Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Science at Trinity

Faculty of Science, Technology, Engineering and Mathematics (STEM)

TR063 Physical Sciences
Sophister Course Programme 2024-2025

tcd.ie/science

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Welcome

Dear Students

Congratulations – you are nearing the end of the Freshman years of your degree and are ready to make the important decision about which science Moderatorship you wish to pursue. The Freshman course structure has given you an excellent grounding in your core subject to prepare you for the advanced material you will cover in your Sophister years. You have also had opportunities to take open modules in other science subjects that have given breadth and context to your science education.

Development of educational breadth continues in the Sophister years via the opportunity to take further open modules and also Trinity Electives. Trinity Electives are stand-alone, College-wide modules that enable you to broaden your knowledge outside of your chosen subject. There is a wide range of choice available to you that encompasses languages and cultures, key societal challenges and Trinity's ground-breaking research activities.
A list of the modules can be found at this link (https://www.tcd.ie/trinity-electives/).

Having the opportunity to develop these broader skills, particularly in communication and presentation, will allow you to derive the greatest benefits from your particular choice of Moderatorship subject and will give you important insights into other subjects and modes of scholarship outside of the sciences.

I wish you the very best in your Sophister years and look forward to seeing your future successes and achievements.

Prof Fraser Mitchell
Associate Dean of Undergraduate Science Education

Foreword from the Physical Science Course Director

I would like to join Prof. Mitchell in congratulating you on your efforts in the Fresh years and soon welcoming you to the Sophister stage of your undergraduate education in the Physical Sciences. The choice that you are facing now, towards the end of the Senior Fresh year is an important one, first in terms of your specialisation into one of the three available Moderatorships, but also as a declaration of your scientific interests and as setting a guide-light for your future career.

This Sophister Course booklet is designed to help you with your choice. It depicts the structure of each of the Sophister years in all three of the Moderatorships within the Physical Sciences course. These are: the **Physics** Moderatorship, the **Physics and Astrophysics** Moderatorship and the **Nanoscience** Moderatorship. The structures, modules, practical elements, progression, capstone research projects, and the choices available whether among the Junior Sophister open modules, Junior Sophister Trinity Elective or Senior Sophister optional modules are all listed in this handbook.

The Physical Sciences Moderatorships has been rapidly evolving in the last few years under the leadership of my predecessor Prof. Cormac McGuinness and within the ambitions of the Trinity Education project. All information presented here is as accurate as possible at the time of compilation of this Booklet. The module codes, the module content, the choice or breadth, or timing of available Core, Mandatory, Open or Optional modules and details of examinations are all, however, still subject to change between the end of this academic year and the beginning of the next when rising Junior Sophister students enter into the Sophister years of the Moderatorships within Physical Sciences. I am only too happy to see you your exciting journey within these three Moderatorships, which are now presented in a way not possible before. The Physical Sciences structures with Core components and Open modules in the Junior Sophister year, and a new broader range of optional modules in the Senior Sophister year, gives you more freedom of choice than previously possible.

Within each of the Moderatorships there are opportunities to further tailor your degree through a parallel choice of Trinity Electives in the summer; by subsequent choices within the Junior Sophister year of Junior Sophister Open modules; your preference of your Senior Sophister project, and your selection from among the Senior Sophister Open modules. Independently of your exact path and the particular Physical Sciences Moderatorship ultimately chosen, you can rest assured that it will be accredited by the Institute of Physics, the professional body for physicists in Ireland and in the United Kingdom. Each of our physics degrees also equips you with a range of transferable skills, which are valued by academia, research, industry and business, alike.

My very best wishes to you all,

Assist. Prof. Plamen Stamenov
Course Director of Physical Sciences

Introduction

Sophister courses in **Physical Sciences** are organised so that students follow a continuous programme of work over two years leading to a Moderatorship in a particular subject. Each module (whether lecture, tutorial, seminar or practical) has a specified credit value, which is an approximate measure of the workload associated with the module and is in turn reflected in its proportional weighting in assessment. One credit is normally considered to represent a minimum of 20 hours of work on the part of a student. Students take modules to the value of 60 credits in each of the Sophister years.

The Physical Sciences (TR063) Sophister Course Booklet is intended as a detailed and comprehensive guide to all Moderatorships within Physical Sciences. Full module descriptors, course descriptions and reading lists are available from the Undergraduate Handbook of the School of Physics.

While every effort will be made to give due notice of major changes, the School of Physics and the Science Course Office reserves the right to suspend, alter or initiate courses, timetables, examinations and regulations at any time.

The information in this booklet is accurate at the time of going to print but may be subject to minor changes.

Course Advisors

Physics	Professor Plamen Stamenov
Physics and Astrophysics	Professor Neale Gibson
Nanoscience	Professor Peter Dunne

Moderatorship Courses and Quotas

To be qualified for a Moderatorship, students must have successfully completed both Freshman years and must have taken the stated prerequisite modules for any Moderatorship for which they wish to be considered. All students in Physical Sciences who have completed both Freshman years are eligible to proceed into the **Physics** or the **Physics and Astrophysics** Moderatorships. In the Physical Sciences course, the only Moderatorship with a prerequisite is **Nanoscience** where a student must have taken in the two Freshman years all 40 credits of Open Chemistry modules.

While every effort will be made to give due notice of major changes in the quotas, the Physical Sciences Course Director reserves the right to alter pre-requisites and quotas, if necessary. In the case of the Nanoscience Moderatorship this will be in conjunction and in consultation with the Chemical Sciences Course Director and the Nanoscience Moderatorship Course Director.

Moderatorship	**Quotas**
Physics	30
Physics & Astrophysics	24
Nanoscience	10 + 6*

***Note regarding Nanoscience quota.** Nanoscience is a shared course between the Schools of Physics and the School of Chemistry accessible through both Physical Sciences (TR063) and Chemical Sciences (TR061) for students with the appropriate 120 credits of Freshman modules in Physics, Chemistry and Mathematics. Thus the 10 highest ranked students from either Physical Sciences or Chemical Sciences are allocated places in the Nanoscience Moderatorship. Six additional places are available to the highest ranked qualified students from either Physical or Chemical Sciences who have not already been allocated a place in the Moderatorship.

Allocation of Places

The Science Course office coordinates and processes the applications for Junior Sophister places in the TR063: Physical Sciences course Moderatorships. The procedures documented below show students that those places are allocated in a fair, transparent, and efficient manner.

The number of places available in each moderatorship is limited by quota. **Allocation is based on the overall mark obtained in the Senior Freshman year** and the order of choice expressed by the student.

The Science Course Office allocates Junior Sophister places. Students cannot be allocated a place by circumventing the Science Course Office and going directly to disciplines. All enquiries regarding the allocation of places, made to disciplines, will be redirected to the Science Course Office via the sophistersco@tcd.ie email address.

Places will be allocated as follows until quotas are reached:

1. All students passing their Senior Freshman year will be placed in **rank order** based on their **overall Senior Freshman year mark**.
2. Students who fail and are required to sit reassessment must reapply for the remaining unfilled places until quotas are reached. Second round forms will be made available via the relevant course page on the Science website: https://www.tcd.ie/Science/ following publication of the first round.
3. Students who are given permission by the Senior Lecturer to defer assessments and or examinations until the reassessment session may defer a place in their **first** preference only. Following publication of the results, students who pass at the reassessment session will be allocated a place based on the same criteria used in the first-round allocation of places. If the student in this category does not qualify for the deferred place, the Science Course Office will allocate that student a place in one of the subjects available in the second round and the deferred place will be offered to the next qualified student from the first-round allocation.
4. In the event a student fails at the reassessment session, be that a deferred exam or reassessment, and are eligible to repeat the SF year, they can do so in **one** of the following ways:
    - Repeating the year in full on books, such students will be treated in the same way as all other SF students in that year.
    - Students may request permission from the Senior Lecturer, via their tutor, to repeat the year off books taking assessment (**OBA**). Sitting an exam OBA is a repeat examination therefore, such students will be allocated a place in one of the remaining Moderatorships available at the **reassessment session** the following year. Students may not repeat more than 20 credits OBA.
5. Students who have passed in the **first round** who then opt to go 'off books' for the year (**OBN**) rather than take up the place offered, will be allocated a place in the first round along with rising JS students in the following year. Places will **not** be reserved for such students.
6. Students who pass in the second round and opt to go "off books" prior to places being allocated, will be allocated a place at the **reassessment session** in the following year.
7. Results will be available on your personal portal at my.tcd.ie by the stated publication date.
8. Publication of first round JS places will be available through the my.tcd.ie portal once the academic year rollover happens in July.
9. Students are informed by email when the places are published, and the procedures followed are clearly outlined in the email.

Special note: Students who have passed their Senior Freshman year may not repeat the SF year to improve their performance.

Summary from the Freshman Physical Sciences (TR063) Programme

The Junior and the Senior Freshman years in the Physical Sciences course provide the foundational material that all the Physical Sciences Moderatorships are predicated upon. Further, exposure to these courses allow time for students to determine the career path they wish to follow. In each of the Freshman years, the academic year is divided into Semester 1 (Michaelmas term) and Semester 2 (Hilary term) and all students take selected modules to the value of 60 credits for the year with no more than 30 credits from Semester 1 and 30 credits from Semester 2. In each semester there are 20 credits of Core modules, and 10 credits of Open modules. The details of the Freshman modules are repeated here.

Moderatorships:

As stated in the earlier Physical Sciences Freshman handbooks, in the Junior and Senior Freshman years Physical Sciences TR063 students complete a course of study which will qualify them to compete for a place in one of the following Moderatorships after the Senior Freshman year: **Physics**, **Physics and Astrophysics** or **Nanoscience**.

Core and Open Module Choices in Junior and Senior Freshman Years

Year 1: JUNIOR FRESHMAN	
CORE MODULES – 40 credits 20/20	
Semester 1	**Semester 2**
PYU11P10: Physics 1	PYU11P20: Physics 2
MAU11S01: Mathematics	MAU11S02: Mathematics

Year 2: SENIOR FRESHMAN	
CORE MODULES – 40 credits 20/20	
Semester 1	**Semester 2**
PYU22P10: Physics 3	PYU22P20: Physics 4
MAU22S01: Multi-variable calculus for Science	MAU22S02: Vector Calculus for Science
MAU22S03: Fourier analysis for Science	PIU22992: History, Philosophy and Ethics of Science

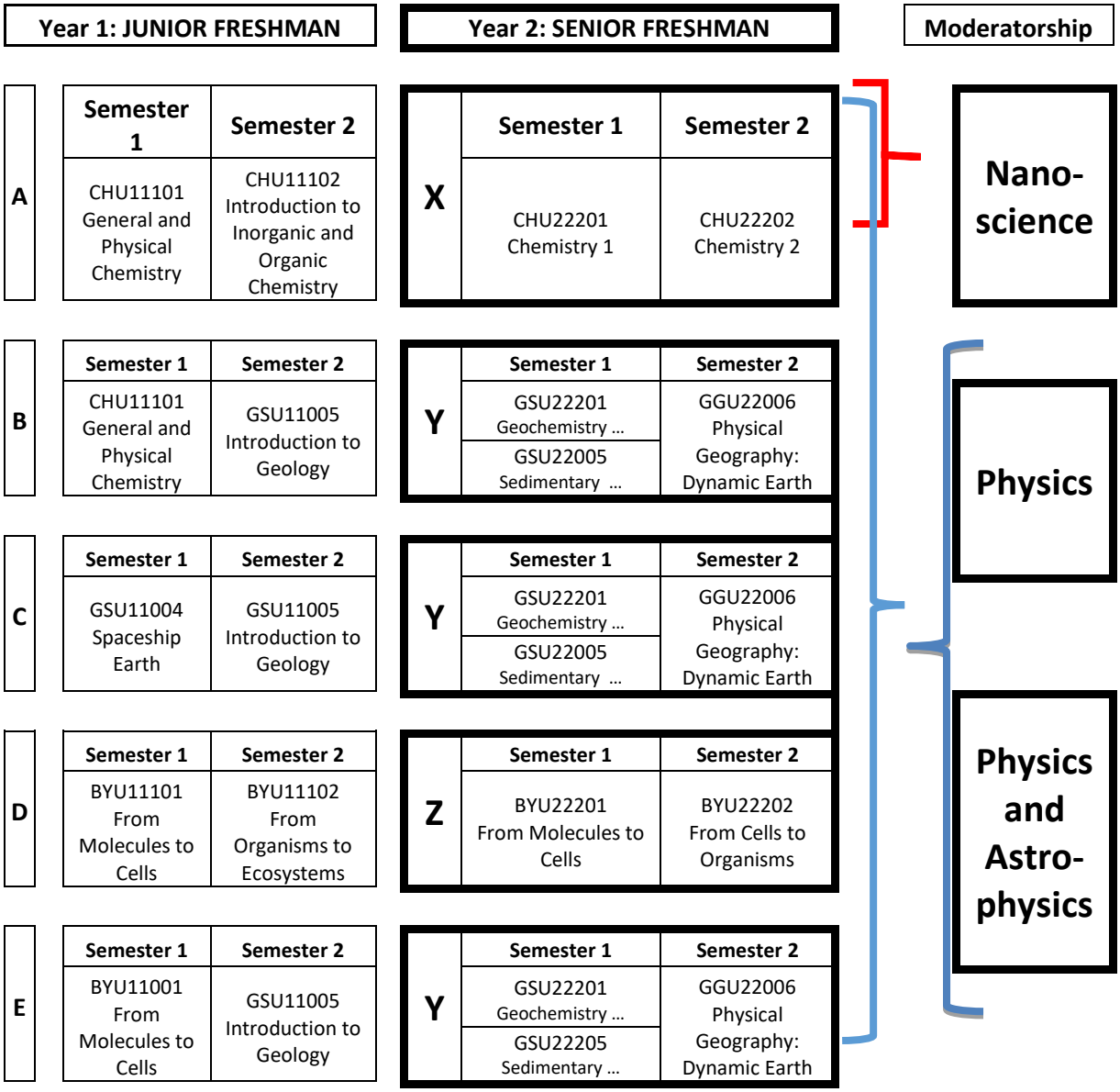
OPEN MODULES – choose 20 credits 10/10	
CHU11101 General and Physical Chemistry	CHU11102 Introduction to Inorganic and Organic Chemistry
GSU11004 Spaceship Earth	GSU11005 Introduction to Geology
BYU11101 From Molecules to Cells	BYU11102 From Organisms to Ecosystems

OPEN MODULES – choose 20 credits 10/10	
CHU22201 Chemistry 1	CHU22202 Chemistry 2
GSU22201 From Atoms to Rocks: Introduction to Geochemistry	GGU22006 Physical Geography: Dynamic Earth
GSU22205 Sedimentary Processes & Environments	
BYU22201 From Molecules to Cells	BYU22202 From Cells to Organisms

TR063: Moderatorships and Open Module Choice Diagram

Moderatorships in **Physics** or in **Physics and Astrophysics** are available to all students regardless of the choice of open modules in the Junior Freshman and Senior Freshman years. To qualify for the Moderatorship in **Nanoscience**, a student must take all available Chemistry open modules in both semesters of the Junior and Senior Freshman years.

Five distinct patterns of open modules are available to students across Junior Freshman and Senior Freshman years. In Junior Freshman these are denoted A, B, C, D and E leading to three distinct module patterns in Senior Freshman, designated as X, Y and Z. The pathways to the possible Moderatorships are indicated in the diagram.



Applications to choose a specific Moderatorship in Sophister years, detailed here occur via a preferred Moderatorship choice form available in Semester 2 of the Senior Freshman year.

Choice of Moderatorship Form

Students are required to complete the choice of subject form. You will rank your subject preferences from 1-3 i.e., Nanoscience - 1, Physics & Astro – 2 etc.

The moderatorship choice form is available online: https://forms.office.com/e/YsadyR67An. The closing date is Friday 19th April 2024.

Open Module Choice Forms

Students take modules totalling 60 credits in the Junior Sophister year. There are 40 credits of core modules, and 20 credits of open modules spread equally over two semesters in the academic year. The module structure for each individual moderatorship is listed in the following pages.

In addition, students can choose one or two (one per semester) 5 credit Trinity Elective modules as shown in the module structure table for each moderatorship subject.

Students can choose their open modules with the help of the Moderatorship Course Adviser following the allocation of moderatorship places. **Online forms will be available at via from your moderatorship discipline.**

Students should note that due to timetable constraints Open Modules may delivered via a blended learning approach involving face to face and online teaching for some open modules.

Trinity Electives

https://www.tcd.ie/trinity-electives/

The Trinity Electives are a unique feature of your Trinity Education. They are stand alone, College-wide 5 credit modules. They cover a broad range of topics in the arts, humanities, sciences, health and social science, and technology. They are designed to allow students to study topics outside of their core discipline and thus provide breadth in their education. Physical Science students take a minimum of one and a maximum of two (one per semester) Trinity Electives in the Junior Sophister year. Depending on your moderatorship, you will choose a combination of Trinity Electives and Open Modules as described in this handbook.

Choosing your Trinity Elective

The choice of Trinity Elective is student driven. Almost all Trinity Electives are open to all students. However, students of some moderatorships may be precluded from taking certain Trinity Electives (e.g. the module 'From Planets to the Cosmos' is not available to TR063 Physical Sciences students, as this topic is part of their core discipline,). The list of exemptions is outlined in the Trinity Electives webpage: https://www.tcd.ie/trinity-electives/

Selection of Trinity Electives will be made through online enrolment which will open in July 2024, after publication of examination results and allocation of moderatorship places. You will be asked to list your choice(s) of Trinity Elective in order of preference.

The Trinity Electives website provides full details of each of the Trinity Electives. A list of the Trinity Electives can be found at https://www.tcd.ie/trinity-electives/

You need to think carefully about your choice of Trinity Elective as the semester in which you take it (Semester 1, Semester 2 or both) will affect your choice of Open Modules. That is: taking one Trinity Elective in the first semester, restricts you to the open modules in Option 1; taking one Trinity Elective in the second semester, restricts you to the open modules in Option 2 while taking two Trinity Electives, (one in each semester) restricts you to the open modules in Option 3. Please refer carefully to the tables in this handbook.

Junior Sophister Examination Information

Modules are assessed by continuous assessment and/or by examination. The Junior Sophister year is comprised of modules to a total of 60 credits. The distribution scheme of marks between papers and practical work at the Sophister examinations will be published by individual schools or departments/disciplines.

Calculation of Moderatorship results

The final moderatorship results are calculated as a weighted average of the overall result for the Junior and Senior Sophister examination results.

Junior Sophister 30%, Senior Sophister 70%:

Physics, Physics & Astrophysics and Nanoscience

Reassessment - Regulation 8: Undergraduate Progression and awards regulations

- Same progression regulations, including compensation, for assessments relating to semesters 1 & 2 and to reassessment.
- Automatic right to reassessment for a student who has achieved a fail grade in any of their modules and is not eligible for compensation.
- Students (in all years) should only be required to re-sit examinations or re-submit coursework for failed modules or components thereof.
- Students are not permitted to present for reassessment in any module for which they have achieved a pass grade, in order to improve their academic performance.
- Rescheduled exams within the session will no longer be permitted.
- Different reassessment modalities permitted.
- No capping of marks - Capping of marks in the reassessment sessions may be introduced, subject to negotiations with the Institution of Physics (IOP).

Repetition of a year: Regulation 7: Undergraduate Progression and awards regulations

- Students are not permitted to repeat any academic year more than once and may not repeat more than two academic years within a programme.
- Repetition of a year is in full, i.e., all modules and all assessment components.
- A student's academic record on their transcript will show clearly the time lost through repetition of a year.
- There will be an option to repeat a year on an 'off-books' basis.

Full **Progression and Awards** regulations can be found via the following:
https://www.tcd.ie/teaching-learning/academic-affairs/ug-prog-award-regs/index.php

Timeline of events 2024

Week	Date	Trinity Term 2024
30	20.03.24	Publication of Sophister Course booklets and Moderatorship Preference forms via the Science TR063 Physical Sciences Junior Sophister webpage: https://www.tcd.ie/science/undergraduate/tr063-physical-sciences/junior-sophister/
33	19.04.24	Closing date for submission of Moderatorship Preference Forms https://forms.office.com/e/YsadyR67An
36	29.04-24 – 04.05.24	Semester two examinations
40	29.05.24	Publication of Science Examination results – mytcd.ie portal
45	04.07.24	Publication of Junior Sophister places via my.tcd.ie

Assessment: procedures for the non-submission of coursework and absence from examinations

All students must fulfil the course requirements of the school or department, as appropriate, with regard to attendance and course work. Where specific requirements are not stated, students may be deemed non-satisfactory if they miss more than a third of their course of study or fail to submit a third of the required course work in any term.

Full regulations on non-submission of coursework can be found via the following: https://www.tcd.ie/calendar/undergraduate-studies/general-regulations-and-information.pdf, Please refer to your department/discipline handbook for specific moderatorship regulations.

Plagiarism Policy

Plagiarism is interpreted by the University as the act of presenting the work of others as one's own work, without acknowledgement.
Plagiarism is considered as academically fraudulent, and an offence against University discipline. The University considers plagiarism to be a major offence, and subject to the disciplinary procedures of the University.

Full details of the University's plagiarism policy can be found via the following: https://www.tcd.ie/teaching-learning/academic-policies/plagiarism/

Physics

Junior Sophister Course Advisor: Assist. Prof Plamen Stamenov stamenp@tcd.ie

The Physics moderatorship covers a range of topics across the spectrum of modern physics, and the experimental, theoretical, and computational techniques used to explore them. It builds on the Physics modules taken in the Fresher years. There is a particular emphasis on condensed matter physics, photonics and nanoscience, reflecting the importance of these fields as well as reflecting the strength of the School's research expertise in these areas.

Junior Sophisters:
The JS year consists of lectures, tutorials and practical delivered in modules, as listed below. Within the Junior Sophister year in Nanoscience there are 40 credits of Core modules, the remaining 20 credits are either Open or Elective modules. **All students are required to take a Trinity Elective in either the first or the second semester.** Students receive training in communication skills as part of the cross-semester practical module.

Assessment and Examination Procedures
Each 5-credit lecture module will be examined separately by a 2-hour exam in the relevant end-of-semester examination period, with the exception of PYU33C01, which is assessed entirely by continuous assessment. Examined modules may include continuous assessment components. Some modules are assessed by a 50:50 combination of continuous assessment and examination (in a 1-hour exam), such as in PYU33P02 and PYU33P15 in recent years. The composition of written papers will be given in the Junior Sophister Physics Orientation issued to rising Junior Sophisters. The JS Physics mark will constitute 30% of the final degree mark. Continuous assessment of the two practical modules contributes 15 credits. For full details of assessments and modules and module descriptors please see the School of Physics Handbook, https://www.tcd.ie/Physics/study/current/undergraduate/handbook/

Senior Sophisters:
The SS year consists of lectures, tutorials and practical physics delivered in modules, as listed. A major component of the year is an independent capstone research project, which is carried out during the first 9 weeks of Michaelmas term. There are no lectures during this period. The project may be carried out at other international partner institutes. The independent capstone research project may be an experimental, theoretical or computational project in almost any physics topic.

Core Modules: The capstone research project, problem solving module and several other modules are designated as core modules. These core modules total 40 credits, the remaining 20 credits of the Senior Sophister year in Physics are made up from among a range of several Open 5 credit modules.

Assessment and Examination Procedures

Each 5-credit lecture module will be examined separately in the relevant end-of-semester examination period. The 10-credit lecture modules PYU44P11 is examined in the semester 2 examination period but will also have continuous assessment components. The 10-credit lecture module PYU44N02 is examined in part in semester 1, with the majority of the assessment by continuous assessment and examination in Semester 2. The research project PYU44PP2 is assessed during semester 2. Problem Solving in Physics (PYU44PP5) will be examined at the end of Semester 1. Examined modules may include continuous assessment components. The PYU44C01 module is assessed entirely by continuous assessment. The SS Physics mark will constitute 70% of the final degree mark. For full details of assessments and modules please see the School of Physics Handbook,

https://www.tcd.ie/Physics/study/current/undergraduate/handbook/

Junior Sophister Course Structure Diagram

The Junior Sophister course structure is diagrammatically illustrated below:

<table>
<tr><th colspan="3">Junior Sophister TR063 – PHYSICS</th></tr>
<tr><th colspan="3">40 Credits core + 20 Credits Open modules or Trinity Elective modules</th></tr>
<tr><td rowspan="5">Core Modules (40 credits)</td><td>Semester 1: Core</td><td>Semester 2: Core</td></tr>
<tr><td>PYU33P01: Quantum Mechanics I
(5 credits)</td><td>PYU33P15: Atomic Physics and Statistical Thermodynamics
(5 credits)</td></tr>
<tr><td>PYU33P03: Condensed Matter I
(5 credits)</td><td>PYU33P04: Semiconductor Physics
(5 credits)</td></tr>
<tr><td colspan="2">PYU33PP3: JS Physics Laboratory (10 credits)</td></tr>
<tr><td>PYU33P02: Electromagnetic Interactions I (5 credits)</td><td>PYU33PP4: JS Physics Laboratory
(5 credits)</td></tr>
<tr><td rowspan="4">Open or Trinity Elective Modules (20 credits)</td><td>Semester 1: Open – choose 2 of 3</td><td>Semester 2: Open – choose 2 of 3</td></tr>
<tr><td>PYU33C01: Computer Simulation I
(5 credits)</td><td>PYU33P07: Experimental Techniques
(5 credits)</td></tr>
<tr><td>PYU33A03: Stellar & Galactic structure
(5 credits)</td><td>PYU33A17: Experimental Techniques for Astrophysics
(5 credits)</td></tr>
<tr><td>Trinity Elective 1
(5 credits)</td><td>Trinity Elective 2
(5 credits)</td></tr>
</table>

A Physics student can choose to take their one required Trinity Elective in either semester but can then take only one of the available Open modules in that semester.

A Physics student can choose to take a second Trinity Elective, one in each semester, but then has a much-reduced choice of only taking only one of the available Open modules in each semester. Taking two Trinity Electives severely reduces the Physics content in the degree and can impact on later choice. For example: Computer Simulation II in the SS year will be (partially) dependent upon taking Computer Simulation I in the JS year.

Note that as of 12th June 2023 the semesters in which PYU33P03 and PYU33P15 are to be taught in the academic 2023/2024 and subsequent years have been exchanged.

Junior Sophister Core Modules **40 credits**

PYU33P01 Quantum Mechanics (S1) **5 credits**
This module covers solution of the Schrödinger Equation in specific topics, such as angular momentum and the hydrogen atom.

PYU33P02 Electromagnetic Interactions I (S1) **5 credits**
This module covers the fundamentals of electromagnetic theory together with quantum optics and lasers.

PYU33P03 Condensed Matter I (S1) **5 credits**
This module introduces condensed matter concepts such as crystal structure and thermal and electronic properties of matter.

PYU33P15 Atomic Physics and Statistical Thermodynamics (S2) **5 credits**
This module covers atomic physics and spectroscopy together with statistical mechanics and thermodynamics.

PYU33P04 Semiconductor Physics (S2) **5 credits**
This module covers the physics of semiconductors and the construction, fabrication and application of semiconductor devices.

PYU33PP3 Practical in Physics (S1 & S2) **10 credits**
PYU33PP4 Practical in Physics (S2) **5 credits**
In these modules' students complete a number of advanced experiments in Physics together with an introduction to data analysis in Physics. The first cross-semester module includes components involving training in communication skills, personal and career development, and requires attendance at School Seminars. The second semester 2 module develops these skills further and ensures that students have a broad experience within a physics laboratory.

Junior Sophister Open Modules and Trinity Electives **20 credits**

PYU33C01 Computer Simulation I (S1) **5 credits**
This module provides an introduction to numerical and computational techniques and how they may be used to solve problems in Physics.

PYU33A03 Stellar and Galactic Structure (S1) **5 credits**
This module covers the evolution of stars, from their hydrogen burning until supernova explosion, and the properties of galaxies in the local and distant Universe.

PYU33P07 Experimental Techniques (S2) **5 credits**
This module covers instrumentation with specific examples in imaging techniques together with common device electronics and measurement methods and strategies.

PYU33A17 Experimental Techniques for Astrophysics (S2) **5 credits**
This module covers astrophysical instrumentation, with the astrophysical spectroscopy required to interpret spectra from across the electromagnetic spectrum.

Trinity Elective (S1 or S2) **5 credits**
Details on Trinity Electives are found at: https://www.tcd.ie/trinity-electives/ .

Senior Sophister Physics

Senior Sophister Course Advisor: **Assist. Prof. Plamen Stamenov stamenp@tcd.ie**

Senior Sophister Course Structure Diagram (Subject to change for AY24/25)

<table>
<tr><th colspan="4">Senior Sophister TR063 – PHYSICS</th></tr>
<tr><th colspan="4">40 Credits Core modules + 20 Credits Open modules (AY 21/22)</th></tr>
<tr><td rowspan="4">Core Modules (40 credits)</td><td colspan="2">Semester 1: Core</td><td>Semester 2: Core</td></tr>
<tr><td colspan="2">PYU44PP2: Capstone Research Project (20 credits) – Assessment in Semester 2</td><td></td></tr>
<tr><td rowspan="2">Project only in first 9 weeks of semester 1</td><td>PYU44PP5: Problem solving (5 credits)</td><td>PYU44P05: Electromagnetic Interactions II (5 credits)</td></tr>
<tr><td colspan="2">PYU44P11: Advanced Quantum Mechanics, Nuclear Structure and High Energy Physics (10 credits)</td></tr>
<tr><td rowspan="8">Open Modules (20 credits)</td><td colspan="2">Semester 1: Open modules</td><td>Semester 2: Open modules</td></tr>
<tr><td rowspan="7">Take 4 Open modules which total 20 credits</td><td colspan="2">PYU44N02: Nanoscience, complex fluids and polymers (10 credits)</td></tr>
<tr><td>PYU44P13: Magnetism & Superconductivity</td></tr>
<tr><td>PYU44P06: Modern Optics</td></tr>
<tr><td>PYU44T20: Quantum Optics and Information</td></tr>
<tr><td>PYU44A05: Cosmology
Or
PYU44P18: Quantum Plasmonics and Metamaterials</td></tr>
<tr><td>PYU44C01: Computer Simulation II</td></tr>
<tr><td>PYU44P17: Energy Science</td></tr>
</table>

The PYU44PP2 capstone research project takes place in the first nine weeks of Semester 1. The assessment of the research project is in Semester 2. The remaining three weeks of Semester 1 has tutorials associated with the PYU44PP5 Problem Solving module which is examined at the end of Semester 1.

Lectures associated with the core PYU44P11 module and the open PYU44N02 module begin in the last three weeks of Semester 1, but examinations for these modules are at the end of Semester 2. All other modules, whether mandatory or optional, occur wholly within Semester 2 and are examined at the end of Semester 2.

Senior Sophister Physics Core Modules **40 credits**

PYU44PP2 Physics Research Project (S1 & S2) **20 credits**
This module comprises a 9-week full-time capstone research project in experimental, theoretical, or computational physics, undertaken at the beginning of Semester 1. The project may be undertaken in Trinity, or in another University or Research Institute in Ireland or abroad. Submission of report and presentation of results is in Semester 2

PYU44PP5 Problem Solving in Physics (S1) **5 credits**
This module develops techniques and approaches to general problem solving in physics.

PYU44P11 Advanced Quantum Mechanics, Nuclear Structure and High Energy Physics (S1 & S2) **10 credits**
The quantum mechanics of this module extends the discussion of quantum physics into multi-electron atoms, time dependent Schrödinger Equation and perturbation theory. It includes nuclear physics, strong nuclear force and nuclear reactions and introduces high energy physics theory and experiment, fundamental particles, and the Standard Model.

PYU44P05 Electromagnetic Interactions II (S2) **5 credits**
This module covers electromagnetic wave phenomena together with the optical properties of materials.

Senior Sophister Physics Open Modules **20 credits**

PYU44N02 Nanoscience, Complex Fluids and Polymers (S1 & S2) **10 credits**
This module covers nanoscience, and the modified properties of nanoscale matter, its fabrication and potential applications together with the rheology and behaviour of liquids as applied to microfluidic systems and a detailed overview of polymer physics.

PYU44P13 Magnetism and Superconductivity (S2) **5 credits**
This module covers magnetism, magnetic materials, and introduces superconductivity.

PYU44P06 Modern Optics (S2) **5 credits**
This module covers optical communications and nonlinear optics involving lasers.

PYU44A05 Cosmology (S2) **5 credits**
This module covers cosmology, deriving its basic equations and using them together with observations to examine the history and future of the Universe. Recent results concerning dark matter and dark energy, and possible future directions are also examined.

PYU44C01 Computer Simulation II (S2) **5 credits**
This module provides an introduction to matrix computing and discrete Fourier transforms and partial differential equations through Python and extends the toolkit of numerical and statistical computer simulation techniques.

PYU44P17 Energy Science (S2) **5 credits**
This module consists of the physics behind key technologies for energy generation.

PYU44P18 Quantum Plasmonics and Metamaterials (S2) **5 credits**
This module covers quantum plasmonics and the fundamentals of photonics of metallic and dielectric nanostructures up to extreme nanoscales and the physics of metamaterials, that is the optics of materials having near-zero and negative refractive index.

PYU44T20 Quantum Optics and Information (S2) **5 credits**
This module covers the mathematical treatment of photons, quantized electromagnetic fields entanglement and quantum information or qubits.

Physics Moderatorship Learning Outcomes.

On the successful completion of this programme, a student should be able to

- demonstrate in written and oral form a comprehensive level of knowledge of physics and the mathematics that underpins this knowledge, together with an awareness of its place within the broader science curriculum

- apply the core concepts of Classical and Modern Physics across a wide spectrum of topics and applications, such as information technology and materials science

- perform calculations to solve practical problems, including the use of numerical methods and computing

- operate sophisticated spectrometers and similar test and evaluation apparata across a wide spectrum of investigation

- independently design and carry out an experiment and evaluate critically the data obtained, including appropriate error analysis

- communicate the results of an experiment or project via dissertation, poster or oral presentation

- employ literature search methods to obtain information relevant to research and development

- act effectively as an individual or as a member of a team in professional, educational and industrial settings

- update personal knowledge with a high degree of autonomy, whether in the workplace or in the context of further study

Physics and Astrophysics

Junior Sophister **Course Advisor: Prof Neale Gibson n.gibson@tcd.ie**

Physics and Astrophysics combines the core modules from the moderatorship in Physics with specialist modules in astrophysics theory and practice. This moderatorship reflects a curriculum for those with an increasing interest in astronomy and space science as well as reflecting the strength of the School's research expertise in these areas.

Junior Sophisters:
The JS year consists of lectures, tutorials and practical delivered in modules, as listed below. Within the Junior Sophister year in Physics and Astrophysics there are 40 credits of Core modules, the remaining 20 credits are either Open or Elective modules. **All students are required to take a Trinity Elective in either the first or the second semester.** Students receive training in communication skills as part of the practical modules.

Assessment and Examination Procedures
Each 5-credit lecture module will be examined separately by a 2-hour exam in the relevant end-of-semester examination period, with the exception of PYU33C01 which is assessed entirely by continuous assessment. Examined modules may include continuous assessment components. Some modules are assessed by a 50:50 combination of continuous assessment and examination (in a 1-hour exam), such as PYU33P02 and PYU33P15 in recent years. The composition of written papers will be given in the Junior Sophister Physics and Astrophysics Orientation issued to rising Junior Sophisters. The JS Physics and Astrophysics mark will constitute 30% of the final degree mark. Continuous assessment of the two practical modules contributes 15 credits. For full details of assessments and modules and module descriptors please see the School of Physics Undergraduate Handbook, https://www.tcd.ie/Physics/study/current/undergraduate/handbook/

Senior Sophisters:
The SS year consists of lectures, tutorials and practical physics delivered in modules, as listed. A major component of the year is an independent capstone research project, which is carried out during the first 9 weeks of Michaelmas term. There are no lectures during this period. The independent capstone research project may be in either an astrophysics topic or in a physics topic.

Core Modules: The research project, problem solving module and several other modules are designated as core modules. These core modules total 50 credits, but the remaining 10 credits of the Senior Sophister year in Physics and Astrophysics are made up from among several Open modules.

Assessment and Examination Procedures
Each 5-credit lecture module will be examined separately in the relevant end-of-semester examination period. The 10-credit lecture modules PYU44P11 and PYU44A03 are examined in the semester 2 examination period. but will have continuous assessment components. The research project PYU44PP2 is assessed during semester 2. Problem Solving in Physics (PYU44PP5) will be examined at the end of Semester 1. Examined modules may include continuous assessment components. The SS Physics mark will constitute 70% of the final

degree mark. For full details of assessments and modules and module descriptors please see the School of Physics Handbook:
https://www.tcd.ie/Physics/study/current/undergraduate/handbook/

Junior Sophister Physics and Astrophysics Course Structure Diagram

The Junior Sophister course structure is diagrammatically illustrated below:

Junior Sophister TR063 – PHYSICS AND ASTROPHYSICS		
40 Credits core + 20 Credits Open modules or Trinity Elective modules		
Core Modules (40 credits)	**Semester 1: Core**	**Semester 2: Core**
	PYU33P01: Quantum Mechanics I (5 credits)	PYU33P15: Atomic Physics and Statistical Thermodynamics (5 credits)
	PYU33A03: Stellar & Galactic Structure (5 credits)	PYU33A17: Experimental Techniques for Astrophysics (5 credits)
	PYU33AP3: JS Physics Laboratory (10 credits)	
	PYU33P02: Electromagnetic Interactions I (5 credits)	PYU33AP4: JS Astrophysics Laboratory (5 credits)
Open or Trinity Elective Modules (20 credits)	**Semester 1: Open – first is core then choose 1 of 2**	**Semester 2: Open – choose 2 of 3**
	* PYU33P03: Condensed Matter I **[Mandatory]** (5 credits)	PYU33P04: Semiconductor Physics (5 credits)
	PYU33C01: Computer Simulation I (5 credits)	PYU33P07: Experimental techniques (5 credits)
	Trinity Elective 1 (5 credits)	**Trinity Elective 2** (5 credits)

A Physics student and Astrophysics can choose to take their one required Trinity Elective in either semester, but if in Semester 1 can then only take the additional mandatory PYU33P03 module and cannot take the PYU33C01 module. If taking the one required Trinity Elective in Semester 2, then both Physics and Astrophysics Open modules in Semester 1 are taken and the student takes only one of the available School of Physics Open modules in Semester 2.

A Physics and Astrophysics student can choose to take a second Trinity Elective, i.e. one in each semester, but then has a much-reduced choice between the two available Open modules in semester 2 and is not able to take Computer Simulation I in Semester 1.

Further, taking one Trinity Elective in Semester 1 or taking two Trinity Electives in Semester 1 and Semester 2, severely reduces the Physics and Astrophysics content in the degree, and can impact on the benefit of later modules. In particular**, not taking PYU33C01 Computer**

Simulation I in the JS year **will be detrimental** to your performance in many of the typical SS Astrophysical capstone research projects involving simulation, even though the JS Astrophysics laboratory also contains relevant astrophysical data analysis and programming. It would also be of general benefit if taking Computer Simulation II in the SS year.

Note that as of 12th June 2023 the semesters in which PYU33P03 and PYU33P15 are to be taught in 2024/2025 and subsequent years have been exchanged.

Junior Sophister Physics and Astrophysics Core Modules 40 credits

PYU33P01 Quantum Mechanics I (S1) **5 credits**
This module covers solution of the Schrödinger Equation in specific topics, such as angular momentum and the hydrogen atom.

PYU33P02 Electromagnetic Interactions I (S1) **5 credits**
This module covers the fundamentals of electromagnetic theory together with quantum optics and lasers.

PYU33A03 Stellar and Galactic Structure (S1) **5 credits**
This module covers the evolution of stars, from their hydrogen burning until supernova explosion, and the properties of galaxies in the local and distant Universe.

PYU33P15 Atomic Physics and Statistical Thermodynamics (S2) **5 credits**
This module covers atomic physics and spectroscopy together with statistical mechanics and thermodynamics.

PYU33A17 Experimental Techniques for Astrophysics (S2) **5 credits**
This module covers astrophysical instrumentation, with the astrophysical spectroscopy required to interpret spectra from across the electromagnetic spectrum.

PYU33AP3 Practical in Physics and Astrophysics (S1 & S2) **10 credits**
PYU33AP4 Practical in Computational Astrophysics & Data Analysis (S2) **5 credits**
In these modules' students complete a number of advanced experiments in Physics together with an introduction to computational methods in Astrophysics. The first includes components involving training in communication skills, personal and career development, and requires attendance at School Seminars. The second module specializes in astrophysical data analysis and trains the students in the appropriate data analysis methods and software in preparation for the final year capstone project.

Junior Sophister Physics and Astrophysics Open Modules and Trinity Electives

20 credits

PYU33P03 Condensed Matter I (S1) **5 credits**

This module introduces condensed matter concepts such as crystal structure and thermal and electronic properties of matter. (This is a mandatory module.)

PYU33C01 Computer Simulation I (S1) **5 credits**

This module provides an introduction to numerical and computational techniques and how they may be used to solve problems in Physics.

PYU33P07 Experimental Techniques (S2) **5 credits**

This module covers instrumentation with specific examples in imaging techniques together with common device electronics and measurement methods and strategies.

PYU33P04 Semiconductor Physics (S2) **5 credits**

This module covers the physics of semiconductors and the construction, fabrication and application of semiconductor devices.

Trinity Elective (S1 or S2) **5 credits**

Details on Trinity Electives (TEs) are found at: https://www.tcd.ie/trinity-electives/. If a TE is taken in Semester 1 then the chosen TE must replace PYU33C01 as PYU33P03 is required for all JS Physics and Astrophysics students.

Senior Sophister Physics and Astrophysics

Course Advisor: Prof Neale Gibson n.gibson@tcd.ie

Senior Sophister Course Structure Diagram (Subject to change for AY23/24)

<table>
<tr><th colspan="4">Senior Sophister TR063 – PHYSICS AND ASTROPHYSICS</th></tr>
<tr><th colspan="4">50 Credits Core modules + 10 Credits Open modules (AY 21/22)</th></tr>
<tr><td rowspan="5">Core Modules (50 credits)</td><td colspan="2">Semester 1: Core</td><td>Semester 2: Core</td></tr>
<tr><td colspan="2">PYU44PP2: Capstone Research Project (20 credits) – Assessment in Semester 2</td><td></td></tr>
<tr><td rowspan="3">Project only in first 9 weeks of semester 1</td><td>PYU44PP5: Problem solving (5 credits)</td><td>PYU44P05: Electromagnetic Interactions II (5 credits)</td></tr>
<tr><td colspan="2">PYU44P11: Advanced Quantum Mechanics, Nuclear Structure and High Energy Physics (10 credits)</td></tr>
<tr><td colspan="2">PYU44A01: Planetary and Space Science and Cosmology (10 credits)</td></tr>
<tr><td rowspan="5">Open Modules (10 credits)</td><td colspan="2">Semester 1: Open modules</td><td>Semester 2: Open modules</td></tr>
<tr><td colspan="2" rowspan="4">Take 2 Open modules which total 10 credits</td><td>PYU44P13: Magnetism & Superconductivity</td></tr>
<tr><td>PYU44P06: Modern Optics</td></tr>
<tr><td>PYU44C01: Computer Simulation II</td></tr>
<tr><td>PYU44P17: Energy Science</td></tr>
</table>

The PYU44PP2 capstone research project takes place in the first nine weeks of Semester 1. The assessment of the research project is in Semester 2. The remaining three weeks of Semester 1 has tutorials associated with the PYU44PP5 Problem Solving module which is examined at the end of Semester 1.

Lectures associated with the core PYU44P11 module and the core PYU44A01 module begin in the last three weeks of Semester 1, but examinations for these modules are at the end of Semester 2. All other modules, whether mandatory or optional, occur wholly within Semester 2 and are examined at the end of Semester 2.

Senior Sophister Physics and Astrophysics Core Modules **50 credits**

PYU44PP2 Physics Research Project (S1 & S2) **20 credits**
This module comprises a 9-week full-time research project in astrophysics, physics or computational physics, undertaken at the beginning of Semester 1. The project may be undertaken in Trinity, or in another University or Research Institute in Ireland or abroad.
Submission of report and presentation of results is in Semester 2

PYU44PP5 Problem Solving in Physics (S1) **5 credits**
This module develops techniques and approaches to general problem solving in physics.

PYU44P11 Advanced Quantum Mechanics, Nuclear Structure and High Energy Physics (S1 & S2) **10 credits**
The quantum mechanics of this module extends the discussion of quantum physics into multi-electron atoms, time dependent Schrödinger Equation and perturbation theory. It includes nuclear physics, strong nuclear force and nuclear reactions and introduces high energy physics theory and experiment, fundamental particles, and the Standard Model.

PYU44A03 Planetary and Space Science and Cosmology (S1 & S2) **10 credits**
This module covers advanced concepts in planetary astrophysics, including the properties of solar system planets and exoplanets, their interiors, and atmospheres. In addition, this module covers cosmology, deriving its basic equations and using them together with observations to examine the history and future of the Universe. Recent results concerning dark matter and dark energy, and possible future directions are also examined.

PYU44P05 Electromagnetic Interactions II (S2) **5 credits**
This module covers electromagnetic wave phenomena together with the optical properties of materials.

Senior Sophister Physics and Astrophysics Open Modules **10 credits**

PYU44P13 Magnetism and Superconductivity (S2) **5 credits**
This module covers magnetism, magnetic materials, and introduces superconductivity.

PYU44P06 Modern Optics (S2) **5 credits**
This module covers optical communications and nonlinear optics involving lasers.

PYU44C01 Computer Simulation II (S2) **5 credits**
This module provides an introduction to matrix computing and discrete Fourier transforms and partial differential equations through Python and extends the toolkit of numerical and statistical computer simulation techniques.

PYU44P17 Energy Science (S2) **5 credits**
This module consists of the physics behind key technologies for energy generation.

Note that a further open module in astrophysics may be expected to be in place in the academic year 2024/2025.

Physics and Astrophysics Moderatorship Learning Outcomes.

On the successful completion of this programme, a student should be able to:

- demonstrate in written and oral form a comprehensive level of knowledge of physics and astrophysics and the mathematics that underpins this knowledge, together with an awareness of its place within the broader science curriculum

- apply the core concepts of classical and modern Physics across a wide spectrum of topics and applications, such as computer modelling of astrophysical phenomena

- perform calculations to solve practical problems, including the use of numerical methods and computing

- understand the operation of modern astronomical instruments, such as electronic cameras and optical and radio telescopes

- independently design and carry out experiments and evaluate critically the data obtained, including appropriate error analysis

- communicate the results of an experiment or project via dissertation, poster or oral presentation

- employ literature search methods to obtain information relevant to research and development

- act effectively as an individual or as a member of a team in professional, educational and industrial settings

- update personal knowledge with a high degree of autonomy, whether in the workplace or in the context of further study

Nanoscience

Junior Sophister **Course Advisor: Prof. Peter Dunne P.W.Dunne@tcd.ie**

Nanoscience is a moderatorship taught jointly by the Schools of Physics and Chemistry. Building on the foundation courses taken in the Freshman years, students follow in-depth courses across the spectrum of modern physics, physical chemistry, materials science and nanoscience while reflecting the strength of Trinity's research expertise in these areas.

Junior Sophister:

The Junior Sophister year consists of lectures, tutorials and practicals delivered in modules, as listed below. Within the Junior Sophister year in Nanoscience there are 40 credits of Core modules, with the remaining 20 credits comprising either Open or Elective modules. Some Open modules are in fact mandatory and this requirement in the Junior Sophister year is to satisfy the progression of students in this specialised degree. **All Nanoscience students are required to take a Trinity Elective in the second semester of their Junior Sophister year.** Students receive training in communication skills within the practical modules.

Safety:
To reinforce and extend laboratory skills rising Junior Sophister students are required to attend workshops on Chemical and Laboratory Safety to be held in at the beginning of semester one. Attendance at all workshops is compulsory.

Core Modules: The Core modules, one Trinity Elective and two Open modules specified below are mandatory. In the second semester, students have the choice of taking a second Trinity Elective or one of the specified Chemistry or Physics Open modules**.**

Assessment and Examination Procedures:
Modules may be assessed by end-of-semester examination and/or continuous assessment. Some modules are assessed by a 50:50 combination of continuous assessment and an examination (in a 1-hour exam), such as in PYU33P02 in recent years. Further information relating to the assessed components and composition of written papers will be given in the Junior Sophister Nanoscience Orientation issued to rising Junior Sophisters. Examined modules may include continuous assessment components. Junior Sophister marks contribute 30% of the final degree Moderatorship mark.

Senior Sophisters:
The Senior Sophister year consists of lectures, tutorials and a capstone research project, as listed below. The independent capstone research project is pursued during the first nine weeks of the first semester, in an internationally recognised laboratory that specialises in aspects of nanoscience, physics, chemistry or advanced materials, either on campus or in a facility off-campus. Projects external to Trinity College are either hosted by cognate universities or research institutes. Projects are also hosted by the Schools of Chemistry and Physics and by CRANN and PIs within AMBER.

Core Modules: The research project and several other modules are designated as core modules. These core modules total 45 credits, but the remaining 15 credits of the Senior Sophister year in Nanoscience are made up from among several Open modules of either 5 or 10 credits in size.

Assessment and Examination Procedures:
Modules may be assessed by end-of-semester examination and/or continuous assessment. Further information relating to the assessed components and composition of written papers will be given in the Senior Sophister Nanoscience Booklets issued to rising Senior Sophisters. Assessment of the full-time research project (PYU44NP2) will be performed in Semester 2. Problem Solving in Nanoscience (PYU44NP5) will be examined at the end of Semester 1. Examined modules may include continuous assessment components. The 10-credit lecture module PYU44N02 is examined in part in semester 1, with the majority of the assessment by continuous assessment and examination in Semester 2. Senior Sophister marks contribute 70% of the final degree Moderatorship mark.

Junior Sophister Nanoscience Course Structure Diagram

The Junior Sophister course structure is diagrammatically illustrated below:

Junior Sophister TR063 – NANOSCIENCE		
40 Credits core + 20 Credits Open modules or Trinity Elective modules		
Core Modules (40 credits)	**Semester 1: Core**	**Semester 2: Core**
	PYU33P01: Quantum Mechanics I (5 credits)	CHU33107: Organometallics and Coordination Chemistry (5 credits)
	CHU33405: Analytical and Computational Methods (5 credits)	CHU33307: Solid State Materials and Modelling (5 credits)
	PYU33NP3: Nanoscience Physics Laboratory (10 credits)	
	CHU33409: Analytical and Computational Methods Workshops (5 credits)	CHU33603: Practical in Physical Chemistry and Nanoscience (5 credits)
Open or Trinity Elective Modules (20 credits)	**Semester 1: Open modules both core**	**Semester 2: Open – choose 1 of 2 and Trinity Elective**
	* **PYU33P03: Condensed Matter I** (5 credits)	PYU33P04: Semiconductor Physics (5 credits)
	* PYU33P02: Electromagnetic Interactions I (5 credits)	CHU33105: Chemistry of Polymers and Macromolecules (5 credits)
	* Indicates a mandatory selection **No Trinity Elective available in Semester 1.**	**Trinity Elective** (Nanoscience students obliged to take a TE in S2) (5 credits)

A Nanoscience student must take their one required Trinity Elective in Semester 2. In Semester 2 the choice of Open module is then between PYU33P04 (Semiconductor Physics) and CHU33105 (Chemistry of Polymers and Macromolecules).

A Nanoscience student cannot choose to take a second Trinity Elective. The requirement by College for these students for 10 Elective credits is met between the JS Trinity Elective in Semester 2 and the SF module in the History Ethics and Philosophy of Science.

Junior Sophister Nanoscience Core Modules **40 credits**

PYU33P01 Quantum Mechanics (S1) **5 credits**
This module covers solution of the Schrödinger Equation in specific topics, such as angular momentum and the hydrogen atom.

CHU33405 Analytical and Computational Methods (S1) **5 credits**
This module introduces the student to instrumental methods in analytical chemistry and to modern computational tools to understand chemical structure and interpret spectroscopic results.

CHU33307 Solid State Materials and Modelling (S2) **5 credits**
This model introduces the student to the fundamental aspects of solid-state materials and the modelling of them. It will focus on the electronic structure and defects and how these can be used to influence the properties of materials and hence create functional materials.

CHU33409 Analytical and Computational Methods Workshops Nanoscience Lab/Workshops (S1) 5 credits
In this module students complete a range of experiments in advanced chemical analysis, spectroscopic and other characterisation techniques which are applied to nanoscience.

CHU33107 Organometallic, Coordination Chemistry & Inorganic chemistry (S2) **5 credits**
The aim of this module is to develop an understanding of the main methods of synthetic organometallic chemistry, fundamental structure-reactivity relationships, and concepts of bonding and structure, functional group chemistry, thermodynamics and kinetics.

CHU33603 Practical in Physical Chemistry and Nanoscience (S2) **5 credits**
In this module students complete several nanoscience and physical chemistry experiments.

PYU33NP3 Practical in Nanoscience (S1 & S2) **10 credits**
In this module students complete several advanced experiments in Nanoscience and Physics together with a practical training in Advanced Nanoscience. It also includes components involving training in communication skills, personal and career development, and requires attendance at Nanoscience related School Seminars in Schools of Physics and Chemistry.

Junior Sophister Nanoscience Open Modules and Trinity Electives **20 credits**

PYU33P02 Electromagnetic Interactions I (S1) **5 credits**
This module covers the fundamentals of electromagnetic theory together with quantum optics and lasers. (This is a mandatory module.)

PYU33P03 Condensed Matter I (S1) **5 credits**
This module introduces condensed matter concepts such as crystal structure and thermal and electronic properties of matter. (This is a mandatory module).

Trinity Elective (S2 only) **5 credits**
Details on Trinity Electives are found at: https://www.tcd.ie/trinity-electives/.
Nanoscience students **must** take a TE in Semester 2. They cannot take two TEs.

PYU33P04 Semiconductor Physics (S2) **5 credits**
This module covers the physics of semiconductors and the construction, fabrication and application of semiconductor devices.
OR
CHU33105 Chemistry of Polymers and Macromolecules (S2) **5 credits**
This module introduces the student to polymer and macromolecular chemistry. Polymer-based materials are an important component of many devices and products.

Senior Sophister Nanoscience

Course Advisor: Prof. Peter Dunne P.W.Dunne@tcd.ie

Senior Sophister Course Structure Diagram (subject to change for AY24/25)

<table>
<tr><th colspan="4">Senior Sophister TR063 – NANOSCIENCE</th></tr>
<tr><th colspan="4">45 Credits Core modules + 15 Credits Open modules (AY 24/25)</th></tr>
<tr><td rowspan="5">Core Modules (45 credits)</td><td colspan="2">Semester 1: Core</td><td>Semester 2 Core</td></tr>
<tr><td colspan="2">PYU44NP2: Capstone Research Project (20 credits) – Assessment in Semester 2</td><td></td></tr>
<tr><td rowspan="3">Project only in first 9 weeks of semester 1</td><td>PYU44NP5: Problem solving (5 credits)</td><td>CHU44304: Physical Chemistry (5 credits)</td></tr>
<tr><td colspan="2">PYU44N02: Nanoscience, complex fluids and polymers (10 credits)</td></tr>
<tr><td></td><td>CHU44004: Inorganic chemistry (5 credits)</td></tr>
<tr><td rowspan="9">Open Modules (15 credits)</td><td colspan="2">Semester 1: Open modules</td><td>Semester 2: Open modules</td></tr>
<tr><td colspan="2" rowspan="8">Take 2 or 3 Open modules which total 15 credits</td><td>PYU44P13: Magnetism & Superconductivity (5 credits)</td></tr>
<tr><td>PYU44P06: Modern Optics (5 credits)</td></tr>
<tr><td>PYU44P05: Electromagnetic Interactions II (5 credits)</td></tr>
<tr><td>PYU44P17: Energy Science (5 credits)</td></tr>
<tr><td>CHU44167: Advanced Physical Chemistry (10 credits)</td></tr>
<tr><td>CHU44005: Advanced Inorganic Chemistry (10 credits)</td></tr>
<tr><td>CHU44705: Advanced Computational Chemistry (10 credits)</td></tr>
</table>

The PYU44NP2 capstone research project takes place in the first nine weeks of Semester 1. This may be extended to 12 weeks in some circumstances, pending approval by the course director. The assessment of the research project is in Semester 2. The remaining three weeks of Semester 1 has tutorials associated with the PYU44NP5 Problem Solving module which is examined at the end of Semester 1. Lectures associated with the core PYU44N02 module begin in the last three weeks of Semester 1, and are examined in part in semester 1, with the majority of the module's assessment by continuous assessment and examination in Semester 2. All other modules, whether mandatory or optional, occur wholly within Semester 2 and are examined at the end of Semester 2.

Senior Sophister Nanoscience Core Modules **45 credits**

PYU44NP2 Nanoscience Research Project (S1 and S2) **20 credits**
This module consists of a 9-12 week independent research project. The project is pursued in an internationally recognised laboratory that specialises in aspects of nanoscience, advanced materials or semiconductor processing. The project may be hosted within the School of Chemistry, School of Physics, CRANN, or at an approved international host institution. Submission of report and presentation of results is in Semester 2.

PYU44NP5 Problem Solving in Nanoscience (S1) **5 credits**
This module involves general problem-solving and scientific comprehension in nanoscience, advanced materials or semiconductor processing.

PYU44N02 Nanoscience, Complex Fluids and Polymers (S1&S2) **10 credits**
This module covers nanoscience, and the modified properties of nanoscale matter, its fabrication and potential applications together with the rheology and behaviour of liquids as applied to microfluidic systems and a detailed overview of polymer physics.

CHU44304: Physical Chemistry (S2) **5 credits**
The student will be introduced to statistical thermodynamics and its applications in chemistry, integrating this topic with kinetics, classical thermodynamics and quantum chemistry covered in previous years. The second part of the module will cover elements of soft matter and macromolecular and colloid chemistry.

CHU44004: Inorganic Chemistry (S2) **5 credits**
The student will be introduced to advanced synthetic methods in materials chemistry. The module focuses on the understanding of the fundamental concepts of structure-property relationships to design materials for specific applications (e.g. alloys, ceramics, glasses, inorganic polymers and various composite materials). The second part of the module will introduce the students to the molecular chemistry of the f-block elements (lanthanides and actinides).

Senior Sophister Nanoscience Open Modules

Options must total 15 credits

PYU44P13 Magnetism and Superconductivity (S2) **5 credits**
This module covers magnetism, magnetic materials, and introduces superconductivity.

PYU44P06 Modern Optics (S2) **5 credits**
This module covers optical communications and nonlinear optics involving lasers.

PYU44P05 Electromagnetic Interactions II (S2) **5 credits**
This module covers electromagnetic wave phenomena together with the optical properties of materials.

PYU44P17 Energy Science (S2) **5 credits**
This module consists of the physics behind key technologies for energy generation.

CHU44167 Advanced Physical Chemistry (S2) **10 credits**
The student will be introduced to advanced topics in physical chemistry that integrate and build on core concepts of kinetics, thermodynamics and quantum chemistry covered in core physical chemistry modules. Topics will include: (a) electrochemistry and its applications to energy devices for sustainability, (b) photochemistry and spectroscopy, and (c) surface and interfacial chemistry, including catalysis for the environment.

CHU44005 Advanced Inorganic Chemistry (S2) **10 credits**
This module covers aspects of advanced coordination, organometallic and bioinorganic chemistry. It focuses on structure-property relationships and outlines characterisation techniques for bioinorganic systems. In addition, the module will cover the synthesis, structural chemistry and physicochemical properties of (i) molecular crystals and (ii) copper oxide superconductors, emphasizing the interplay between composition, structure and properties.

CHU44705 Advanced Computational Chemistry (S2) **10 credits**
This module will cover the main computational quantum chemistry methods and computational techniques, including optimisation and molecular dynamics, used in the modelling of structure, chemical reactivity and electronic properties of molecular systems and solid crystals. The performance and suitability of these methods for different applications will also be analysed and discussed. In addition, lectures will be complemented with computational practicals to see the direct application of these methods to specific scientific questions.

Nanoscience Moderatorship Learning Outcomes

On successful completion of this programme students should be able to:

- Articulate in written and oral form a foundation level of knowledge and understanding of Physics, Chemistry and Mathematics.

- Apply key concepts of Physics and Chemistry to Nanomaterials.

- Design, perform and analyse the results obtained from experiments in materials' physics and chemistry, using modern physical and chemical experimental methodologies and instrumentation, with particular reference to materials and nanomaterials.

- Demonstrate skills in problem-solving, critical thinking and analytical reasoning, and be able to effectively communicate the results of their work to chemists, physicists, material scientists and others, both verbally and in writing.

- Use modern library searching and retrieval methods to obtain information pertinent to the identification and solution of problems in the physics and chemistry of materials, and the exploration of new research areas.

- Work effectively and safely in a laboratory environment operating within the proper procedures and regulations for safe handling and use of chemicals and instruments.

- Design and perform appropriate experiments to address materials' physics, chemistry and nanoscience problems and analyse the results.

- Update their knowledge and be able to undertake further study with a high degree of autonomy.

Important information

Attendance

All students should enter residence in or near Dublin and must begin attendance at the College not later than the first day of teaching term and may not go out of residence before the last day of teaching term unless **they have previously obtained permission from the Senior Lecturer through their tutor.**

Students must attend College during the teaching term. They must take part fully in the academic work of their class throughout the period of their course. Lecture timetables are published through my.tcd.ie, and on school or department notice-boards or in Blackboard before the beginning of Michaelmas teaching term. The onus lies on students to inform themselves of the dates, times and venues of their lectures and other forms of teaching by consulting these timetables.

The requirements for attendance at lectures and tutorials vary between the different faculties, schools, and departments. The school, department, or course office, whichever is relevant, publishes its requirements for attendance at lectures and tutorials on noticeboards, and/or in handbooks and elsewhere, as appropriate.

Student Services

Trinity Tutorial Service
The Tutorial Service is unique, confidential, and available to all undergraduate students offering student support in all aspects of College life. The Tutorial Service is supported and co-ordinated by the Senior Tutor's Office which is located on the ground floor in House 27.

Opening Hours and Appointments
The Senior Tutor's Office is open for student appointments between 10.30am - 12.30pm and 2.30pm - 4.00pm Monday to Friday ONLY (email stosec@tcd.ie to arrange an appointment).

What is a Tutor?
A Tutor is a member of the academic staff who is appointed to look after the general welfare and development of the students in his/her care. Whilst the Tutor may be one of your lecturers, this is not always the case as the role of the College Tutor is quite separate from the teaching role.

When should I go to see my Tutor?
You should visit your Tutor whenever you are worried or concerned about any aspect of College life or indeed your personal life, especially if it is affecting your academic work. The conversation with your Tutor takes place in strictest confidence. Unless you give him/her permission to do so, s/he will not divulge information given to them to anybody, whether a member of College or to anyone outside College (to your parents/family for example). Your Tutor can only help you if s/he knows you are facing difficulties, so if you are worried about anything go and see your Tutor before things get out of hand.

Further information on the Senior Tutors Office and College Tutors may be found via the following webpage: **Senior Tutor Services-**
https://www.tcd.ie/seniortutor/students/undergraduate/

Disability Services
The Disability Service aims to provide appropriate advice, support and information to help students and staff with disabilities. The Disability Service has in place a range of supports to ensure that students with disabilities have full access to the same facilities for study and recreation as their peers. Most students registering with the Disability Service request access to a range of supports that help the student reach their full potential while studying. Most students' needs are accommodated through these supports. The student decides what level of support they require.

For contact information or to make an appointment please contact the Disability Services – contact details are available via the following webpage:
https://www.tcd.ie/disability/contact/

Learning Development
Student Learning Development offers support in a variety of study and learning skills including essay writing, exam preparation, study skills, self and time-management and note taking. Mechanisms of support are workshops, individual appointments and drop-in clinics.
https://www.tcd.ie/Student_Counselling/student-learning/services/

Student Counselling
The Student Counselling Service is here to help you to manage any difficulties you are experiencing so you can enjoy and fully participate in your time here at College.

If you wish to make an appointment with the Student Counselling Service, please consider one of the options below. If you have any other queries you can call into reception on the 3rd floor of 7-9 South Leinster Street or contact us on:
Phone: (01) 896 1407
Email: student-counselling@tcd.ie

For further information visit the following webpage:
https://www.tcd.ie/StudentCounselling/

Useful College Websites:

Student Life
Student life offers information on Supports and Services, Clubs and Societies, Student Unions etc., https://www.tcd.ie/students/

Academic Registry
The Academic Registry is responsible for services that support the complete student lifecycle of Trinity College Dublin – from application to graduation. Academic Registry is located

For information on Registration, Fees, Grants, ID Cards etc. visit the Academic Registry (AR) in the Watts Building, on the first floor, or the visit the AR website:
https://www.tcd.ie/academicregistry/

Student Accommodation
CAMPUS: The Accommodation Office is open Monday to Friday from 8.30am to 1pm and 2pm-5pm each day. Queries can be emailed to residences@tcd.ie, or you can telephone 01 896 1177 during office hours.

After hours you can contact Front Gate at 896 3978 in case of difficulties or key problems. In Goldsmith Hall attendants are on duty in the residential area at weekends and overnight and they will assist with local problems.

In the event of a serious emergency, particularly where you require the attendance of ambulance, fire or police services please telephone College Security at 01 896 1999 (internal 1999). To ensure a co-ordinated response please do not call these services directly. We recommend that you programme these numbers into your mobile phone using the prefix “01” before the number. https://www.tcd.ie/accommodation/

Dates to note

Event(s)	Date(s)
Closing date for submission of Mod Preferences	19th April 2024
Semester two assessments session	29 April 2024 – 4th May 2024 inclusive
Publication of Science examination results	29th May 2024
Publication of First Round Sophister Places	Friday 4th July 2024
Reassessment Examinations	To be confirmed
Publication of Second Round Sophister places	To be confirmed
Semester one starts	9th September 2024
Semester one ends	29th November 2024
Semester one examinations	9th to 14th December 2024

Teaching Term Dates 2024-25

Michaelmas Term Monday 9 September - Friday 29 Nov 2024			**Hilary Term Monday 20 January 2025 - Friday 11 April 2025**		
Teaching wk. 1	Week 03	09 Sept – 13 Sept	Teaching wk. 1	Week 22	20 Jan - 24 Jan
Teaching wk. 2	Week 04	16 Sept - 20 Sept	Teaching wk. 2	Week 23	27 Jan – 31 Jan
Teaching wk. 3	Week 05	23 Sept - 27 Sept	Teaching wk. 3	Week 24	*03 Feb - 07 Feb
Teaching wk. 4	Week 06	30 Sept – 04 Oct	Teaching wk. 4	Week 25	10 Feb - 14 Feb
Teaching wk. 5	Week 07	07 Oct - 11 Oct	Teaching wk. 5	Week 26	17 Feb - 21 Feb
Teaching wk. 6	Week 08	14 Oct – 18 Oct	Teaching wk. 6	Week 27	24 Feb – 28 Feb
Study week	**Week 09**	*** 21 Oct - 25 Oct**	**Study week**	**Week 28**	***03 Mar - 07 Mar**
Teaching wk. 8	Week 10	*28 Oct - 01 Nov	Teaching wk. 8	Week 29	10Mar - 14 Mar
Teaching wk. 9	Week 11	04 Nov - 08 Nov	Teaching wk. 9	Week 30	*17 Mar - 21 Mar
Teaching wk. 10	Week 12	11 Nov - 15 Nov	Teaching wk. 10	Week 31	24 Mar - 28 Mar
Teaching wk. 11	Week 13	18 Nov - 22 Nov	Teaching wk. 11	Week 32	*31 Mar - 04 Apr
Teaching wk. 12	Week 14	25 Nov – 29 Nov	Teaching wk. 12	Week 33	07 Apr - 11 Apr

October bank holiday – Monday 28th October 2024
February bank holiday – Monday 3rd February 2025
St Patrick's Day - Monday 17th March 2025

Dates are correct at time of publication, however; they are subject to change in line with College policies and procedures. All changes will be reflected on the Science Course Office webpages: www.tcd.ie/Science and on the College Calendar website: https://www.tcd.ie/calendar/academic-year-structure/academic-year-structure.pdf

Contact Details

Course Director TR063 Physical Sciences		
Professor Plamen Stamenov		E-mail: stamenp@tcd.ie
School Manager		
Dr Colm Stephens		E:mail: colm.stephens@tcd.ie
		Ph: 01 896 2024
Administrative Officer		
Ms Una Dowling		E-mail: dowlingu@tcd.ie
		Ph: 01 896 1675
Executive Officer		
Ms Rashima Sharma		E-mail: sharmar3@tcd.ie
		Ph: 01 896 4141

NOTE: All the information contained in this booklet is accurate at time of publication. However, the Science Course Office reserves the right to modify information, dates and times as necessary. Students will be notified of any changes via e-mail and the Science webpage.

Graduate Attributes

The Trinity Graduate Attributes represent the qualities, skills and behaviours that you will have the opportunity to develop as a Trinity student over your entire university experience, in other words, not only in the classroom, but also through engagement in co- and extra-curricular activities (such as summer work placements, internships, or volunteering).

The four Trinity Graduate Attributes are:

- To Think Independently
- To Act Responsibly
- To Develop Continuously
- To Communicate Effectively

Why are the Graduate Attributes important?

The Trinity Graduate Attributes will enhance your personal, professional and intellectual development. They will also help to prepare you for lifelong learning and for the challenges of living and working in an increasingly complex and changing world.

The Graduate Attributes will enhance your employability. Whilst your degree remains fundamental, also being able to demonstrate these Graduate Attributes will help you to differentiate yourself as they encapsulate the kinds of transversal skills and abilities, which employers are looking for.

How will I develop these Graduate Attributes?

Many of the Graduate Attributes are 'slow learned', in other words, you will develop them over the four or five years of your programme of study.

They are embedded in the curriculum and in assessments, for example, through undertaking independent research for your final year project, giving presentations and engaging in group work.

You will also develop them through the co-curricular and extra-curricular activities. If you help to run a club or society you will be improving your leadership skills, or if you play a sport you are building your communication and team-work skills.

Appendix 1

Item	Reference/Source
General College Regulations	Calendar, Part II, General Regulations and Information, Section II, Item 12 Calendar, Part III, GeneralRegulations, Section I
Student Supports Co-curricular activities TCDSU, GSU & student representation structures	Student Supports
Emergency Procedures	In the event of anemergency, **dial Security Serviceson extension 1999** Security Services provide a 24-hourservice to the college community, 365 days a year. They are the liaison to the Fire, Garda and Ambulance services and all staff and students are advised to alwaystelephone extension 1999 (+353 1 896 1999) in case of an emergency. Should you require any emergencyor rescue services on campus, you must contact Security Services. This includes chemical spills,personal injury or first aid assistance. It is recommended that all studentssave at least one emergency contact in their phone under ICE (In Case of Emergency).
Data Protection	Data Protection for StudentData
Research Ethics	Policy on Good ResearchPractice
Key Locations for students: Include Programme Offices, Laboratories, Online Learning Environments, Libraries, AcademicRegistry, Places of Faith/Prayer Rooms, Photocopiers and any relevant introductory information on these locations	Blackboard Academic Registry

Item	Reference/Source
Plagiarism & Referencing Guidance	Calendar, Part II, General Regulations and Information, Section II, Items 95-102 Calendar, Part III, General Regulations & Information,Section I 'Plagiarism' Plagiarism Policy https://www.tcd.ie/teaching-learning/academic-policies/plagiarism/
Explanation of ECTS Weighting	https://www.tcd.ie/teaching-learning/ug-regulations/Academic_credit_system.php
Health and Safety	Faculty of Science, Technology, Engineering and Mathematics website - https://www.tcd.ie/stem/undergraduate/health-safety.php School Handbooks will have School/Discipline information on Health and Safety.
Foundation Scholarships	Calendar, Part II, Foundationand Non-Foundation Scholarships
Prizes, medals, and other scholarships	Provided by School/Discipline handbooks
Absence from Examinations	Calendar, Part II, General Regulations and Information, Section II, Item 35 Calendar, Part III, Section III,'Examinations, Assessment and Progression' Academic Policies
Reference to Relevant University Regulations	Academic Policies Student ComplaintsProcedure Dignity & Respect PolicyEquality Policy
General Information for students teaching, assessment etc. May include Programme Offices, Laboratories, Online Learning Environments, Libraries, Academic Registry, Places of Faith/Prayer Rooms, Photocopiers and any relevant introductory information on these locations	Blackboard Academic Registry

Item	Reference/Source
Timetable for students	My TCD
Teaching & Learning Study Abroad	Contact School/Discipline
Teaching & Learning Coursework Requirements	Student LearningDevelopment
Marking Scale	Calendar, Part II, General Regulations & Information, Section II, Item 30
Progression Regulations	Calendar, Part II, General Regulations & Information Calendar, Part II, Part C Calendar, Part III, Section III 'Examinations, Assessment and Progression' and 'Assessment and Progression Regulations'
Awards	National Framework forQualifications Trinity PathwaysTrinity Courses
Professional and Statutory Body Accreditation	Provide by School/Discipline Handbooks
Careers Information & events	https://www.tcd.ie/Science/careers/ For further information refer to School/Discipline Handbooks.
External Examiner	Procedure for the transfer ofstudents assessed work to external examiners
Capstone (UG Programmes)	Capstone website Policy on Good ResearchPractice
Attendance Requirements	Calendar, Part II, General Regulations and Information, Section II, Items 17-23 Calendar, Part III, General Regulations and Information, Section I 'Attendance and Off-Books'; Section II 'Attendance'; Section III 'Attendance, Registration, Extensions'; Section IV
Examination Attendance	'Attendance andExaminations'

Item	Reference/Source
Feedback andEvaluation	Student Evaluation andFeedback Student Partnership Policy Procedure for the conduct ofFocus Groups
Registration(UG only)	Students in TR060, TR061, TR062 & TR063 will find handbooks and information on the Science Course website https://www.tcd.ie/Science/#menu and in School/Discipline Handbook.

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Science Course Office

Faculty of Science, Technology, Engineering and Mathematics, Trinity College Dublin 2, Ireland.

Oifig na gCúrsaí Éolaíochta Dámh na hinne-altóireachta, na Matamaitce agus na hÉolaíochta Ollscoil Átha Clíath, Coláiste na Tríonóide Baile Átha Cliath 2. Éire.

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tcd.ie/science