Faculty of Engineering, Mathematics and Science

I GENERAL FACULTY REGULATIONS[1]

Degrees

1 The faculty provides courses leading to the following degrees:

(a) COMPUTER SCIENCE AND STATISTICS

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

(b) ENGINEERING SCIENCE

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

(c) MATHEMATICS[2]

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

(d) SCIENCE[2]

Bachelor in Arts (Moderatorships in Science (in one of the following subjects: biochemistry, botany, chemistry, chemistry with molecular modelling, environmental sciences, genetics, geography, geology, geoscience, human genetics, immunology, medicinal chemistry, microbiology, molecular medicine, nanoscience, neuroscience, physics, physics and astrophysics, physiology, plant sciences, zoology), in Earth Sciences, in Human Genetics, in Chemistry with Molecular Modelling, in Medicinal Chemistry, and in Nanoscience, Physics and Chemistry of Advanced Materials.

Diploma

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

Admission

3 See ADMISSION REQUIREMENTS.

Advanced entry

4 See GENERAL REGULATIONS AND INFORMATION.

Academic progress

5 See GENERAL REGULATIONS AND INFORMATION.

Examinations and assessment

6 See GENERAL REGULATIONS AND INFORMATION.

Repetition of year

7 See GENERAL REGULATIONS AND INFORMATION.

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

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

Transfer of course

8 See GENERAL REGULATIONS AND INFORMATION.

Foundation scholarship

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

Gold medals and prizes

10 See GENERAL REGULATIONS AND INFORMATION.

Ordinary degree of B.A.

11 See GENERAL REGULATIONS AND INFORMATION.

II COURSES IN COMPUTER SCIENCE AND STATISTICS

MODERATORSHIP IN COMPUTER SCIENCE AND BUSINESS[3]

Admission

1 For admission requirements see ADMISSION REQUIREMENTS section I, table A, note 15.

Course

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

Progression

3 For assessment and academic progress regulations, please refer to GENERAL REGULATIONS AND INFORMATION.

4 The pass mark in each year is 40 per cent. Students must submit prescribed course work in each year. Students who fail to do so may be refused permission to take all or part of the examinations for that year.

Moderatorship degree

5 The B.A. (Moderatorship) degree result is calculated as a credit-weighted average of the overall results achieved in the Senior Sophister year.

Syllabus

6 **Junior Freshmen**

Students must take three mandatory modules:

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

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

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

[3]Prior to 2012-13 this course was called the Moderatorship in Business and Computing.

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

7 **Senior Freshmen**

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

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

Students are required to take the following computer science modules:

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

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

8 **Junior Sophisters**

Students must take 60 credits in total with an even distribution over the two semesters. Students must take at least 20 credits in business and 20 credits in computer science.

BUSINESS MODULES

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

COMPUTER SCIENCE MODULES

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

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

9 **Senior Sophisters**

*Students must take 60 credits in total with an even distribution over the two semesters. Students must take at least 15 credits in business and 15 credits in computer science. The computer science final year project is mandatory.

BUSINESS MODULES

BU4511 International business and the global economy (15 credits)
BU4522 Exploring organisational experiences (15 credits)
BU4530 Financial reporting and analysis (15 credits)
BU4640 Derivatives and international finance (15 credits)
BU4550 Advances in marketing theory and practice (15 credits)
BU4580 Managing new product development (15 credits)
BU4621 Social innovation and social impact (15 credits)
BU4630 Economic policy and business history (15 credits)

COMPUTER SCIENCE MODULES

CS4091 Final year project (15 credits*)
CS3031 Advanced telecommunications (5 credits)
CS4001 Fuzzy logic (5 credits)
CS4004 Formal verification (5 credits)
CS4012 Topics in functional programming (5 credits)
CS4400 Internet applications (5 credits)
CS4051 Human factors (5 credits)
CS4052 Computer graphics (5 credits)
CS4053 Computer vision (5 credits)
CS4404 Machine learning (5 credits)
ST4500 Strategic information systems (10 credits)

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

*Will change to 20 credits with effect from 2020-21.

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

Course

10 The programme will normally last for four or five years and will lead to the degrees of B.A. (Moderatorship) (after four years) and Master in Computer Science (after five years).

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

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

Students on the four-year programme leading to the B.A. (Moderatorship) degree complete a substantial capstone project in fourth year.

Progression

12 For assessment and academic progress regulations, please refer to GENERAL REGULATIONS AND INFORMATION.

13 The pass mark in the first, second, third and fourth years of this programme is 40 per cent. The pass mark in fifth year (the master's year) of this programme is 50 per cent.

14 Students must achieve an average of at least 60 per cent at the first attempt of their third year examinations to be eligible to participate in the master's internship in fourth year. Students who have passed the third year but who do not choose to proceed to the fourth year of the five-year master's programme, or are ineligible to participate in the master's internship, may instead proceed to the final year of the four-year programme, leading to the B.A. (Moderatorship) degree.

Students who pass the fourth year of the five year master's course, achieve an average of at least 60 per cent at the first attempt of their fourth year examinations and satisfy the requirements for the award of Moderatorship in Computer Science may progress to the fifth year or exit the course with a B.A. (Moderatorship) degree.

Moderatorship degree

15 Students who have passed fourth year may have the B.A. (Moderatorship) degree conferred if they do not choose, or are not allowed, to proceed to the fifth year of the course. Students who are eligible and choose to proceed to the fifth year of the programme will be awarded a classified B.A. (Moderatorship) degree on completion of fifth year.

The B.A. (Moderatorship) degree result is calculated as a weighted average of the overall results achieved in third year (contributing 20 per cent) and fourth year (contributing 80 per cent). Students who enter the programme from 2019-20 onwards will have their B.A. (Moderatorship) degree result calculated as a weighted average of their overall results achieved in third year (contributing 30 per cent) and fourth year (contributing 70 per cent). The B.A. (Moderatorship) degree result of candidates who spend one semester or more of third year studying abroad will be determined by their fourth year results only.[4]

Master in Computer Science degree

16 Successful candidates at the fifth year examinations will be awarded the degree of Master in Computer Science or Master in Computer Science with distinction. A distinction shall require at least 70 per cent in the dissertation and at least 70 per cent in the final credit-weighted average mark.

Modules

17 **Year 1**

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

18 **Year 2**

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

[4]This will change for students entering from 2019-20 onwards.

19 **Year 3**

ST3009 Statistical methods for computer science (5 credits)
CS3011 Symbolic programming (5 credits)
CS3012 Software engineering (5 credits)
CS3013 Software engineering group project (5 credits)
CS3014 Concurrent systems (5 credits)
CS3016 Introduction to functional programming (5 credits)
CS3021 Computer architecture II (5 credits)
CS3031 Advanced telecommunications (5 credits)
CS3041 Information management II (5 credits)
CS3061 Artificial intelligence I (5 credits)
CS3081 Computational mathematics (5 credits)
CS3071 Compiler design I (5 credits)
Additional topics

20 **Year 4**[5]

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

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

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

and must choose four options from the following list:[5]

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

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

CS7091 Industrial/research laboratory internship (30 credits)

and must choose four options[6] from the following list:[5]

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

[5]It may not be possible to offer all of the listed options in each year. Some options may have prerequisites.
[6]A maximum of 20 credits of CS4 level modules can be taken over year four and five.

21 **Year 5**

CS7064 Research methods (5 credits)
CS7092 Master in Computer Science dissertation (30 credits)

and five options from the following list:[5]

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

MODERATORSHIP IN COMPUTER SCIENCE AND LANGUAGE

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

MODERATORSHIP IN MANAGEMENT SCIENCE AND INFORMATION SYSTEMS STUDIES

23 This is a four year programme and will lead to the degree of B.A. (Moderatorship) of Management Science and Information Systems Studies.

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

Progression

25 In all years students are assessed by assignments and tests during the year and/or by formal examinations. The pass mark in each year of the course is 40 per cent.

Moderatorship degree

26 The Junior Sophister and Senior Sophister results together constitute the moderatorship examination to which they contribute 35 percent and 65 percent of the marks respectively. For students who enter the programme from 2019-20 onwards, the Junior Sophister and Senior Sophister results will contribute 30 percent and 70 percent of the moderatorship result respectively. For candidates who spend one or more semesters of their Junior Sophister year

abroad, their B.A. (Moderatorship) degree result will be determined by their Senior Sophister year results only.[7]

Modules

27 **Junior Freshmen**

Students take mandatory modules in business and management, computer science, economics, management science, mathematics and statistics.

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

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

28 **Senior Freshmen**

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

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

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

29 **Junior Sophisters**

Mandatory modules must be taken in a number of areas including information systems, management science and statistics. Students also take an option from a list of modules in business, computer science, economics, mathematics and statistics.

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

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

[7]This will change for students entering from 2019-20 onwards.

30 **Senior Sophisters**

Mandatory modules must be taken in information systems, management science and statistics, and a capstone project undertaken based on a real industrial or organisational problem. Students also take an option from a list of modules in business, computer science, economics, mathematics and statistics. The choice of options may be restricted by staff availability and timetable considerations. Each student's choice of elective modules and final year project must be approved by the course director.

ST4500 Strategic information systems (10 credits)
ST4003 Data analytics (10 credits)
ST4005 Decision analysis (5 credits)
ST4001 MSISS final year project (20 credits)
Option (15 credits)

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

DIPLOMA IN INFORMATION SYSTEMS (EVENING COURSE)

31 There will be no admission to the first year of this programme in 2018-19.

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

32 There will be no admission into this programme in 2018-19.

Progression

33 The pass mark in each year of this programme is 40 per cent.

Degree award

34 Successful candidates in year 4 are placed in the following classes: first class honors, second class honors (with two divisions, first and second), and third class honors. The degree result is based entirely on a credit-weighted average of marks attained in year 4 modules.

Choice of options

35 In both years of the B.Sc. (Honors) Information Systems degree the choice of options may be restricted due to resource or timetable considerations. Modules with insufficient student numbers will not be offered. Information concerning elective modules may be obtained from the Programme Director, Information Systems Programme. Each student's choice of elective modules must be approved by the Programme Director.

Syllabus

36 **Year 3**

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

37 **Year 4**

CS4101 Information security (10 credits)
CS4102 Innovation (10 credits)
CS4103 Information systems management (10 credits)
CS4104 Advanced information systems (10 credits)

CS4105 Final-year project (20 credits)
CS4106 Information systems development III (10 credits)

In the fourth year CS4105 is mandatory. In addition, students choose modules worth 40 credits from the remaining modules in the list above.[8]

III COURSES IN ENGINEERING SCIENCE

Fees

1 See COLLEGE CHARGES.

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

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

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

civil, structural and environmental engineering
mechanical and manufacturing engineering
biomedical engineering
electronic engineering
computer engineering
electronic/computer engineering (combined programme)

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

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

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

Inbound I.N.S.A. de Lyon students: A similar arrangement exists for engineering students of the I.N.S.A. de Lyon whereby suitably qualified candidates are admitted to the fourth year of the Trinity College Dublin engineering course and complete two years here taking modules from the engineering department corresponding to their chosen option in I.N.S.A. de Lyon. Following successful completion of these two years in Trinity College Dublin students are eligible to be

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

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

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

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

Syllabus

8 **Year 1**

Students take mandatory modules amounting to 60 credits.

1E1	Engineering mathematics I (5 credits)
1E2	Engineering mathematics II (5 credits)
1E3	Computer engineering I (5 credits)
1E4	Physics (5 credits)
1E5	Chemistry (5 credits)
1E6	Electrical engineering (5 credits)
1E7	Mechanics (5 credits)
1E8	Introduction to professional engineering (5 credits)
1E9	Engineering design I: graphics and computer aided engineering (5 credits)
1E10	Engineering design II: project (10 credits)
1E11	Experimental methods (5 credits)

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

9 **Year 2**

Students take mandatory modules amounting to 60 credits.

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

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

10 **Year 3**

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

3E1	Engineering mathematics V (5 credits) or
3E1a	Engineering analysis (5 credits)

3E3 Probability and statistics (5 credits)
3E4 Innovation and entrepreneurship for engineers (5 credits)

and admissible combinations from the following:[9]

3A1 Engineering surveying (5 credits)
3A2 Structural design (5 credits)
3A3 Hydraulics (5 credits)
3A4 Structural analysis (5 credits)
3A5 Soil mechanics (5 credits)
3A6 Construction technology (5 credits)
3A7 Transportation and highway engineering (5 credits)
3A8 Geology for engineers (5 credits)
3A9 Group design project (10 credits)
3B1 Thermodynamics (5 credits)
3B2 Fluid mechanics 1 (5 credits)
3B3 Mechanics of solids (5 credits)
3B4 Mechanical engineering materials (5 credits)
3B5 Mechanics of machines (5 credits)
3B6 Mechatronics (instrumentation and control) (5 credits)
3B7 Manufacturing technology and systems (5 credits)
3B8 Universal design innovation (10 credits)
3C1 Signals and systems (5 credits)
3C2 Digital circuits (5 credits)
3C3 Analogue circuits (5 credits)
3C4 Applied electromagnetism (5 credits)
3C5 Telecommunications (5 credits)
3C7 Digital systems design (5 credits)
(for electronic and electronic/computer engineering strands)
3C8 Digital circuits design (5 credits)
(for electronic and electronic/computer engineering strands)
3C9 Analogue circuits design (5 credits) (for electronic engineering strand only)
3D1 Microprocessor systems 1 (5 credits)
3D2 Microprocessor systems 2 (5 credits)
3D3 Computer networks (5 credits)
3D4 Operating systems and concurrent systems (5 credits)
3D5A Data structures and algorithms (5 credits)
(for all electronic/computer engineering strands)
3D5B Software design and implementation (5 credits)
(for computer engineering strand only)
CS2022 Computer architecture I (5 credits)
3BIO1 Anatomy and physiology (5 credits)
3BIO2 Biomedical design project (5 credits)
3BIO3 Quantitative physiology (5 credits)

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

11 **Year 4**

Students take admissible combinations of modules amounting to 60 credits by following one of three modes of study involving modules and project work in College (mode 1), a project-based

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

engineering internship (mode 2), or an international academic exchange (mode 3), comprising admissible combinations of the following:[10]

4E1	Management for engineers (5 credits)
4E2	Engineering project (15 credits)
4E2B	Engineering design group project: part 1 (5 credits)
4E2C	Engineering design group project: part 2 (10 credits)
4E3	Research methods (5 credits)
4E4	Engineering project internship (30 credits)
4E5	Innovation in product development (20 credits)
4E6	Robotic design (10 credits)
4A1	Civil engineering materials (5 credits)
4A2	Hydrogeology and engineering geology (5 credits)
4A3(1)	Environmental engineering I (5 credits)
4A3(2)	Environmental engineering II (5 credits)
4A4	Hydraulics (5 credits)
4A5(1)	Geotechnical engineering I (5 credits)
4A5(2)	Geotechnical engineering II (5 credits)
4A6(1)	Structures I (5 credits)
4A6(2)	Structures II (5 credits)
4A6(3)	Structures III (5 credits)
4A7	Design and the built environment (5 credits)
4A8	Transportation (5 credits)
4B1	Mechanics of solids (5 credits)
4B2	Forensic materials engineering (5 credits)
4B3	Thermodynamics (5 credits)
4B4	Heat transfer (5 credits)
4B5	Manufacturing technology (5 credits)
4B6	Manufacturing systems and project management (5 credits)
4B7	Computer aided design (5 credits)
4B9	Control engineering 1 (5 credits)
4B10	Instrumentation and experimental techniques (5 credits)
4B11	Engineering vibrations and noise (5 credits)
4B12	Acoustics (5 credits)
4B13	Fluid mechanics 2 (5 credits)
4B15	Introduction to bioengineering (5 credits)
4B16	Biomechanics of tissues and plants (5 credits)
4B17	Multibody dynamics (5 credits)
4B21	Thermal engineering and technology (5 credits)
4BIO1	Cell and molecular biology (5 credits)
4BIO2	Telemedicine (5 credits)
4BIO3	Physical and physiological measurement (5 credits)
4BIO4	Experimental and research methods in biomedical engineering (5 credits)
4BIO5	Biomechanics (5 credits)
4BIO6	Biomaterials (5 credits)
4C1	Integrated systems design (5 credits)
4C2	Microelectronic circuits (5 credits)
4C3	Digital control systems (5 credits)
4C4	Next generation networks (5 credits)
4C5	Digital signal processing (5 credits)
4C6	Microelectronic technology (5 credits)
4C7	Information and communication theory (5 credits)

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

4C8	Digital image and video processing (5 credits)
4C10	Digital communications (5 credits)
4C11	Optoelectronics (5 credits)
4C12	Applied signal processing (5 credits)
4C14	Introduction to bioengineering (5 credits)
4C15	Analogue signal processing (5 credits)
4C16	Deep learning and its applications (10 credits)
4C17	Electromagnetic fields and waves (5 credits)
4MEMS8	Research methods (5 credits)
4MEMS9	User centred design innovation (5 credits)
CS3421	Computer architecture II (5 credits)
CS4D2A	Information management II (5 credits)
CS4D2B	Knowledge engineering (5 credits)
CS4031	Next generation networks (5 credits)
CS4052	Computer graphics (5 credits)
CS4404	Machine learning (5 credits)
CS4053	Computer vision (5 credits)
CS4405	Optimisation algorithms for data analysis (5 credits)
CS4406	Data visualisation (5 credits)
CS4400	Internet applications (5 credits)
CS7434	Augmented reality (5 credits)
CS4407	Security and privacy (5 credits)

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

12 **Year 5**

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

5E1	Engineering research project (25 credits)
5E2	Research methods (5 credits)
5E3	Innovation in product development (15 credits)
5E4	Introduction to computational fluid mechanics (5 credits)
C1	Renewable energy I (5 credits)
C2	Renewable energy II (5 credits)
C3	Modelling of engineering systems (5 credits)
C4	Façade engineering (5 credits)
C5	Advanced spatial analysis using GIS (5 credits)
C6	Construction innovation and research (5 credits)
E2	Spatial environmental analysis and impact assessment using GIS (5 credits)
E3	Air quality and noise pollution (5 credits)
E4	Waste management and energy recovery (5 credits)
E5	Water quality and hydrological modelling (5 credits)
E7	Sustainable water supply and sanitation (5 credits)
J1	Wind energy (5 credits)
J2	Solar energy conversion and applications (5 credits)
J3	Building energy physics and control (5 credits)
J4	Energy policy and demand (5 credits)
J5	Renewable heat (5 credits)
J6	Wave and hydro energy (5 credits)
S1	Geotechnical engineering (5 credits)
S2	Advanced computation for structures (5 credits)
S3	Wind and earthquake engineering (5 credits)
S4	Bridge engineering (5 credits)

S5	Advanced concrete technology (5 credits)
S6	Offshore geotechnical engineering (5 credits)
S8	Concrete durability and sustainability (5 credits)
S9	Advanced theory of structures (5 credits)
T1	Transportation policy (5 credits)
T2	Transport modelling and planning (5 credits)
T3	Highway engineering (5 credits)
T4	Intelligent transportation systems (ITS) (5 credits)
T5	Transport design (5 credits)
5B1	Flow induced vibration and fluid structure interaction (5 credits)
5B2	Advanced materials (5 credits)
5B3	Advanced thermal fluids design (10 credits)
5B4	Engineering vibration and noise (5 credits)
5B5	Human factors (5 credits)
5B9	Control engineering 2 (5 credits)
5B10	Instrumentation and experimental techniques (5 credits)
5M1	Mechanics of solids (5 credits)
5M2	Forensic materials engineering (5 credits)
5M3	Thermodynamics (5 credits)
5M4	Heat transfer (5 credits)
5M5	Manufacturing technology (5 credits)
5M6	Manufacturing systems and project management (5 credits)
5M7	Computer aided design (5 credits)
5M9	Control engineering 1 (5 credits)
5M12	Acoustics (5 credits)
5M13	Fluid mechanics (5 credits)
5M15	Introduction to bioengineering (5 credits)
5M16	Biomechanics of tissues and implants (5 credits)
5M17	Multibody dynamics (5 credits)
5M21	Thermal engineering and technology (5 credits)
5BIO1	Medical devices (10 credits)
5BIO2	Advanced tissue mechanics and mechanobiology (5 credits)
5BIO3	Tissue engineering (5 credits)
5BIO4	Finite element analysis (5 credits)
5BIO5	Injury biomechanics and musculoskeletal dynamics (5 credits)
5BIO6	Neural signal analysis (5 credits)
5BIO7	Advanced medical imaging (5 credits)
5BIO8	Implanted devices and systems (10 credits)
5BIO9	Foundation medical device design (5 credits)
5C1	Motion picture engineering (10 credits)
5C2	Wireless networks and communications (5 credits)
5C3	Statistical signal processing (5 credits)
5C4	Speech and audio engineering (5 credits)
5C5	Optical fibre communications (5 credits)
5C6	Digital control systems (5 credits)
5C7	Complex systems science (5 credits)
CS4501	Fuzzy logic (5 credits)
CS4521	Advanced computer architecture (5 credits)
CS4504	Formal verification (5 credits)
CS7NS6	Distributed systems (5 credits)
CS7NS2	Internet of things (5 credits)
CS7IS2	Artificial intelligence (5 credits)
CS7GV5	Real time animation (5 credits)

CS7IS5	Adaptive applications (5 credits)
CS7IS1	Knowledge and data engineering (5 credits)
CS7GV2	Mathematics of light and sound (5 credits)
CS7CS3	Advanced software engineering (5 credits)
CS7DS2	Optimisation algorithms for data analysis (5 credits)
CS7DS3	Applied statistical modelling (10 credits)
CS7DS4	Data visualisation (5 credits)
CS7IS3	Information retrieval and web search (5 credits)
CS7IS4	Text analytics (5 credits)
CS7GV3	Real-time rendering (5 credits)
CS7NS1	Scalable computing (5 credits)
CS7NS4	Urban computing (5 credits)
5MEMS1	Micro and precision manufacturing (5 credits)
5MEMS2	Advanced manufacturing I (5 credits)
5MEMS3	Supply chain management (5 credits)
5MEMS4	Operations strategy (5 credits)
5MEMS7	Risk management and safety assessment systems (5 credits)

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

Examinations and assessment

13 As per College's GENERAL REGULATIONS AND INFORMATION, with the following additions for the Engineering and Engineering with Management courses[11]:

(a) The following minimum requirements are necessary for a student to be eligible to proceed to the fifth year of the M.A.I. programme: students must attain at least a grade of II.1 (60-69 per cent) in their B.A.I. degree result or a credit-weighted result of at least 55 per cent in their Junior Sophister year and at least 55 per cent in their Senior Sophister year.

(b) For the purposes of calculating contribution from the Junior Sophister year to the B.A.I. degree award and to determine eligibility to progress to the M.A.I., in the event that examinations are taken at the reassessment session in the Junior Sophister year, all components contributing towards the overall reassessment mark will be capped at 40 per cent.

(c) Students are permitted one repeat of their Senior Sophister year to achieve the grade required to proceed to the fifth year of the course. Should a student choose not to proceed to the fifth year, the overall grade obtained in their first attempt at the Senior Sophister year will be used in the calculation of the degree award, not the grade obtained during the repeat year.

(d) 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 end-of-semester fifth year M.A.I. examinations only. A distinction shall require at least 70 per cent in both the examinations and the dissertation and at least 70 per cent in the final credit-weighted average mark.

Conferring of degrees

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

[11]This will change for students in the Senior Freshman year in 2018-19.

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

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

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

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

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

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

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

Syllabus

20 **Year 1**

Students take mandatory modules amounting to 60 credits.

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

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

21 **Year 2**

Students take mandatory modules amounting to 60 credits.

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

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

22 **Year 3**

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

3B3	Mechanics of solids (5 credits)
3B4	Mechanical engineering materials (5 credits)
3E3	Probability and statistics (5 credits)
3MEMS1	Manufacturing technology II (5 credits)
3MEMS3	Design II (10 credits)
ST3005	Information systems (5 credits)
3MEMS5	Operations and project management (5 credits)
3B1	Thermodynamics (5 credits)
3B2	Fluid mechanics (5 credits)
3B5	Mechanics of machines (5 credits)
3C1	Signals and systems (5 credits)
3BIO1	Anatomy and physiology (5 credits)
ST3010	Applied forecasting (5 credits)

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

23 **Year 4**

Students take admissible combinations of modules amounting to 60 credits. Students follow one of three modes of study involving courses and project work in College (mode 1), a project-based internship (mode 2), or an international academic exchange (mode 3), comprising admissible combinations of the following:[12]

4MEMS1	Engineering project (15 credits)
4MEMS2	Advanced manufacturing I – digital manufacturing (5 credits)
4MEMS3	Supply chain management (5 credits)
4MEMS4	Operations strategy (5 credits)
4MEMS5	Advanced manufacturing II – additive manufacturing and laser processing (5 credits)
4MEMS8	Research methods (5 credits)

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

4MEMS9	User centred design innovation (5 credits)
4E4	Engineering with management project internship (30 credits)
4E5	Innovation in product development (20 credits)
4E6	Robotic design (10 credits)
4A8	Transportation (5 credits)
4B1	Mechanics of solids (5 credits)
4B2	Forensic materials engineering (5 credits)
4B3	Thermodynamics (5 credits)
4B4	Heat transfer (5 credits)
4B7	Computer aided design (5 credits)
4B9	Control engineering 1 (5 credits)
4B10	Instrumentation and experimental techniques (5 credits)
4B11	Engineering vibrations (5 credits)
4B12	Acoustics (5 credits)
4B13	Fluid mechanics 2 (5 credits)
4B17	Multibody dynamics (5 credits)
4BIO5	Biomechanics (5 credits)
4BIO6	Biomaterials (5 credits)
4C8	Digital image and video processing (5 credits)
4C15	Analogue signal processing (5 credits)
4C16	Deep learning and its applications (10 credits)
CS4052	Computer graphics (5 credits)
CS4053	Computer vision (5 credits)
ST3001	Software applications 3 (10 credits)
ST3001A	Software applications 3 (5 credits)
ST3011	Multivariate linear analysis (MLA) (5 credits)
ST4005	Decision analysis (5 credits)
ST4500	Strategic information systems (10 credits)
BU458D	Managing new product development (5 credits)
BU4580A	Managing new product development (10 credits)

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

24 **Year 5**

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

5E1	Engineering research project (25 credits)
5E2	Research methods (5 credits)
5E3	Innovation in product development (15 credits)
5E4	Introduction to computational fluid mechanics (5 credits)
5MEMS1	Advanced manufacturing II – additive manufacturing and laser processing (5 credits)
5MEMS3	Supply chain management (5 credits)
5MEMS7	Risk management and safety assessment systems (5 credits)
C1	Renewable energy I (5 credits)
C2	Renewable energy II (5 credits)
T1	Transportation (5 credits)
5B1	Flow induced vibration and fluid structure interaction (5 credits)
5B2	Advanced materials (5 credits)
5B3	Advanced thermal fluid sciences (5 credits)
5B4	Engineering vibration and noise (5 credits)
5B9	Control engineering 2 (5 credits)

5B10	Instrumentation and experimental techniques (5 credits)
5BIO1	Medical devices (10 credits)
5BIO2	Advanced tissue mechanics and mechanobiology (5 credits)
5BIO3	Tissue engineering (5 credits)
5BIO4	Finite element analysis (5 credits)
5M1	Mechanics of solids (5 credits)
5M2	Forensic materials engineering (5 credits)
5M3	Thermodynamics (5 credits)
5M4	Heat transfer (5 credits)
5M5	Manufacturing technology (5 credits)
5M6	Manufacturing systems and project management (5 credits)
5M7	Computer aided design (5 credits)
5M9	Control engineering 1 (5 credits)
5M12	Acoustics (5 credits)
5M13	Fluid mechanics (5 credits)
5M15	Introduction to bioengineering (5 credits)
5M16	Biomechanics of tissues and implants (5 credits)
5M17	Multibody dynamics (5 credits)
5M21	Thermal engineering and technology (5 credits)
ST3451	Applied linear statistical models I (5 credits)
ST3452	Applied linear statistical models II (5 credits)
ST3453	Stochastic models in space and time I (5 credits)
ST3454	Stochastic models in space and time II (5 credits)
ST3455	Modern statistical methods I (5 credits)
ST3456	Modern statistical methods II (5 credits)
ST3457	Statistical inference I (5 credits)
ST3458	Statistical inference II (5 credits)
ST4003	Data analytics (5 credits)

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

Examinations

25 As §13 above but with specific reference to the B.Sc. (Ing.) instead of the B.A.I. degree.

26 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 end-of-semester fifth year M.A.I. examinations only. A distinction shall require at least 70 per cent in both the examinations and the dissertation and at least 70 per cent in the final credit-weighted average mark.

Conferring of degrees

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

INTERNATIONAL ENGINEERING PROGRAMME (IN PARTNERSHIP WITH THAPAR INSTITUTE OF ENGINEERING AND TECHNOLOGY)

28 Students admitted to the International Engineering Programme (IEP) will have successfully completed two years undergraduate study in Civil, Mechanical, Electronic and Electrical, Computer Engineering, or Electronic and Computer Engineering disciplines at the Thapar Institute of Engineering and Technology (TIET). Students follow the Junior Sophister and Senior Sophister degree years as prescribed in the School of Engineering undergraduate handbook. Progression rules for students in the Sophister years of the degree programme are the same as

for students who enter the programme via the TR032 entry stream. On passing the Junior and Senior Sophister years, students will receive a B.A.I. in Engineering. Upon successful completion of this four year course of study, students may be eligible to pursue the fifth year integrated pathway and receive an M.A.I. degree, provided they meet the strict entry eligibility requirements.

Admission

Students enrolled in the engineering degree course at TIET who have successfully completed the first two years of study and satisfied other requirements are eligible to apply for admission. The application procedure and all entry requirements stipulated by the articulation agreement between TIET and Trinity College Dublin are described in the School of Engineering undergraduate handbook and on its website.

IV SCHOOL OF MATHEMATICS

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

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

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

Fees

4 See COLLEGE CHARGES.

Rowe Fund Library

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

MODERATORSHIP IN MATHEMATICS

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

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

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

Each of these modules is assessed by means of continuous assessment and/or papers set at the examination session at the end of the semester during which the module is delivered.

7 In the Junior Sophister year, students take modules providing a total of 60 credits with modules providing 30 credits taken in each teaching term. At most 10 credits should be

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

In the Senior Sophister year, students take modules at the advanced level providing a total of 60 credits, which, in the academic year 2018-19, must include a 10 credit project (module MA4492). In addition to modules in statistics listed in §17 below, and subject to the agreement of both schools concerned and prerequisites, students may take modules provided by schools in College other than the School of Mathematics with an appropriate mathematical content or significant relation to applications of mathematics (up to at most 20 credits, 10 per term). Projects in the Senior Sophister year (module MA4492) must be approved and undertaken in accordance with regulations established by the School of Mathematics. Projects should be completed and submitted three weeks before the end of Hilary term and subject to a subsequent poster presentation held before the end of Hilary term.

In all years students should make their choice of modules in accordance with the course requirements published by the School of Mathematics before the commencement of the academic year. The Director of Teaching and Learning (Undergraduate) may permit certain module combinations that are not expressly provided for in these published course requirements, provided that the resulting choice of modules accords with the objectives of the moderatorship course. Certain combinations of modules may not be available due to timetabling constraints.

8 Results for examinations and assessments are published according to the following grades: I = 70-100, II_1 = 60-69, II_2 = 50-59, III = 40-49, F_1 = 30-39, F_2 = 0-29.

For students completing the course in 2018-19, the examinations of the two Sophister years count equally towards the overall mark for moderatorship.

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 As per GENERAL REGULATIONS AND INFORMATION.

MODERATORSHIP IN THEORETICAL PHYSICS

11 Theoretical physics is taught jointly by the School of Mathematics and the School of Physics. In each year of study, students must take modules providing a total of 60 credits in accordance with regulations published prior to the commencement of the academic year in the course handbook or on the websites of the schools. The format of content delivery and assessment, as well as any module prerequisites, may vary between different modules and is explained separately in each of the module descriptions. Typical means of assessment include continuous assessment, laboratory work, and/or papers set at the examination sessions.

In the Junior Freshman year, students take 20 credits of physics modules covering material on waves and optics, special relativity, astronomy and astrophysics, statistics, electricity and magnetism, and quantum physics. Students also attend experimental/computational laboratory sessions and tutorials. In mathematics, students take 40 credits of modules covering material in

calculus, real analysis, linear algebra, mechanics, and computer programming.

In the Senior Freshman year, students take physics modules for 20 credits involving lectures on thermodynamics, electricity and magnetism, waves and optics, materials, nuclear and particle physics, oscillations, chaos and complexity, and astronomy. Each of these modules includes practicals with set experiments, computational exercises and group study projects. In mathematics, students take modules for 40 credits on Lagrangian and Hamiltonian mechanics, special relativity, equations of mathematical physics, group theory, real and complex analysis, and calculus on manifolds.

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

In the Senior Sophister year, students take mandatory physics modules on high energy physics, condensed matter theory, quantum optics and information, and problem solving. Students can choose from optional physics modules in topics that may include nanoscience, cosmology, computer simulation, and advanced topics in physics. In mathematics, students can choose from a variety of topics that include, but are not limited to, quantum field theory, standard model, differential geometry, general relativity, and practical numerical simulations. Students can also take at most one 5-credit Broad Curriculum module, subject to timetable availability. Students should also complete a compulsory research project in theoretical physics, which is allocated 10 credits. The project can be supervised by a researcher from either of the schools or, in some cases, by an approved supervisor external to the schools. The choice among optional modules offered across both schools is constrained by the following requirements: *(i)* at least 20 credits of mathematics modules should be taken, and the research project cannot be counted towards this end; *(ii)* at least 5 credits in either quantum field theory or general relativity should be taken, and *(iii)* students must have studied any necessary prerequisite material.

13 Results for examinations and assessments are published according to the following grades: I = 70-100, II_1 = 60-69, II_2 = 50-59, III = 40-49, F_1 = 30-39, F_2 = 0-29.

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

For students successfully completing the Senior Sophister year in the academic year 2018-19, the moderatorship mark is based on the results of both Sophister years, with a weighting of 35 per cent allocated to Junior Sophister modules and a weighting of 65 per cent to the Senior Sophister modules.

Repetition of year in theoretical physics

14 As per GENERAL REGULATIONS AND INFORMATION.

Transfer of course

15 Students may apply through their tutor to transfer from the honor course in theoretical physics to the honor course in mathematics not later than the beginning of the Senior 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 will then make recommendations to the Senior Lecturer. All transfers are subject to general College regulations (see GENERAL REGULATIONS AND INFORMATION).

TWO-SUBJECT MODERATORSHIP COURSES

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

Modules

17 Prerequisites for all modules below are published on the webpage of the School of Mathematics. Students lacking prerequisites for a module must obtain prior permission of the course director to take the module.

Introductory level

MA1111 Linear algebra I (5 credits)
MA1112 Linear algebra II (5 credits)
MA1213 Introduction to group theory (5 credits)
MA1125 Single-variable calculus and introductory analysis (10 credits)
MA1126 Introduction to set theory and general topology (5 credits)
MA1132 Advanced calculus (5 credits)
MA1216 Introduction to number theory and combinatorics (5 credits)
MA1241 Mechanics I (5 credits)
MA1242 Mechanics II (5 credits)
ST1251 Introduction to statistics I (5 credits)
ST1252 Introduction to statistics II (5 credits)
MA1266 Introduction to programming in C (5 credits)

Intermediate level

MA2214 Fields, rings and modules (5 credits)
MA2223 Metric spaces (5 credits)
MA2224 Lebesgue integral (5 credits)
MA2321 Analysis in several real variables (5 credits)
MA2322 Calculus on manifolds (5 credits)
MA2327 Ordinary differential equations (5 credits)
MA2328 Complex analysis (5 credits)
MA232A Euclidean and non-Euclidean geometry (5 credits)
MA2331 Equations of mathematical physics I (5 credits)
MA2332 Equations of mathematical physics II (5 credits)
MA2341 Advanced classical mechanics I (5 credits)
MA2342 Advanced classical mechanics II (5 credits)
MA2361 Computation theory and logic (5 credits)
ST2004 Applied probability I (5 credits)
ST2005 Applied probability II (5 credits)
ST2351 Probability and theoretical statistics I (5 credits)

Advanced modules

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

MA3415 Introduction to Lie algebras (5 credits)
MA3416 Group representations (5 credits)
MA3419 Galois theory (5 credits)
MA341D Introduction to Gröbner bases (5 credits)
MA341L Commutative algebra (5 credits)
MA3421 Functional analysis I (5 credits)
MA3422 Functional analysis II (5 credits)

MA3423 Topics in complex analysis I (5 credits)
MA3424 Topics in complex analysis II (5 credits)
MA3425 Partial differential equations I (5 credits)
MA3426 Partial differential equations II (5 credits)
MA3427 Algebraic topology I (5 credits)
MA3428 Algebraic topology II (5 credits)
MA3429 Differential geometry I (5 credits)
MA342A Harmonic analysis (5 credits)
MA342H Partial differential equations (methods and applications) (5 credits)
MA342N Ordinary differential equations (5 credits)
MA3431 Classical field theory I (5 credits)
MA3432 Classical field theory II (5 credits)
MA3441 Quantum mechanics I (5 credits)
MA3442 Quantum mechanics II (5 credits)
MA3443 Statistical physics I (5 credits)
MA3444 Statistical physics II (5 credits)
MA3461 Computational geometry and computer graphics (5 credits)
MA3464 Computation theory and logic II (5 credits)
MA3469 Practical numerical simulations (5 credits)
MA3484 Methods of mathematical economics (5 credits)
MA3486 Fixed point theorems and economic equilibria (5 credits)
MA4445 Quantum field theory I (5 credits)
MA4446 Quantum field theory II (5 credits)
MA4448 General relativity (5 credits)
MA444D The standard model of elementary particle physics (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.

ST3010 Applied forecasting (5 credits)
ST3011 Multivariate data analysis (5 credits)
ST3453 Stochastic models in space and time I (5 credits)
ST3454 Stochastic models in space and time II (5 credits)
ST3455 Modern statistical methods I (5 credits)
ST3456 Modern statistical methods II (5 credits)
ST4003 Data analytics (10 credits)
ST4005 Decision analysis (5 credits)

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

V COURSES IN SCIENCE

REGULATIONS[13]

1 For students who entered the science programmes in 2018 onwards, the following science programmes are available:

TR060 Biological and biomedical sciences
TR061 Chemical sciences

[13]These regulations should be read in conjunction with GENERAL FACULTY REGULATIONS and GENERAL REGULATIONS AND INFORMATION.

TR062 Geography and geoscience
TR063 Physical sciences
TR031 Mathematics (see SCHOOL OF MATHEMATICS, section IV, §6)
TR035 Theoretical physics (see SCHOOL OF MATHEMATICS, section IV, §11)

TR060 Biological and biomedical sciences

This stream is the pathway for entry into the biological and biomedical sciences, leading to moderatorships in biochemistry, botany, environmental sciences, genetics, human genetics, immunology, microbiology, molecular medicine, neuroscience, and zoology. Students will study a suite of core modules in their Junior Freshman year (40 credits) designed to impart the foundation knowledge required for entry into all moderatorships. In addition, students will choose 20 credits from a suite of approved modules in related and complementary disciplines, designed to enrich and impart breadth to the core curriculum.

Junior Freshman core modules, students take all four modules (40 credits):

BYU11001	From molecules to cells	10 credits
BYU11002	From organisms to ecosystems	10 credits
CHU11B01	Chemistry for biologists	10 credits
MAU11001	Mathematics, statistics and computation	10 credits

Junior Freshman approved modules, students choose 20 credits (10 from each semester):

PYU11F10 PYU11F20	Foundation physics	10 credits
GSU11001	Spaceship Earth: introduction to Earth systems	10 credits
GSU11002	Geology: a beginners guide to planet Earth	10 credits
SEU10001 SEU10002	Science education and communication	10 credits

TR061 Chemical sciences

In the chemical sciences stream, students will study the core concepts that are fundamental to all of chemistry including topics in physical, organic and inorganic chemistry. Moderatorship subjects will be available in chemistry, chemistry with molecular modelling, medicinal chemistry and nanoscience (the physics and chemistry of advanced materials). In the Junior Freshman year, students must take 20 credits of chemistry and 20 credits of mathematics as core modules and choose 20 credits of approved option modules in physics and biology. Students wishing to specialise in medicinal chemistry are required to select biology (10 credits) and foundation physics (10 credits) as their approved options. Students wishing to specialise in nanoscience are required to select physics (20 credits) as approved options.

Junior Freshman core modules, students take all four modules (40 credits):

CHU11101	General and physical chemistry	10 credits
CHU11102	Introduction to inorganic and organic chemistry	10 credits
MAU11S01	Mathematics 1	10 credits
MAU11S02	Mathematics 2	10 credits

Junior Freshman approved modules, students choose 20 credits:

BYU11001 and PYU11F20	From molecules to cells Foundation physics	10 credits 10 credits

or

PYU11P10 and PYU11P20	Physics 1 Physics 2	10 credits 10 credits

TR062 Geography and geoscience

The geography and geoscience degree programme is the new entry pathway to the study of geography, geology and geoscience. Moderatorship subjects will be available in geography and geoscience. The first two years comprise a suite of foundation modules (40 credits per year) designed to provide students with a firm grounding in geography and geoscience. In addition, students will select a further 20 credits per year from a portfolio of approved modules that span the sciences (biology, chemistry, foundation physics) and cognate humanities (human geography). In the final years, students select from a range of more specialist/advanced modules, in addition to undertaking an independent research project. The programme combines classroom lectures, seminars, laboratory-based practical classes, and outdoor field work, including several residential field courses.

Junior Freshman core modules, students take all four modules (40 credits):

GSU11001	Spaceship Earth: introduction to Earth systems	10 credits
GSU11002	Geology: a beginners guide to planet Earth	10 credits
GSU11003	The anthropocene: constructing the human planet	10 credits
MAU11001	Mathematics, statistics and computation	10 credits

Junior Freshman approved modules, students choose 20 credits:

BYU11001	From molecules to cells	10 credits
BYU11002	From organisms to ecosystems	10 credits
CHU11101	General and physical chemistry	10 credits
CHU11102	Introduction to inorganic and organic chemistry	10 credits
PYU11F10 *or* PYU11F20	Foundation physics	10 credits
GGU11026	Human geography	10 credits

TR063 Physical sciences

In the physical sciences stream, students will study the core concepts that are fundamental to all of physics with the opportunity to choose between degrees in the available moderatorship subjects of physics, physics and astrophysics, and nanoscience. Students wishing to specialise in nanoscience are required to select chemistry (20 credits) as approved options.

Junior Freshman core modules, students take all four modules (40 credits):

PYU11P10	Physics 1	10 credits
PYU11P20	Physics 2	10 credits
MAU11S01	Mathematics 1	10 credits
MAU11S02	Mathematics 2	10 credits

Junior Freshman approved modules, students choose 20 credits:

BYU11001	From molecules to cells	10 credits
BYU11002	From individuals to ecosystems	10 credits
CHU11101	General and physical chemistry	10 credits
CHU11102	Introduction to inorganic and organic chemistry	10 credits
GSU11001	Spaceship Earth: introduction to Earth systems	10 credits
GSU11002	Geology: a beginners guide to planet Earth	10 credits

MODERATORSHIP IN SCIENCE

2 For students who entered the TR071 Science course up to and including 2017, the moderatorship in science is available in each of the following subjects: biochemistry, chemistry, environmental sciences, genetics, geography, geology, immunology, microbiology, molecular medicine, neuroscience, physics, physics and astrophysics, physiology, plant sciences, and zoology.

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

4 For students who entered Trinity College up to and including 2017, separate moderatorship courses are available in earth sciences (see below), human genetics (see below), chemistry with molecular modelling (see below), medicinal chemistry (see below), nanoscience, physics and chemistry of advanced materials (see below), and political science and geography (see 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 Associate Dean of Undergraduate Science Education.[14]

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 sessions in the science programmes, 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 Associate Dean of Undergraduate Science Education not later than the end of the third week of Michaelmas teaching term.

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

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

Attendance and course work

9 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.

[14] See also section I, §4 'Advanced entry'.

Field courses

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

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

11 *Modules*

Senior Freshmen – students who entered TR071 up to and including 2017

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

BYU22201	Cell structure and function (5 credits)
BYU22202	Vertebrate form and function (5 credits)
BYU22203	Metabolism (5 credits)
BYU22204	Evolution (5 credits)
BYU22205	Microbiology (5 credits)
BYU22206	Ecosystem biology and global change (5 credits)
BYU22207	Behaviour (5 credits)
BYU22208	Genetics (5 credits)
BYU22209	Infection and immunity (5 credits)
BYU22010	Agriculture, environment and biotechnology (5 credits)
CHU22201	Chemistry 1 (10 credits)
CHU22202	Chemistry 2 (10 credits)
GGU22924	Physical geography – changing environments (10 credits)
GGU22925	Human geography – changing worlds (10 credits)
GLU22905	The dynamic Earth 1: rocks and evolution (10 credits)
GLU22906	The dynamic Earth 2: structure and microscopy (10 credits)
MAU22S01	Multivariable calculus for science (5 credits)
MAU22S02	Vector calculus for science (5 credits)
MAU22S03	Fourier analysis for science (5 credits)
MAU22S04	Mechanics (5 credits)
MAU22S06	Numerical and data analysis techniques (5 credits)
PYU22P10	Physics I (10 credits)
PYU22P20	Physics II (10 credits)

Junior Sophisters – students who entered TR071 up to and including 2017

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

Biochemistry
Chemistry
Environmental sciences
Genetics
Geography
Geology
Immunology
Microbiology
Molecular medicine
Neuroscience
Physics
Physics and astrophysics
Physiology
Plant sciences
Zoology

12 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 §15).

13 **TABLE I —** MODERATORSHIP PREREQUISITES (applies to students who entered TR071 Science up to and including 2017)

Moderatorship	Senior Freshman*	Junior Freshman*
Biochemistry[15]	BYU22201, BYU22203, BYU22205, BYU22208	CH1101, CH1102, MA1S11 or MA1M01
Chemistry	CHU22201, CHU22202	CH1101, CH1102, MA1S11 or MA1M01
Environmental sciences	Four of the following: BYU22201, BYU22202, BYU22203, BYU22204, BYU22205, BYU22206, BYU22207, BYU22208, BYU22209, BYU22010	BY1101, BY1102
Genetics	BYU22201, BYU22203, BYU22205, BYU22208	BY1101, CH1101, CH1102, MA1S11 or MA1M01
Geography	GGU22924, GGU22925	GG1024 and/or GG1025
Geology	GLU22905, GLU22906	GL1101
Immunology[15]	BYU22201, BYU22203, BYU22205, BYU22208	CH1101, CH1102, MA1S11 or MA1M01
Microbiology	BYU22201, BYU22203, BYU22205, BYU22208	BY1101, CH1101, CH1102, MA1S11 or MA1M01
Molecular medicine[15]	BYU22201, BYU22203, BYU22205, BYU22208	CH1101, CH1102, MA1S11 or MA1M01
Neuroscience[16]	BYU22201, BYU22202, BYU22203, BYU22208	CH1101, CH1102, MA1S11 or MA1M01
Physics	PYU22P10, PYU22P20, MAU22S01, MAU22S02, MAU22S03, MAU22S04	PY1P10, PY1P20, MA1S11, MA1S12
Physics and astrophysics	PYU22P10, PYU22P20, MAU22S01, MAU22S02, MAU22S03, MAU22S04	PY1P10, PY1P20, MA1S11, MA1S12
Physiology[16]	BYU22201, BYU22202, BYU22203, BYU22208	MA1S11 or MA1M01

[15]Junior Freshman BY1101 is advisable.

[16]Junior Freshman BY1101 and BY1102 are advisable.

Plant sciences	Four of the following: BYU22201, BYU22202, BYU22203, BYU22204, BYU22205, BYU22206, BYU22207, BYU22208, BYU22209, BYU22010	BY1101 or BY1102
Zoology	BYU22201, BYU22202, BYU22203, BYU22208	BY1101, BY1102, MA1S11 or MA1M01

*All module codes are subject to change and students will be informed of changes by email and on the science web site: https://www.tcd.ie/science.

14 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.

15 Advice on how to choose appropriate Freshman module combinations for the various moderatorships is given in the document *'Science TR071, Senior Freshman programme 2018-19'*.

Examinations and assessment

16 See GENERAL REGULATIONS AND INFORMATION.

Moderatorship examination

17 The Junior and Senior Sophister examinations constitute part I and part II of the moderatorship examination.

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

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

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

TABLE II — CALCULATION OF MODERATORSHIP RESULTS (2018-19)

Moderatorship	
Biochemistry	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Chemistry	Junior Sophister 35 per cent, Senior Sophister 65 per cent
Environmental sciences	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Genetics	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Geography	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Geology	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Immunology	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Microbiology	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Molecular medicine	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Neuroscience	Junior Sophister 20 per cent, Senior Sophister 80 per cent

Physics	Junior Sophister 35 per cent, Senior Sophister 65 per cent
Physics and astrophysics	Junior Sophister 35 per cent, Senior Sophister 65 per cent
Physiology	Junior Sophister 20 per cent, Senior Sophister 80 per cent
Plant sciences	Junior Sophister 30 per cent, Senior Sophister 70 per cent
Zoology	Junior Sophister 20 per cent, Senior Sophister 80 per cent

Subjects/modules

Senior Freshmen – TR071 students who entered in 2017

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.

BYU22201	Cell structure and function
BYU22202	Vertebrate form and function
BYU22203	Metabolism (prerequisite BYU22201)
BYU22204	Evolution
BYU22205	Microbiology
BYU22206	Ecosystem biology and global change
BYU22207	Behaviour
BYU22208	Genetics
BYU22209	Infection and immunity (prerequisites BYU22201, BYU22205)
BYU22010	Agriculture, environment and biotechnology

CHEMISTRY

The modules provide a broad intermediate level overview of modern chemistry, and form the basis for further studies at Sophister level, both in chemistry and in other sciences. There are two 10 credit chemistry modules: CHU22201 and CHU22202. Lectures are complemented by laboratory work. In addition, students will participate in a team-based activity that will involve a research and presentation exercise on some aspect of chemistry. The modules include core material in physical, inorganic and organic chemistry, and elements of computational, materials and biological/medicinal chemistry.

GEOGRAPHY

Students must take two 10 credit geography modules in the Senior 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 are also developed in the Senior Freshman year through a module dealing with a number of key issues within contemporary human geography which exposes them to a range of methodological approaches and research techniques. Practical and fieldwork skills are also developed during the Senior Freshman year.

GEOLOGY

The two 10 credit Senior Freshman geology modules provide a foundation of knowledge about the Earth for further studies at Sophister level, in geology and other sciences. The modules reinforce the concept of a dynamic Earth and consist of lectures and practical work as well as field excursions. An array of expertise will be acquired, including palaeontology, mineralogy, and petrography. Students will be equipped with the skills to describe and interpret minerals and rocks, extract information from geological maps, and will get hands-on experience with polarised

light microscopy. In addition, an overnight field excursion is held in first semester and a residential field course is held in second semester. These field courses are very strongly recommended for prospective geology Sophister students.

MATHEMATICS

These modules are a continuation of the topics introduced in Junior Freshman mathematics modules MA1S11 and MA1S12. Modules MAU22S01 and MAU22S03 are offered in the Michaelmas term, with modules MAU22S02, MAU22S04 and MAU22S06 in the Hilary term. MAU22S04 and MAU22S06 cannot be taken simultaneously.

MAU22S01 Multivariable calculus for science (5 credits, prerequisites MA1S11, MA1S12)
Vector-valued functions; functions of several variables; line integrals; multiple integrals

MAU22S02 Vector calculus for science (5 credits, prerequisites MA1S11, MA1S12, MAU22S01, MAU22S03)
Surface integrals, theorems of Green, Gauss and Stokes; partial differential equations

MAU22S03 Fourier analysis for science (5 credits, prerequisites MA1S11, MA1S12)
Linear algebra; Fourier series; ordinary differential equations; special functions

MAU22S04 Mechanics (5 credits, prerequisites MA1S11, MA1S12, MAU22S01, MAU22S03)
Motion under a central force; work and energy; rotating frames; Lagrangian mechanics

MAU22S06 Numerical and data analysis techniques (5 credits, prerequisites MA1M01 or MA1S11)
Probability, random variables, correlation, sampling, chi-squared fitting, Markov chains

PHYSICS

Tuition will consist of lectures, practicals and tutorials in physics at intermediate level. The module PYU22P10 classical physics includes lectures on oscillations, materials, electricity and magnetism, and thermodynamics. The module PYU22P20 modern physics includes lectures on special relativity, nuclear and particle physics, waves and optics, and astronomy. Each of these 10 credit modules include practicals with set experiments, computational exercises and group study projects. This tuition may only be taken by students taking the mathematics modules: MAU22S01, MAU22S02, MAU22S03 and MAU22S04.

Sophister courses – TR071 programme

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 60 credits in each year.

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

BIOCHEMISTRY

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

the third year, studying in a university in the United Kingdom, Western or Eastern Europe. Assistance and advice in future careers is also offered.

CHEMISTRY

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

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

ENVIRONMENTAL SCIENCES

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

GENETICS

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

Sophister students to spend part of the long vacation working in genetics research laboratories abroad, usually in the United States, supported by the American Ireland Fund.

The Senior Sophister course allows students to choose modules relevant to their interests. All carry out a research project in association with one of the research groups in the department. There is a wide choice from molecular evolution, plant and animal development, human genetics and molecular genetics. The possible combinations and emphases are according to the aims of the students; the department believes that maximum realisation of aptitudes is primarily determined by motivation.

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

GEOGRAPHY

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

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

GEOLOGY

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

The Junior Sophister year consists of modules involving lectures and practical work that introduce the major branches and skills of the geological sciences. This includes in-depth training with the polarising light microscope and skills to interpret a variety of geological data. Junior

Sophister students attend at least two major field classes away from Dublin, during which students learn the craft of geological mapping and data acquisition.

Senior Sophister students attend a set of core modules in geology that further deepen the understanding in the most critical aspects of geological interpretation. They also choose from a range of optional modules, some of which may be delivered by other schools or departments. Training of field skills is deepened with additional field classes. Senior Sophisters undertake an independent project which is the subject of their dissertation.

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

IMMUNOLOGY

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

MICROBIOLOGY

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

MOLECULAR MEDICINE

Molecular medicine is a moderatorship run jointly by the School of Biochemistry and Immunology and the School of Medicine. This option has been introduced to recognise the revolutionary advances in disease diagnosis, therapy and prevention brought about by bio-molecular research and aims to demonstrate how basic science is translated into clinical treatment. In the Junior Sophister year students are introduced to core aspects of biochemistry (protein chemistry, membrane and cell biology, eukaryotic gene structure and expression, immunology) and varied topics related to molecular medicine (diagnostics and therapeutics, drug absorption and metabolism and clinical aspects of cancer and infection). In the Junior Sophister year there are also practicals, tutorials and a mini-review of the literature on a chosen topic. In the Senior Sophister year students will be required to choose a research project in either of the schools. Lectures in the Senior Sophister year are divided equally between St James's Hospital and the main campus. Topics include innate and adaptive immunity, immunodeficiency, autoimmunity and inflammation, neuroscience and endocrinology, microbial diseases, molecular haematology and oncology, diagnostics and therapeutics, cell cycle and cancer. Assistance and advice in future careers is offered.

NEUROSCIENCE

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

PHYSICS

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

Junior Sophister modules of 5 credits each include quantum mechanics I, electromagnetic interactions I, condensed matter I, condensed matter II, atomic and nuclear physics, dynamical systems, experimental techniques, with a choice of either computer simulation I or stellar and galactic structure. Students also take either the practical module of 20 credits or the practical module of 15 credits and a Broad Curriculum module of 5 credits. The practical modules combine set experiments of an advanced nature with a component of communication skills and career development.

Senior Sophister modules cover quantum mechanics II, high energy physics, condensed matter III, nanoscience, electro-magnetic interactions II, and modern optics. Students also take the module advanced topics in physics, in which they choose from a range of specialist topics, and complete a course in problem-solving and an extended research project.

PHYSICS AND ASTROPHYSICS

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

Junior Sophister modules of 5 credits each include quantum mechanics I, electromagnetic interactions I, condensed matter I, atomic and nuclear physics, computer simulation I, stellar and galactic structure, statistical thermodynamics and astrophysical spectroscopy, experimental techniques for astrophysics. Students also take either the practical module of 20 credits or the practical module of 15 credits and a Broad Curriculum module of 5 credits. The practical modules combine set experiments of an advanced nature, a component of communication skills and career development, and specialist computer training.

Senior Sophister modules cover quantum mechanics II, high energy physics, electromagnetic interactions II, modern optics, computer simulation III, planetary and space science, and cosmology. Students also complete a course in problem-solving and an extended research project in physics or astrophysics.

PHYSIOLOGY

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

To be eligible to enter the physiology moderatorship, students must have successfully completed the prerequisite Senior 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 cell physiology, neuroscience and exercise physiology.

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

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

PLANT SCIENCES[17]

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

Junior Sophisters take modules in plant physiology, angiosperm diversity and systematics, environmental dynamics, fundamentals of ecology, soil science, experimental design and

[17]Prior to 2011-12 this Sophister option was called botany.

analysis, diversity of plant morphology, plant molecular biology, as well as attending workshops and tutorials, two field courses and ecology and evolution seminars. There is a strong practical element in most of the modules. In the Junior Sophister year students may choose a Broad Curriculum module, or an entomology module, or an economic botany module.

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

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

ZOOLOGY

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

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

MODERATORSHIP IN EARTH SCIENCES

21 For students who entered the direct entry moderatorship course in earth sciences (TR077) up to and including 2017, the course 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) course in addition to several bespoke modules tailored for earth sciences students. Students in their Senior Freshman year select one module (5 credits) from the Broad Curriculum cross-faculty modules or language modules.

22 The course differs from the moderatorships in geography and geology in its tailored combination of modules that blend the traditional disciplines of geology and physical geography with an array of other physical, chemical and biological sciences to address key issues regarding the functioning of the Earth. The degree is awarded under the regulations of the science course.

23 The earth sciences moderatorship aims to produce graduates with a broad and holistic knowledge of the planet Earth. It emphasises the interconnected nature of the geosphere (rocks and sediments), the hydrosphere (lakes, oceans and ice), the atmosphere (weather and

climate) and the biosphere (plants and animals). It seeks to develop an understanding of the processes operating today and in the past, and how this knowledge can inform us about the future.

Modules

Senior Freshmen – TR077 students who entered in 2017

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

Junior Sophisters

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

Senior Sophisters

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

MODERATORSHIP IN HUMAN GENETICS

24 For students who entered the moderatorship course in human genetics (TR073) up to and including 2017, it provides students with a strong foundation in biology, mathematics and chemistry, an introduction to major fields of genetics and specialised modules in human genetics.

25 The course differs from the moderatorship in genetics in the obligation to study a particular combination of modules in the four year course and the concentration on human genetics. The degree is awarded under the regulations of the science course. Human genetics will be available as a moderatorship option through the TR060 biological and biomedical stream from 2018 onwards.

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

27 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.

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

Modules

Senior Freshmen – TR073 students who entered in 2017

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

Junior Sophisters

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

Senior Sophisters

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

MODERATORSHIP IN CHEMISTRY WITH MOLECULAR MODELLING

29 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.

30 The degree is awarded under the regulations of the science course. In certain cases it may be possible for students to transfer from the TR071 Science course, as detailed below. Chemistry with molecular modelling will be available as a moderatorship option through the TR061 Chemical sciences stream from 2018 onwards.

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

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

Modules

Senior Freshmen - TR074 students who entered in 2017

Chemistry modules CHU22201 and CHU22202, mathematics modules MAU22S01, MAU22S02 and MAU22S03 and either physics modules PYU22P10, PYU22P20 and mathematics module MAU22S04 or biology modules BYU22201, BYU22203, BYU22205, BYU22208 and mathematics module MAU22S06.

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

Junior Sophisters

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

Senior Sophisters

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

MODERATORSHIP IN MEDICINAL CHEMISTRY

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

34 The degree is awarded under the regulations of the science course. In certain cases it may be possible for students to transfer from the TR071 Science course, as detailed below. Medicinal chemistry will be available as a moderatorship option through the TR061 Chemical sciences stream from 2018 onwards.

35 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.

36 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 students will study the more specialised aspects of medicinal chemistry along with modules shared with the TR071 course.

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

Modules

Senior Freshmen - TR075 students who entered in 2017

Medicinal chemistry students will take TR071 chemistry modules CHU22201 and CHU22202, biology modules BYU22201, BYU22203, BYU22205 and BYU22208, and the remaining 20 credits from the biology modules BYU22202, BYU22204, BYU22206, BYU22207, BYU22209, BYU22010 or the mathematics modules MAU22S01, MAU22S02, MAU22S03, MAU22S04 and MAU22S06.

Junior Sophisters

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

Senior Sophisters

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

MODERATORSHIP IN NANOSCIENCE, PHYSICS AND CHEMISTRY OF ADVANCED MATERIALS[18]

38 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.

39 The course shares many lectures with those given for the moderatorships in chemistry and in physics, and also provides some specialist advanced nanoscience and materials modules with a specifically tailored practical module that emphasises nanoscience. The degree is awarded under the regulations of the science course. Nanoscience will be available as a moderatorship option through the TR061 Chemical sciences stream and the TR063 Physical sciences stream from 2018 onwards.

40 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.

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

Modules

Senior Freshmen

Chemistry modules CHU22201 and CHU22202, mathematics modules MAU22S01, MAU22S02, MAU22S03 and MAU22S04 and physics modules PY2N10, PY2N20. In addition, special tutorials/seminars will be given in nanoscience and advanced materials.

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

Junior Sophisters

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

Senior Sophisters

The Senior Sophister year includes lecture modules of 5 or 10 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. In addition, students complete a 5 credit problem-solving module, which will develop their problem-solving techniques in both physics and chemistry. In the Senior Sophister year students also complete an extended full-time research project (20 credits) during the Michaelmas term. The project is frequently carried out in an advanced industrial laboratory. The final physics and chemistry of advanced materials degree mark will be composed of 35 per cent from the Junior Sophister year and 65 per cent from the Senior Sophister year.

MODERATORSHIP IN PHYSICS
(IN CONJUNCTION WITH THE UNIVERSITY OF SCIENCE AND TECHNOLOGY BEIJING)

43 Students admitted to this degree programme will have successfully completed the first two years of undergraduate study in physics at the University of Science and Technology Beijing (USTB) and enter the Junior Sophister year of the physics degree programme in Trinity College Dublin. Students follow the Junior and Senior Sophister years of the physics degree as prescribed in the School of Physics undergraduate handbook. Progression rules for students in the Sophister years of the degree programme are the same as for students who enter the programme via the TR063 entry stream. On passing the Junior and Senior Sophister years, students will receive a B.A. (Moderatorship) degree in Physics.

Admission

Students enrolled in the physics degree course at the University of Science and Technology Beijing who have successfully completed the first two years of study, as well as the physics course in the Chinese National College entrance examination, and satisfied other requirements, are eligible to apply for admission. The application procedure and all entry requirements stipulated by the articulation agreement between USTB and Trinity College Dublin are described in the School of Physics undergraduate handbook and on its website: www.tcd.ie/physics.

MODERATORSHIP IN POLITICAL SCIENCE AND GEOGRAPHY

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

BACHELOR IN SCIENCE (HUMAN HEALTH AND DISEASE)

45 For details see FACULTY OF HEALTH SCIENCES.

VI THE STATISTICS AND OPERATIONS RESEARCH LABORATORY

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

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

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