister examination count as 20 per cent of the total available marks in moderatorship.

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 Freshman 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 cellular 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 programme 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. In the physiology moderatorship, 10 per cent of the total available marks in the moderatorship are awarded at the Junior Sophister examination in physiology.

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 SCIENCES²⁷

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 Mediterranean or Tropics. 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

²⁷Prior to 2011-12 this Sophister option was called botany.

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programme 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, plant cell ultrastructure, anatomy and metabolism, fundamentals of ecology, 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 either a Broad Curriculum module or a molecular genetics module offered by the School of Genetics and Microbiology.

Senior Sophisters take a mix of mandatory and optional modules in environmental physiology, plant community ecology, plant conservation and biodiversity, data analysis, global environmental change, plant-animal interactions, 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.

In most modules, practical notebooks and prescribed exercises form part of the assessment. The workshops and tutorials will be assessed by essays, small project reports, literature reviews, oral presentations and by answers in problem-solving sessions.

ZOOLOGY

The Department of 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 programme highlights the major concerns of modern zoology and introduces the student to microscopical, molecular biological and analytical techniques and computer-aided data handling procedures. 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. A practical module on molecular techniques covers the application of molecular biology to zoological research. Freshwater, marine and terrestrial fieldwork gives another opportunity to learn about the diagnostic features of various animals and their interactions with the environment. Elective modules cover marine and freshwater biology and wildlife management.

The Senior Sophister programme is largely tutorial-taught. Senior Sophister students choose advanced modules from topics in medical and environmental zoology and can pursue personal interests by selecting a series of special subject tutorials from the fields of freshwater and marine zoology, wildlife biology, ecology, developmental biology and parasitology. A research project is a significant part of the Senior Sophister year.

MODERATORSHIP IN EARTH SCIENCES

26 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 Freshman modules from the science (TR071) programme. Students in their Senior Sophister year have the opportunity to take elective modules (up to a total of 10 credits) chosen from the Broad Curriculum cross-faculty modules or language modules.

27 The course differs from the moderatorships in geography and geology in its prescribed combination of Freshman modules that are considered most appropriate for the field of earth sciences. 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.

28 The earth sciences moderatorship aims to produce graduates with a broad knowledge of the planet Earth, with a particular emphasis on the inhabited surface. In doing so, the degree programme provides students with a firm grounding in those aspects of geology and geography

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that relate to the surface of the Earth and to surface-forming and atmospheric and oceanic processes.

Modules

Junior Freshmen

Introduction to geography (physical and environmental), geology, foundation physics, physical chemistry and mathematical methods

Senior Freshmen

Earth sciences students will take prescribed geography and geology modules together with geochemistry for earth scientists and physics for earth scientists.

Junior Sophisters

Earth sciences students will take prescribed modules in equal proportions from the geography and geology Junior Sophister modules.

Senior Sophisters

The Senior Sophister earth sciences course comprises a compulsory research project (20 credits), geography modules of up to 20 credits and geology modules of up to 20 credits. The latter components are selected from available Senior Sophister geography and geology modules. Optional modules from the Broad Curriculum or language modules (up to 10 credits) may be taken with a *pro rata* reduction in the optional components from geography and geology.

MODERATORSHIP IN HUMAN GENETICS

29 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.

30 The course differs from the moderatorship in genetics in the obligation to study a particular combination of modules in the four year programme 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.

31 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, RFLP mapping, 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.

32 A tutorial programme in association with relevant College schools and departments and outside authorities where appropriate, extending over the Freshman 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.

33 A student who has taken the specified modules in biology, chemistry and mathematics in the Freshman 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

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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.

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

Modules

Junior Freshmen

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

Senior Freshmen

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. biochemistry 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. 10 per cent of the total available marks in the moderatorship are awarded on the basis of the Junior Sophister examinations.

MODERATORSHIP IN CHEMISTRY WITH MOLECULAR MODELLING

35 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.

36 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.

37 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 their qualifications at entry, as well as their academic record in College, and any transfer will be subject to the availability of places.

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

Modules

Junior Freshmen

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 tutorials will be given on molecular modelling.

Senior Freshmen

Chemistry modules CH2201 and CH2202, mathematics modules MA22S1, MA22S2 and
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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 molecular modelling tutorials and computational molecular modelling laboratories.

Junior Sophisters

The course will comprise the core of the chemistry modules 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

The core of the chemistry moderatorship modules will be taken as well as specialist molecular modelling modules which will develop on topics introduced in the Junior Sophister year. 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 is composed of 20 per cent from the Junior Sophister year and 80 per cent from the Senior Sophister year.

MODERATORSHIP IN MEDICINAL CHEMISTRY

39 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, which is 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.

40 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.

41 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.

42 The medicinal chemistry course for the Freshman 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 there will be some modules common with the TR071 modules, students at this stage will study the more specialised aspects of medicinal chemistry.

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

Modules

Junior Freshmen

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 Freshmen

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, MA22S6.

Junior Sophisters

Medicinal chemistry students will share organic chemistry modules with TR071 students, and will also share some relevant inorganic and physical chemistry modules. In addition, they 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 chemistry Senior Sophister 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 is composed of 20 per cent from the Junior Sophister year and 80 per cent from the Senior Sophister year.

MODERATORSHIP IN NANOSCIENCE, PHYSICS AND CHEMISTRY OF ADVANCED MATERIALS²⁸

44 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.

45 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 which 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.

46 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.

47 A student who has taken mathematics, chemistry and physics in the Freshman 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

²⁸Prior to 2011-12 this course was called the Moderatorship in Physics and Chemistry of Advanced Materials.

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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.

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

Modules

Junior Freshmen

Chemistry modules CH1101 and CH1102, mathematics modules MA1S11 and MA1S12 and physics modules PY1P10 and PY1P20. In addition, special tutorials/seminars in nanoscience will be given.

Senior Freshmen

Chemistry modules CH2201 and CH2202, mathematics modules MA22S1, MA22S2, MA22S3 and MA22S4 and physics modules PY2P10, PY2M20. In addition, special tutorials/seminars will be given in advanced materials.

Junior Sophisters

The Junior Sophister year consists of eight modules of 5 credits each and includes 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 (20 credits) introduces students to a wide range of characterisation methods and incorporates a component of communication skills and career development.

Senior Sophisters

The Senior Sophister year contains 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 problem-solving techniques in physics and chemistry. The final physics and chemistry of advanced materials degree mark is composed of 20 per cent from the Junior Sophister year and 80 per cent from the Senior Sophister year.

MODERATORSHIP IN POLITICAL SCIENCE AND GEOGRAPHY

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

BACHELOR IN SCIENCE (HUMAN HEALTH AND DISEASE)

50 For details see FACULTY OF HEALTH SCIENCES.

VI OTHER COURSES

FRENCH FOR APPLIED SCIENTISTS

1 An optional course of two years' duration is available to engineering science undergraduates (starting in their Senior Freshman year) or those with equivalent qualifications. The course continues over two years and aims to give a knowledge of basic French grammar and some relevant technical vocabulary.

GERMAN FOR APPLIED SCIENTISTS

2 This is a programme of supported self-instruction that the Centre for Language and Communication Studies provides for undergraduates in the Faculty of Engineering, Mathematics

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and Science in the Senior Freshman and Junior Sophister years. The aim of the programme is to equip students with an ability to communicate through German in everyday situations and to extend their knowledge of the language to areas related to their developing academic and professional interests. In the two weeks immediately preceding Michaelmas teaching term students who have not learned German before attend an eight-day intensive beginners course and all students attend a two-day introduction to self-instructional language learning.

VII 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.