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Swansea University
Prifysgol Abertawe

FACULTY OF SCIENCE AND ENGINEERING

UNDERGRADUATE STUDENT HANDBOOK

YEAR 3 (FHEQ LEVEL 6)

BSC PHYSICS

DEGREE PROGRAMMES

SUBJECT SPECIFIC
PART TWO OF TWO
MODULE AND COURSE STRUCTURE
2022-23

DISCLAIMER

The Faculty of Science and Engineering has made all reasonable efforts to ensure that the information contained within this publication is accurate and up-to-date when published but can accept no responsibility for any errors or omissions.

The Faculty of Science and Engineering reserves the right to revise, alter or discontinue degree programmes or modules and to amend regulations and procedures at any time, but every effort will be made to notify interested parties.

It should be noted that not every module listed in this handbook may be available every year, and changes may be made to the details of the modules. You are advised to contact the Faculty of Science and Engineering directly if you require further information.

The 22-23 academic year begins on 19 September 2022

Full term dates can be found here

DATES OF 22-23 TERMS

19 September 2022 – 16 December 2022

9 January 2023 – 31 March 2023

24 April 2023 – 09 June 2023

SEMESTER 1

19 September 2022 – 27 January 2023

SEMESTER 2

30 January 2023 – 09 June 2023

SUMMER

12 June 2023 – 22 September 2023

IMPORTANT

Swansea University and the Faculty of Science of Engineering takes any form of **academic misconduct** very seriously. In order to maintain academic integrity and ensure that the quality of an Award from Swansea University is not diminished, it is important to ensure that all students are judged on their ability. No student should have an unfair advantage over another as a result of academic misconduct - whether this is in the form of **Plagiarism**, **Collusion** or **Commissioning**.

It is important that you are aware of the **guidelines** governing Academic Misconduct within the University/Faculty of Science and Engineering and the possible implications. The Faculty of Science and Engineering will not take intent into consideration and in relation to an allegation of academic misconduct - there can be no defence that the offence was committed unintentionally or accidentally.

Please ensure that you read the University webpages covering the topic – procedural guidance here and further information here. You should also read the Faculty Part One handbook fully, in particular the pages that concern Academic Misconduct/Academic Integrity. You should also refer to the Faculty of Science and Engineering proof-reading policy and this can be found on the Community HUB on Canvas, under Course Documents.

Welcome to the Faculty of Science and Engineering!

Whether you are a new or a returning student, we could not be happier to be on this journey with you.

This has been a challenging period for everyone. The COVID-19 pandemic has prompted a huge change in society as well as how we deliver our programmes at Swansea University and the way in which you study, research, learn and collaborate. We have been working hard to make sure you will have or continue to having an excellent experience with us.

We have further developed some exciting new approaches that I know you will enjoy, both on campus and online, and we cannot wait to share these with you.

At Swansea University and in the Faculty of Science & Engineering, we believe in working in partnership with students. We work hard to break down barriers and value the contribution of everyone. Our goal is an inclusive community where everyone is respected, and everyone's contributions are valued. Always feel free to talk to academic staff, administrators, and your fellow students - I'm sure you will find many friendly helping hands ready to assist you.

We all know this period of change will continue and we will need to adapt and innovate to continue to be supportive and successful. At Swansea we are committed to making sure our students are fully involved in and informed about our response to challenges.

In the meantime, learn, create, collaborate, and most of all – enjoy yourself!

Professor Johann (Hans) Sienz
Interim Pro-Vice Chancellor/Interim Executive Dean
Faculty of Science and Engineering

Faculty of Science and Engineering	
Interim Pro-Vice Chancellor/Interim Executive Dean	Professor Johann Sienz
Head of Operations	Mrs Ruth Bunting
Associate Dean – Student Learning and Experience (SLE)	Professor Paul Holland
School of Biosciences, Geography and Physics **Head of School: Siwan Davies**	
School Education Lead	Dr Laura Roberts
Head of Physics	Dr Daniel Thompson and Professor Prem Kumar
Physics Programme Director	Professor David Dunbar
Year Coordinators	Year 0 – Dr Warren Perkins Year 1 – Dr Timothy Burns Year 2 – Professor Ardalan Armin Year 3 – Professor Timothy Hollowood Year M – Dr Kevin O’Keeffe

STUDENT SUPPORT

The Faculty of Science and Engineering has two **Reception** areas - Engineering Central (Bay Campus) and Wallace 223c (Singleton Park Campus).

Standard Reception opening hours are Monday-Friday 9am-5pm.

The **Student Support Team** provides dedicated and professional support to all studentsin the Faculty of Science and Engineering. Should you require assistance, have any questions, be unsure what to do or are experiencing difficulties with your studies or in your personal life, our team can offer direct help and advice, plus signpost you to further sources of support within the University. There are lots of ways to get information and contact the team:

Email: studentsupport-scienceengineering@swansea.ac.uk (Monday–Friday, 9am–5pm)

Call: +44 (0) 1792 295514 and 01792 6062522 (Monday-Friday, 10am–12pm, 2–4pm).

Zoom: By appointment. Students can email, and if appropriate we will share a link to our Zoom calendar for students to select a date/time to meet.

The current student **webpages** also contain useful information and links to otherresources:

https://myuni.swansea.ac.uk/fse/coe-student-info/

READING LISTS

Reading lists for each module are available on the course Canvas page and are also accessible via http://ifindreading.swan.ac.uk/. We've removed reading lists from the 22-23 handbooks to ensure that you have access to the most up-to-date versions. Access to print material in the library may be limited due to CV-19; your reading lists will link to on-line material whenever possible. We do not expect you to purchase textbooks, unless it is a specified key text for the course.

THE DIFFERENCE BETWEEN COMPULSORY AND CORE MODULES

Compulsory modules must be **pursued** by a student.

Core modules must not only be **pursued**, but also **passed** before a student can proceed to the next level of study or qualify for an award. Failures in core modules must be redeemed.

Further information can be found under "Modular Terminology" on the following link - https://myuni.swansea.ac.uk/academic-life/academic-regulations/taught-guidance/essential-info-taught-students/your-programme-explained/

Year 3 (FHEQ Level 6) 2022/23
Physics
MPhys Physics[F303]
MPhys Physics with a Year Abroad[F304]

Compulsory Modules

Semester 1 Modules	Semester 2 Modules
PH-302 **Quantum World III** **10 Credits** **Prof TJ Hollowood**	**PH-333** **Atomic Physics and Quantum Optics II** **10 Credits** **Prof N Madsen**
PH-306 **Atomic Physics I** **10 Credits** **Prof SJ Eriksson**	**PH-353** **Computational Physics** **10 Credits** **Prof CR Allton**
PH-307 **Condensed Matter Physics II** **10 Credits** **Dr SM Shermer**	**PH-355** **Mathematical Methods in Physics III** **10 Credits** **Dr DC Thompson**
PH-312 **Advanced Research in Physics** **10 Credits** **Dr K O'Keeffe/Dr SG Roberts**	
PH-335 **Particle Physics II** **10 Credits** **Prof A Armoni**	
PH-338 **Frontiers of Nuclear Physics** **10 Credits** **Prof C Nunez/Dr SM Shermer**	
Total 120 Credits	

Optional Modules
Choose exactly 30 credits

PH-300	Semiconductor Device Physics	Prof A Armin	TB2	10
PH-320	Foundations of Astrophysics	Prof SP Kumar	TB2	10
PH-321	Gravity	Prof TJ Hollowood	TB2	10
PH-322	Cosmology	Prof M Piai	TB2	10
PH-325	Teaching Physics via a School Placement	Dr SG Roberts	TB2	10
PH-325C	Addysgu ffiseg trwy leoliad mewn ysgol	Dr SG Roberts	TB2	10
PH-339	Climate Physics	Prof DP Van Der Werf	TB2	10

Year 3 (FHEQ Level 6) 2022/23
Physics
BSc Physics[F300,F301]
BSc Physics with a Year Abroad[F302]
BSc Physics with a Year in Industry[F478]

Compulsory Modules

Semester 1 Modules	Semester 2 Modules
PH-302 **Quantum World III** **10 Credits** **Prof TJ Hollowood**	**PH-333** **Atomic Physics and Quantum Optics II** **10 Credits** **Prof N Madsen**
PH-306 **Atomic Physics I** **10 Credits** **Prof SJ Eriksson**	
PH-307 **Condensed Matter Physics II** **10 Credits** **Dr SM Shermer**	
PH-312 **Advanced Research in Physics** **10 Credits** **Dr K O'Keeffe/Dr SG Roberts**	
PH-335 **Particle Physics II** **10 Credits** **Prof A Armoni**	
PH-338 **Frontiers of Nuclear Physics** **10 Credits** **Prof C Nunez/Dr SM Shermer**	
Total 120 Credits	

Optional Modules

Choose exactly 30 credits

PH-300	Semiconductor Device Physics	Prof A Armin	TB2	10
PH-308	Modern Laser Systems	Dr K O'Keeffe	TB2	10
PH-320	Foundations of Astrophysics	Prof SP Kumar	TB2	10
PH-321	Gravity	Prof TJ Hollowood	TB2	10
PH-322	Cosmology	Prof M Piai	TB2	10
PH-325	Teaching Physics via a School Placement	Dr SG Roberts	TB2	10
PH-325C	Addysgu ffiseg trwy leoliad mewn ysgol	Dr SG Roberts	TB2	10
PH-329	Quantum Information Processing	Prof GAP Aarts	TB2	10
PH-339	Climate Physics	Prof DP Van Der Werf	TB2	10
PH-355	Mathematical Methods in Physics III	Dr DC Thompson	TB2	10

And

Choose exactly 20 credits

PH-311	Project	Prof TJ Hollowood	TB2	20
PH-311C	Prosiect	Dr CA Isaac	TB2	20

Year 3 (FHEQ Level 6) 2022/23
Physics
MPhys Physics with a Year in Industry[F30Y]

Compulsory Modules

Semester 1 Modules	Semester 2 Modules
PH-302 **Quantum World III** **10 Credits** **Prof TJ Hollowood**	**PH-333** **Atomic Physics and Quantum Optics II** **10 Credits** **Prof N Madsen**
PH-306 **Atomic Physics I** **10 Credits** **Prof SJ Eriksson**	**PH-353** **Computational Physics** **10 Credits** **Prof CR Allton**
PH-307 **Condensed Matter Physics II** **10 Credits** **Dr SM Shermer**	**PH-355** **Mathematical Methods in Physics III** **10 Credits** **Dr DC Thompson**
PH-312 **Advanced Research in Physics** **10 Credits** **Dr K O'Keeffe/Dr SG Roberts**	
PH-335 **Particle Physics II** **10 Credits** **Prof A Armoni**	
PH-338 **Frontiers of Nuclear Physics** **10 Credits** **Prof C Nunez/Dr SM Shermer**	
Total 100 Credits	

Optional Modules
Choose exactly 10 credits

PH-320	Foundations of Astrophysics	Prof SP Kumar	TB2	10
PH-322	Cosmology	Prof M Piai	TB2	10
PH-325	Teaching Physics via a School Placement	Dr SG Roberts	TB2	10
PH-325C	Addysgu ffiseg trwy leoliad mewn ysgol	Dr SG Roberts	TB2	10
PH-361	Probing the nano-scale	Prof PR Dunstan	TB2	10

PH-300 Semiconductor Device Physics

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof A Armin

Format: 22 lectures, 3 feedback sessions

Delivery Method: Lectures and feedback sessions.

Module Aims: This module covers semiconductor device physics with the emphasis on the "next generation" solar cells made of disordered semiconductors.

Module Content: Brief review on semiconductors: electrons in semiconductors, density of state, holes, thermal equilibrium, doping, quasi Fermi level distributions, work function, photo-generation of electrons and holes.

Semiconductor devices: transition from vacuum valves to modern electronics, p-n junction, metal-semiconductor contact, Schottky contact, MIS contact, transistors, solar cells, LEDs and lasers, photodetectors.

Solar cells: electrochemical equilibrium of electrons in a p-n junction, current-voltage characteristics, photo-generation in excitonic and non-excitonic solar cells, organic solar cells, detailed balance theory and thermodynamic limit of photovoltaics.

Organic solar cells: organic semiconductors, donors and acceptors, device optics, charge transfer states, mechanism of recombination, charge carrier collection, scaling-up.

Intended Learning Outcomes: Demonstrate an understanding of the basic principles of semiconductor devices physics.

The ability to use those principles to solve problems of practical interest.

Students will be able to perform calculations and solve problems based on the content of this module taking the form of analytical and/or numerical calculations without the use of text books or other sources.

Students will be able to demonstrate that they have mastered the content of the module by being able to define and summarize important terms and concepts, recall key formulae without the aid of text books or other sources.

Assessment: Coursework 1 (30%)
Examination 1 (70%)

Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Examination (70%): 2 hour written exam.
Continuous Assessment (30%): 2 pieces of coursework

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Students receive assessed work back with the point of error indicated.
Students have a feedback session to go through solutions to the problems.
Students can arrange with lecturer to have personal feedback on their assessments.

Failure Redemption: Re-sit if applicable.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available to visiting and exchange students.

PH-302 Quantum World III

Credits: 10 Session: 2022/23 September-January

Pre-requisite Modules: PH-205

Co-requisite Modules:

Lecturer(s): Prof TJ Hollowood

Format: 22 lectures, 3 feedback sessions

Delivery Method: Lectures and feedback sessions.

Module Aims: Students will deepen their study of Quantum Mechanics by learning the general formalism. Students will be challenged by the strange and puzzling aspects of the theory. Students will learn various approximation techniques for solving complicated systems.

Module Content: 1. Formalism of quantum mechanics: state vectors and Dirac notation, space of states, bases, operators and observables. Recovering wave mechanics.
2. Spin: Nature of spin in QM: matrix representation of states and operators, Stern-Gerlach experiment and measurement, angular momentum addition theorem.
3. Interpretation of quantum mechanics: measurement in quantum mechanics, reduction of the state vector; the EPR experiment and classical versus quantum entanglement, Bell's inequalities, other interpretations of measurement.
4. Approximation theory: the variational method, non-degenerate and degenerate time independent perturbation theory, first order formula and applications. Time dependent perturbation theory, the two-state system, radiative transitions in atoms.

Intended Learning Outcomes: Students will learn the underlying formulation of quantum mechanics, appreciate the issues involving measurement in quantum mechanics, and learn how to solve quantum problems using various kinds of approximations.

Students will be able to perform calculations and solve problems based on the content of this module taking the form of analytical and/or numerical calculations without the use of text books or other sources.

Students will be able to demonstrate that they have mastered the content of the module by being able to define and summarize important terms and concepts, recall key formulae without the aid of text books or other sources.

Assessment: Examination 1 (70%)
Coursework 1 (30%)
Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Examination (70%): 2 hour written exam.
Continuous Assessment (30%): 2 pieces of coursework

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Students receive assessed work back with the point of error indicated.
Students have a feedback session to go through solutions to the problems.
Students can arrange with lecturer to have personal feedback on their assessments.

Failure Redemption: Re-sit if applicable.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available to visiting and exchange students.

PH-306 Atomic Physics I

Credits: 10 Session: 2022/23 September-January

Pre-requisite Modules: PH-205

Co-requisite Modules: PH-302

Lecturer(s): Prof SJ Eriksson

Format: 22 lectures, 3 feedback sessions

Delivery Method: Lectures and feedback sessions.

Module Aims: This course describes the application of quantum mechanics to atomic structure, together with the implications for spectroscopy. The electronic structure of hydrogen (including spin, fine structure and hyperfine structure), helium and alkali metals will be discussed from first principles in quantum mechanics. The effect on energy levels of applied magnetic fields (Zeeman effect) is calculated in perturbation theory. Practical examples of spectroscopy are briefly described.

Module Content: 1. Hydrogen atom with spin, angular momentum addition.
2. Quantum mechanics of identical particles, spin-statistics theorem and Pauli principle, electron state in helium, periodic table.
3. Spectra of hydrogen, sodium, helium, selection rules, spectral line width.
4. Fine structure in hydrogen: spin-orbit coupling, relativistic energy correction, Lamb shift.
5. Zeeman effect.
6. Nuclear spin and hyperfine structure.

Intended Learning Outcomes: An appreciation of the relation of the experimental science of spectroscopy to quantum theoretical understanding of atomic structures.

Students will be able to perform calculations and solve problems based on the content of this module taking the form of analytical and/or numerical calculations without the use of text books or other sources.

Students will be able to demonstrate that they have mastered the content of the module by being able to define and summarize important terms and concepts, recall key formulae without the aid of text books or other sources.

Assessment: Examination 1 (70%)
Coursework 1 (30%)

Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Examination (70%): 2 hour written exam.
Continuous Assessment (30%): 2 pieces of coursework

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Students receive assessed work back with the point of error indicated.
Students have a feedback session to go through solutions to the problems.
Students can arrange with lecturer to have personal feedback on their assessments.

Failure Redemption: Re-sit if applicable.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available to visiting and exchange students.

PH-307 Condensed Matter Physics II

Credits: 10 Session: 2022/23 September-January

Pre-requisite Modules: PH-203

Co-requisite Modules: PH-306

Lecturer(s): Dr SM Shermer

Format: 22 lectures, 3 feedback sessions

Delivery Method: Lectures, problem classes, revision sessions, lab sessions (computer lab)

Module Aims: The course builds on module PH-207 and provides a theoretical and experimental overview of the thermal, electronic and magnetic properties of material.

Module Content: Review of classical Drude and quantum Sommerfeld model and their limitations.
Introduction to Monte Carlo simulations of electron dynamics.

Solution of the Schrodinger equation in periodic potentials and Bloch's theorem.
Emergence of bandgaps and bandstructure due to periodic potentials.
Energy dispersion relations in periodic potentials and effect on Fermi surfaces.
Tight-binding and nearly-free electron approximations.

Band electron dynamics, acceleration theorem, group velocities, effective mass.
Electron trajectories in electric and magnetic fields without and with scattering.
Ohm's Law with generalized conductivity tensor.

Semiconductors.
Bandstructure of semiconductors and carrier types.
Principles of charge neutrality and law of mass action.
Dependence of carrier concentrations and Fermi level on temperature.
Doped semiconductors, carrier concentrations, intrinsic and extrinsic regime, carrier freezeout
Interface between positive and negatively doped semiconductors (pn-junctions)
Carrier concentrations and bandstructure
Operation of pn-junction with forward and reverse bias.
Applications of pn-junctions: diodes and transistors -- basics of their operation and applications

Magnetic properties of matter.
Types of magnetism (dia, para, ferro, anti-ferro, ferri)
Classical explanation of diamagnetism
Quantum model of paramagnetism and Curie law
Heisenberg and Ising model of electron spins in solids
Ferro, ferri and antiferro-magnetism as a result of electron-electron interactions (J-coupling)
Phase transitions and critical temperatures
Mean-field theory and Curie-Weiss law for ferromagnetic materials.
Magnetic resonance: electron (and nuclear) spin resonance in magnetic fields

Superconductivity.
Definition and origin (Cooper-pair formation)
Meissner Effect and London equation
Applications

Intended Learning Outcomes: An understanding of the fundamental laws of condensed matter physics.
The ability to use these laws to solve problems of practical interest.
Students will be able to perform calculations and solve problems based on the content of this module taking the form of analytical and/or numerical calculations without the use of text books or other sources.
Students will be able to demonstrate that they have mastered the content of the module by being able to define and summarize important terms and concepts, recall key formulae without the aid of text books or other sources.

Assessment: Examination 1 (70%)
Coursework 1 (30%)

Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Examination (70%): 2 hour written exam.
Continuous Assessment (30%): 2 pieces of coursework

Moderation approach to main assessment: Second marking as sampling or moderation
Assessment Feedback: Students receive assessed work back with the point of error indicated. Students have a feedback session to go through solutions to the problems. Students can arrange with lecturer to have personal feedback on their assessments.
Failure Redemption: Re-sit if applicable.
Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus. Available to visiting and exchange students.

PH-308 Modern Laser Systems

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr K O'Keeffe

Format: 22 lectures, 3 feedback sessions

Delivery Method: Lectures and feedback sessions.

Module Aims: The objective of this module is to develop a link between basic principles of laser physics and the practical realization of laser systems, which have revolutionised laser applications.

Module Content: Besides the fundamentals of selected laser systems, aspects of assessing specific laser parameters and characteristics will be discussed, as well as some key applications in atomic and molecular physics. The following topics will be addressed:

1. The basics of laser action: 3-level and 4-level systems; simple rate equations; laser cavities (including mode structure).
2. Continuous wave lasers: exemplified for semiconductor diode and Nd:YAG lasers - fundamental principles and practical realisation; operation; wavelength and intensity distributions; wavelength selection; selected applications.
3. Pulsed solid-state laser sources: exemplified for Nd:YAG and Ti:sapphire lasers - fundamental principles and practical realisation; wavelength, intensity and time distributions (including Q-switching); selected applications.
4. Ultra-short laser pulses: generating and characterising femto-second (fs) pulses; the use of fs-laser sources in atomic and molecular physics.

Intended Learning Outcomes: To become familiar with the "new generation" of laser systems, and to understand the basic physics behind the tailoring/optimisation of individual laser sources.

To gain insight into the operation of different laser systems and their use in specific applications in atomic and molecular physics problems.

Students will be able to perform calculations and solve problems based on the content of this module taking the form of analytical and/or numerical calculations without the use of text books or other sources.

Students will be able to demonstrate that they have mastered the content of the module by being able to define and summarise important terms and concepts, recall key formulae without the aid of text books or other sources.

To understand the basic operating principles, and real world applications, of a wide range of laser systems.

Assessment: Examination 1 (70%)
Coursework 1 (30%)

Resit Assessment: Coursework reassessment instrument (100%)

Assessment Description: 70% Written Exam - 2 hours
30% Coursework consisting of 3 assessed problem sheets.

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Students receive assessed work back with the point of error indicated.
Students have a feedback session to go through solutions to the problems.
Students can arrange with lecturer to have personal feedback on their assessments.

Failure Redemption: Re-sit if applicable.

Additional Notes: Available to visiting and exchange students.

PH-311 Project

Credits: 20 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof TJ Hollowood

Format: 20

Delivery Method: Campus

Module Aims: Project carried out individually under the supervision of a member of staff on a suitable theoretical or experimental topic.

Module Content: The project is intended to last one semester and the written reports on the work carried out must be handed in by the end of the second semester. Each project will have a supervisor and the student should liase closely with the supervisor at all times. In addition to the written report, student will give a poster presentation and answer questions on their work.

Intended Learning Outcomes: 1. Experience in specifying, designing, organising and carrying out an extended project lasting the whole of a semester.
2. Acquisition of skills in writing a report, designing a poster and giving an oral presentation of their work.

Assessment: Project (100%)

Assessment Description: .

Moderation approach to main assessment: Universal double-blind marking

Assessment Feedback: From discussion with project supervisor

Failure Redemption: N/A final year module

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available to visiting and exchange students.

PH-311C Prosiect

Credits: 20 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr CA Isaac

Format: 20

Delivery Method: Campws

Module Aims: Prosiect a gynhaliwyd yn unigol dan oruchwyliaeth aelod o staff ar destun damcaniaethol neu arbrofol addas.

Module Content: Bwriad y prosiect yw i bara am un semester a rhaid bod yr adroddiadau ysgrifenedig ar y gwaith a gyflawnir cael ei derbyn cyn diwedd yr ail semester. Bydd pob prosiect â goruchwyliwr a ddylai'r myfyriwr cysylltu'n agos gyda'r goruchwyliwr ar bob adeg. Yn ychwanegol i'r adroddiad ysgrifenedig, bydd y myfyrwyr yn rhoi cyflwyniad ar ffurf poster ac yn ateb cwestiynau ar eu gwaith.

Intended Learning Outcomes: 1. Profiad mewn nodi, dylunio, trefnu a chynnal prosiect estynedig sy'n para'r semester cyfan.
2. Caffael sgiliau mewn ysgrifennu adroddiad, dylunio poster a rhoi cyflwyniad llafar ar eu gwaith.

Assessment: Project (100%)

Assessment Description: .

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: O drafod gyda goruchwyliwr y prosiect

Failure Redemption: Dim yn gymwys. Modiwl flwyddyn olaf.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Dim ar gael i fyfyrwyr sy'n ymweld nac rhai cyfnewidiol.

PH-312 Advanced Research in Physics

Credits: 10 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr K O'Keeffe, Dr SG Roberts

Format: 36

Delivery Method: Online

Module Aims: Experiments conducted in two weekly 3-hour laboratory sessions on topics related to advanced research themes in Physics. Students will be allocated by staff to appropriate themes.

Module Content: The option experiments will be tailored to illustrate and amplify specific topics discussed in the specialist option modules. They will include:
Particle identification
Atmospheric Neutrinos
Scanning tunnelling microscopy experiment
Atomic force microscopy experiment
Scanning tunnelling microscope spectroscopy
Gamma Ray Spectroscopy
Operation/Characterisation of a Laser
Characterisation of solid state devices
Astronomy

Intended Learning Outcomes: 1. A deeper knowledge of the Physics of the advanced research theme.
2. An ability to keep a detailed contemporaneous record or laboratory diary of the work undertaken.
3. An ability to write a detailed scientific dissemination as appropriate to current standards in research.

Assessment: Report (100%)

Assessment Description: Continuous assessment consisting of 2 individual reports.

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Feedback on the first assessment is given both in written form in the marking sheet and orally with a feedback session during one of the lab sessions. Individual feedback on second assessment in written form, orally upon student request.

Failure Redemption: Student will be asked to re-write one or more of the reports (depending on the outcome of the first sits) and to repeat the data analysis procedures connected with it.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Not available to Visiting and Exchange Students.

PH-320 Foundations of Astrophysics

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof SP Kumar

Format: 22 lectures, 3 feedback sessions

Delivery Method: Module delivery will be in person.

Module Aims: This module will introduce students to the quantitative physics underlying the formation, evolution and eventual demise of stars. Students will learn how fundamental concepts from diverse areas of physics, such as gravity, thermodynamics, statistical physics and quantum mechanics come together to provide a complete mathematical model of stellar dynamics which is in beautiful and comprehensive agreement with observational data.

Module Content: 1. Basic stellar parameters and their observed values: Mass, luminosity, radius and typical values; Blackbody relation between luminosity and temperature, Hertzsprung-Russell diagram, etc.
2. Hydrostatic equilibrium: Condition for equilibrium between gravity and pressure, Virial theorem, bounds and estimates for stellar temperatures, pressures, etc.
3. Radiative transport: Relation between luminosity, temperature gradients, mean free path and energy production rates; equations of state.
4. Nuclear processes: Energy production by fusion, quantum tunnelling, Fusion chain reactions, etc.
5. Complete Stellar life-cycle: Charting quantitatively and qualitatively the formation of a star, evolution through Main-Sequence, Red Giant, White Dwarf/Supernova phases; Exact description of degenerate Fermi gases and White Dwarfs/Neutron Stars.

Intended Learning Outcomes: Knowledge of basic observed properties of stars.
Ability to construct a mathematical model of a gravitating matter distribution in equilibrium.
Ability to infer scaling relations and estimates from the stellar model.
Knowledge of stellar evolution, the role of equilibrium thermodynamical constraints, equations of state, and inputs from quantum mechanics and nuclear physics.
Students will be able to perform calculations and solve problems based on the content of this module taking the form of analytical and/or numerical calculations without the use of text books or other sources.
Students will be able to demonstrate that they have mastered the content of the module by being able to define and summarize important terms and concepts, recall key mathematical relations and derivations without the aid of text books or other sources.

Assessment: Coursework 1 (30%)
Examination 1 (70%)
Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Examination (70%): 2 hour written exam.
Continuous Assessment (30%): 2 pieces of coursework

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Students receive assessed work back with the point of error indicated.
Students have a feedback session to go through solutions to the problems.
Students can arrange with lecturer to have personal feedback on their assessments.

Failure Redemption: Re-sit if applicable.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available to visiting and exchange students.

PH-321 Gravity

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules: PH-221

Co-requisite Modules:

Lecturer(s): Prof TJ Hollowood

Format: 22 lectures, 3 feedback sessions

Delivery Method: Lectures and feedback sessions.

Module Aims: The objective of this module is to educate students in the General Theory of Relativity in a way that introduces just enough of the mathematical tools required, namely pseudo Riemannian geometry, so that many applications of the theory can be considered. Students will learn about curved geometries mainly through simple examples and by taking the point of view of a freely falling observer. Applications will include: a discussion of the classic test of general relativity involving planetary motion and bending of light; the strange geometry of black-holes, wormholes and warp drive space-times. Finally students will learn how general relativity determines the dynamics of the whole universe.

Module Content: 1. Newtonian gravitation.
2. Special relativity - geodesics spacetime.
3. Geometry of curvature and tensor calculus.
4. General relativity - foundations, curved spacetime, geodesics, Einstein field equations
5. Classic test of GR - Schwarzchild metric, bending of light, gravitational geodesics, perihelion of mercury.
6. Black holes.
and either
7a. Cosmology - FRW metric, expanding universe, de Sitter metric, inflation
or
7b. Gravitational waves.

Intended Learning Outcomes: Students will gain an understanding of:

- the general principles of general relativity
- how curved geometry lies at the heart of gravity
- the essential mathematics of geodesics in curved space-time
- black holes, singularities and event horizons
- experimental test of general relativity
- cosmology and the dynamics of the universe

Students will be able to perform calculations and solve problems based on the content of this module taking the form of analytical and/or numerical calculations without the use of text books or other sources.

Students will be able to demonstrate that they have mastered the content of the module by being able to define and summarize important terms and concepts, recall key formulae without the aid of text books or other sources..

Assessment: Examination 1 (70%)
Coursework 1 (30%)
Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Examination (70%): 2 hour written exam.
Continuous Assessment (30%): 2 pieces of coursework

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Students receive assessed work back with the point of error indicated.
Students have a feedback session to go through solutions to the problems.
Students can arrange with lecturer to have personal feedback on their assessments.

Failure Redemption: Re-sit if applicable.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available to visiting and exchange students.

PH-322 Cosmology

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules: PH-321

Lecturer(s): Prof M Piai

Format: 22 lectures, 3 feedback sessions

Delivery Method: Lectures and feedback sessions.

Module Aims: This module describes our current understanding of the origin, constituents and evolution of the universe, from the hot big bang to the present day.

Module Content: 1. Galaxies, rotation curves, dark matter

2. Observational cosmology: evidence for an expanding universe and the hot Big Bang model;

3. FRW cosmology: the expanding universe, cosmological parameters and the age of the universe, constituents - matter, dark matter, radiation, dark energy, accelerating expansion and the concordance model of cosmology;

4. The hot Big Bang: thermodynamics in the expanding universe, nucleosynthesis, neutrino decoupling, matter-radiation equality, photon decoupling and the origin of the CMB radiation;

5. Classic problems of the hot Big Bang model and the motivation for inflationary cosmology.

6. Introduction to Inflation

Intended Learning Outcomes: Students will,
Understand the motivations and evidence for the expanding universe and hot Big Bang.
Have a quantitative understanding of FRW comological models with matter, dark matter, radiation and dark energy.
Have a quantitative understanding of the evolution of the universe in the hot Big bang model, especially nucleosynthesis and the origin of the CMB radiation.
Appreciate the motivations for inflationary cosmology.
Students will be able to perform calculations and solve problems based on the content of this module taking the form of analytical and/or numerical calculations without the use of text books or other sources.
Students will be able to demonstrate that they have mastered the content of the module by being able to define and summarize important terms and concepts, recall key formulae without the aid of text books or other sources.

Assessment: Coursework 1 (30%)
Examination 1 (70%)
Resit Assessment: Coursework reassessment instrument (100%)

Assessment Description: Examination (70%): 2 hour written exam.
Continuous Assessment (30%): 2 pieces of coursework

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Students receive assessed work back with the point of error indicated.
Students have a feedback session to go through solutions to the problems.
Students can arrange with lecturer to have personal feedback on their assessments.

Failure Redemption: Re-sit if applicable.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available to visiting and exchange students.

PH-325 Teaching Physics via a School Placement

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr SG Roberts

Format: 40

Delivery Method: 1 day preparatory training on campus

Module Aims: This module is for students with an interest in entering teaching, and involves a weekly placement in a local school under the mentorship of a physics teacher. The student will engage both in observation and in various teaching activities. The module will be assessed on the basis of the mentor's report and on written project work.

Module Content: No formal syllabus - students will have an introductory training day to provide basic information and practical advice. Students will then spend 10 half-days in schools under the supervision of a teacher-mentor, first mainly observing, and then progressing to small-scale teaching activities.

Intended Learning Outcomes: First-hand experience of teaching in a secondary-school environment

Assessment: Coursework 1 (100%)
Resit Assessment: Coursework reassessment instrument (100%)

Assessment Description: 1) There will be a written assessment of the students performance within school by the teacher-mentor. Teachers are used to making quite detailed reports on many different aspects of the performance of PGCE students; we would seek something a little more course-grained, perhaps highlighting
(a) basic punctuality, appearance, attitude and helpfulness
(b) communication skills, to cover both formal teaching/demonstrating, and also interpersonal skills including relating with schoolchildren and maintaining order.
2)The student should maintain a diary/log of all activity during the time they are in the school, which should evidence insights based on their observation of lessons being delivered, and also show development of plans for their own teaching activities, perhaps in the form of lesson plans, exercise sheets, etc.
3i) The student should prepare some course material which could actually be distributed to pupils as a resource to assist teaching a particular component of the curriculum, eg.electrical circuits, nuclear power. The material should be illustrated, and contain both explanatory material and tests/quizzes which help to reinforce the material which has been learned.

Moderation approach to main assessment: Universal non-blind double marking

Assessment Feedback: Coversheets for continuous assessment

Failure Redemption: Resubmission of project work

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Requires an enhanced Criminal Records Bureau check. Not available to visiting and exchange students.

This module has proved popular and is space limited because it is linked to particular schools in the area. If the module is over subscribed there will be a selection procedure and so it would be good to have in mind a backup choice.

PH-325C Addysgu ffiseg trwy leoliad mewn ysgol

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr SG Roberts

Format:

Delivery Method: 1 diwrnod o hyfforddiant ar gampws

Module Aims: Mae'r modiwl yma ar gyfer myfyrwyr sydd â diddordeb mewn dechrau dysgu; sy'n cynnwys lleoliad wythnosol mewn ysgol leol dan fentoriaeth athro ffiseg. Bydd y myfyriwr yn ymgymryd ag arsylwi ac amryw o weithgareddau addysgu. Caiff y modiwl ei asesu trwy adroddiad y mentor ac ar waith prosiect ysgrifenedig.

Module Content: Dim maes llafur ffurfiol - bydd myfyrwyr yn mynychu cwrs un dydd o hyfforddiant rhagarweiniol sy'n rhoi gwybodaeth sylfaenol ac ymarferol. Bydd myfyrwyr yn treulio 10 hanner-diwrnod yn yr ysgol dan oruchwyliaeth yr athro-mentor, i gychwyn yn arsylwi ac yna'n ymgymryd â gweithgareddau dysgu ar raddfa fach.

Intended Learning Outcomes: Profiad o addysgu ffiseg mewn ysgol uwchradd

Assessment: Coursework 1 (100%)
Resit Assessment: Coursework reassessment instrument (100%)

Assessment Description: 1) Bydd yna asesiad ysgrifenedig o berfformiad y myfyriwr yn yr ysgol gan yr athro-mentor. Mae athrawon wedi arfer â chreu adroddiadau manwl ar berfformiad myfyrwyr PGCE; rydyn ni am dderbyn rhywbeth llai manwl sydd efallai'n tynnu sylw at
(a) prydlondeb, ymddangosiad, agwedd a chymwynasgarwch
(b) sgiliau cyfathrebu, addysgu/arddangos ffurfiol, a hefyd sgiliau rhyngbersonol gan gynnwys ymwneud â phlant ysgol a chynnal trefn
2) Dylai'r myfyriwr cynnal dyddiadur/log o'r holl weithgareddau yn ystod ei amser yn yr ysgol sy'n dangos mewnwelediadau sy'n seiliedig ar ei arsylwadau o'r wers sy'n cael ei darparu a hefyd sy'n dangos datblygiadau ar gyfer gweithgareddau ei gwersi ei hun, efallai ar ffurf cynllun-gwers, taflen ymarfer ac ati.
3)Dylai'r myfyriwr paratoi deunyddiau cwrs gall cael ei rhoi i'r disgyblion fel adnodd i gynorthwyo wrth ddysgu rhyw agwedd o'r cwricwlwm e.e. cylchedau trydanol, per niwclear. Dylai'r deunydd bod yn ddarluniadol a chynnwys deunyddiau esboniadol a phrofion/cwisiau sy'n atgyfnerthu'r deunydd sydd wedi ei ddysgu.

Moderation approach to main assessment: Universal non-blind double marking

Assessment Feedback: Taflenni clawr ar waith

Failure Redemption: Ailgyflwyno gwaith prosiect

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Gofyn am wiriad estynedig o'ch cofnodion gyda'r swyddfa cofnodion troseddol. Dim ar gael i fyfyrwyr cyfnewidio.

Mae'r modiwl hwn wedi profi'n boblogaidd ac mae gofod yn gyfyngedig oherwydd ei fod yn gysylltiedig ag ysgolion penodol yn yr ardal. Os yw'r modiwl wedi'i ordanysgrifio bydd gweithdrefn ddewis ac felly byddai'n dda cael dewis wrth gefn mewn golwg.

PH-329 Quantum Information Processing

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof GAP Aarts

Format: 22 lectures, 3 feedback sessions

Delivery Method: Lectures and feedback sessions.

Module Aims: The basic concepts of quantum mechanics, quantum algorithms and quantum computers are introduced. Students will reach an understanding of some of today's most relevant quantum algorithms, including Grover's search algorithm and Shor's algorithm for factoring, as well as quantum teleportation and quantum cryptography protocols. Various state-of-the-art experimental realisations of prototype quantum computers based on photons, trapped ions and superconducting qubits, as well as modern developments such as quantum error correction and the D-Wave quantum machine will be discussed.

Module Content: 1. Module introduction and overview

2. Brief history of quantum information and computation

3. Basics of quantum mechanics - two-state systems
• Hilbert spaces
• Spin-1/2 particles and qubits
• Bras & kets
• Quantum measurement

4. The Deutsch algorithm
• Quantum parallelism, interference and quantum speedup

5. Quantum computing basics
• Qubits and quantum logic gates
• Bell states and entanglement
• The no-cloning theorem
• Dense coding
• Universality of quantum gates

6. Quantum teleportation
• Theory and experimental realisations

7. Speeding up database search
• A brief tour through complexity classes
• Grover's quantum search algorithm

8. Quantum cryptography
• Private key cryptography
• Quantum key distribution protocols

9. Shor's quantum algorithm for fast factoring of large numbers
• Quantum Fourier transform
• Order finding and breaking RSA encryption

10. Physical realisations of quantum computers
• Photons, trapped ions, superconductors

11. Protecting quantum information: quantum error correction
• The challenge of decoherence
• Quantum error correcting codes

12. Modern Topics in Quantum Information Processing
• Adiabatic quantum computing
• The D-Wave machine – a real quantum computer? A critical assessment
• Topological quantum error correction

Intended Learning Outcomes: At the end of this module students should be able to demonstrate knowledge of quantum mechanical principles and how they can be used in quantum algorithms and to implement quantum computers.

They will have developed the ability to (i) read, understand and construct quantum circuits, and will have gained a solid understanding of (ii) algorithms and problems, which can be solved efficiently on quantum computers, (iii) basic concepts in information theory, including entanglement and quantum speedup, (iv) and of physical realisations of prototype quantum computers.

Students will be able to perform calculations and solve problems based on the content of this module taking the form of analytical and/or numerical calculations, define and summarize important terms and concepts, recall key formulae, without the use of text books or other sources.

Thereby, students will at the end of the module also have developed a sufficiently broad background to allow them to critically assess news and articles on novel developments in the growing field of quantum computing and quantum technologies, which they come across in outreach publications, scientific media, TV, internet and social media.

Assessment:	Examination 1 (70%) Coursework 1 (30%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Examination (70%): 2 hour written exam.
Continuous Assessment (30%): 2 pieces of coursework

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Students receive assessed work back with the point of error indicated.
Students have a feedback session to go through solutions to the problems.
Students can arrange with lecturer to have personal feedback on their assessments.

Failure Redemption: Re-sit if applicable.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Not available to visiting and exchange students.

PH-333 Atomic Physics and Quantum Optics II

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof N Madsen

Format: 22 lectures, 3 feedback sessions

Delivery Method: Lectures and feedback sessions.

Module Aims: This module covers the basics of modern topics in atomic physics and quantum optics.

Module Content: 1. Atom-light interactions: electric dipole approximation, absorption rates, spontaneous and stimulated emission.
2. Lasers: optical gain media, laser cavities, tunable lasers, pulsed lasers.
3. Precision measurements: Ramsey fringes and atomic clocks, Doppler-free spectroscopy, frequency combs.
4. Laser cooling and trapping.

Intended Learning Outcomes: Students will learn the basic formulation of light-atom interactions, the principles of lasers and some associated instruments, and finally how to apply this knowledge in modern atomic physics experiments such as laser spectroscopy. Laser cooling is used as an example to highlight the possibilities that open up once this knowledge is mastered.

Students will be able to perform calculations and solve problems based on the content of this module taking the form of analytical and/or numerical calculations without the use of text books or other sources.

Students will be able to demonstrate that they have mastered the content of the module by being able to define and summarize important terms and concepts, recall key formulae without the aid of text books or other sources.

Assessment: Coursework 1 (30%)
Examination 1 (70%)

Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Examination (70%): 2 hour written exam.
Coursework (30%): 2 pieces of coursework

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Students receive assessed work back with the point of error indicated.
Students have a feedback session to go through solutions to the problems.
Students can arrange with lecturer to have personal feedback on their assessments.

Failure Redemption: Re-sit if applicable.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available to visiting and exchange students.

PH-335 Particle Physics II

Credits: 10 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof A Armoni

Format: 22 lectures, 3 feedback sessions

Delivery Method: Lectures and feedback sessions.

Module Aims: This module presents the structure of the standard model of particle physics and reviews current experimental developments.

Module Content: 1. Introduction to modern particle physics.
2. Symmetries and gauge theories: SU symmetry and the structure of gauge theories; QED, QCD, SU(3) x SU(2) x U(1).
3. Electroweak interactions (leptons): leptons in SU(2) x U(1); electroweak unification and the Weinberg angle; neutral currents; LEP and the Z resonance.
4. Electroweak interactions (quarks): quarks in SU(2) x U(1); CKM mixing; FCNCs, the GIM mechanism and charm; precision electroweak physics and the top and Higgs masses.
5. Higgs boson and the origin of mass: Higgs sector of the standard model; Yukawa couplings and quark masses; the Higgs boson.

Intended Learning Outcomes: At the end of this module, the students should:

have a detailed understanding of the structure and symmetries of the standard model of particle physics;
be able to deduce interactions for quarks, leptons and W,Z bosons from electroweak symmetries;
know why the Higgs boson is related to the origin of mass;
appreciate future developments in particle physics arising from the LHC experiments.

Students will be able to perform calculations and solve problems based on the content of this module taking the form of analytical and/or numerical calculations without the use of text books or other sources.

Students will be able to demonstrate that they have mastered the content of the module by being able to define and summarize important terms and concepts, recall key formulae without the aid of text books or other sources.

Assessment: Coursework 1 (30%)
Examination 1 (70%)

Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Examination (70%): 2 hour written exam.
Continuous Assessment (30%): 2 pieces of coursework

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Students receive assessed work back with the point of error indicated.
Students have a feedback session to go through solutions to the problems.
Students can arrange with lecturer to have personal feedback on their assessments.

Failure Redemption: Re-sit if applicable.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available to visiting and exchange students.

PH-338 Frontiers of Nuclear Physics

Credits: 10 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof C Nunez, Dr SM Shermer

Format: 22 lectures, 3 feedback sessions

Delivery Method: Lectures and feedback sessions.

Module Aims: This module covers nuclear physics, including applications of fission and fusion, together with modern developments in the theory of strong interactions.

Module Content: 1. Nuclear size: Rutherford scattering, form factors, diffraction.
2. Nuclear structure and stability: the strong interaction, binding energy, saturation, Semi-empirical mass formula, Shell model.
3. Radioactive decays: alpha, beta, gamma radiation, applications.
4. Nuclear fission and fusion: chain reactions, fission and fusion in power generation, weapons
5. Quark structure of hadrons: quark model, deep-inelastic scattering, colour.
6. QCD: asymptotic freedom and confinement.
7. Bag and string models of hadrons.
8. QCD thermodynamics: deconfinement and the quark-gluon plasma; heavy ion collisions at RHIC and ALICE.

Intended Learning Outcomes: At the end of this module, the students should:

Be aware of the need for phenomenological models to supplement first-principles theory in complex physical situations.
have a thorough knowledge of standard nuclear physics and its applications to power generation and nuclear weapons;
understand at a semi-quantitative level how quarks are bound into hadrons;
appreciate advanced ideas in the statistical mechanics of many-quark/gluon systems

Students will be able to perform calculations and solve problems based on the content of this module taking the form of analytical and/or numerical calculations without the use of text books or other sources.

Students will be able to demonstrate that they have mastered the content of the module by being able to define and summarize important terms and concepts, recall key formulae without the aid of text books or other sources.

Assessment: Examination 1 (70%)
Coursework 1 (30%)

Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Examination (70%): 2 hour written exam.
Continuous Assessment (30%): 2 pieces of coursework

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Students receive assessed work back with the point of error indicated.
Students have a feedback session to go through solutions to the problems.
Students can arrange with lecturer to have personal feedback on their assessments.

Failure Redemption: Re-sit if applicable.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available to visiting and exchange students.

PH-339 Climate Physics

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof DP Van Der Werf

Format: 22 lectures, 3 feedback sessions

Delivery Method: Lectures and feedback sessions.

Module Aims: This module covers the Physics of Climate Change including issues related to energy generation.

Module Content: A physical description of the climate including topics such as:

Radiation balance
Atmosphere
Clouds and aerosols
Greenhouse effect
Ozone layer
Circulation models
Climate on other planets
Evidence for Climate Change

Intended Learning Outcomes: To have an understanding of the physical processes which drive climate change. Students will also have conceptual understanding of the mechanisms and processes of global climatic and environmental change and the ability to assess the evidence for past global changes and its implications for the future.

Students will be able to perform calculations and solve problems based on the content of this module taking the form of analytical and/or numerical calculations without the use of text books or other sources.

Students will be able to demonstrate that they have mastered the content of the module by being able to define and summarize important terms and concepts, recall key formulae without the aid of text books or other sources.

Assessment: Examination 1 (70%)
Coursework 1 (30%)

Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: 70% Written Exam - 2 hours
30% Coursework consisting of 3 assessed problem sheets.

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Students receive assessed work back with the point of error indicated.
Students have a feedback session to go through solutions to the problems.
Students can arrange with lecturer to have personal feedback on their assessments.

Failure Redemption: Re-sit if applicable.

Additional Notes: Available to visiting and exchange students.

PH-353 Computational Physics

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof CR Allton

Format: 66 hours

Delivery Method: Lecture based with guided practical sessions.

Module Aims: Computer simulations play a fundamental role in Physics. This course will introduce the the main techniques used in the field; in particular, Monte Carlo calculations. The student will also be equipped with the needed computing skills.

Module Content: The module is intended as a planned practical course in Monte Carlo methods. The teaching will take place in the College's computer facilities with a 'hands-on' approach. After an introduction to the Python programming language, and various software skills in the UNIX environment, the student will work on a variety of problems in statistical and quantum physics, including the Gaussian model, and the harmonic and anharmonic oscillators. It is intended that the assignments are progressive in complexity.

Intended Learning Outcomes: To have confidence using a UNIX-like operating system, in particular the command shell.
To be able to write programs to perform numerical computations in the Python language, based on specifications given symbolically.
To use Monte Carlo methods, be able to apply them to systems of physical interest, and understand their limitations.
To appreciate data-specific skills such as sampling, statistical uncertainty, handling bias, and effective visualisation
To present results in an accurate, comprehensible and visually appealing manner.

Assessment: Coursework 1 (100%)
Resit Assessment: Coursework reassessment instrument (100%)

Assessment Description: Computer simulations in Physics.
The continuous assessment will consist of 3 assessed pieces of work broken down as below:

Assessment 1: General programming exercise on Canvas (30%)
Assessment 2: Programming exercise on Monte Carlo methods on Canvas (50%)
Assessment 3: Presentation on Monte Carlo methods (20%)

Moderation approach to main assessment: Not applicable

Assessment Feedback: Written feedback.

Failure Redemption: Revision and resubmission of the reports related to the practical sessions.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available to visiting and exchange students.

PH-355 Mathematical Methods in Physics III

Credits: 10 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr DC Thompson

Format: 22 lectures, 3 feedback sessions

Delivery Method: Lectures and feedback sessions.

Module Aims: This module introduces a range of important mathematical skill for physicists including advanced techniques for solving differential equations, variational method and group theory. These ideas will be illustrated with applications to well known physical systems.

Module Content: Variational methods: Stationary-value (SV) problems, SV problems with constraints, Lagrange's method of undetermined multipliers. The Euler-Lagrange equation basic form and generalisations, Classical problems (brachistochrone, etc.) Rayleigh-Ritz methods, examples in quantum mechanics.

-Group theory: Group operations, discrete groups, types of groups (permutation, dihedral, etc.) group relationships (subgroups, isomorphisms, co-sets, generators, etc.). Continuous groups, rotations, orthogonal and Unitary groups, Physical applications.

-advanced solutions to DE's, Sturm Liouville Theory, Special Functions.

Intended Learning Outcomes: Students will extend their knowledge of advanced mathematical techniques in preparation for their level M modules.

Students will be able to perform calculations and solve problems based on the content of this module taking the form of analytical and/or numerical calculations without the use of text books or other sources.

Students will be able to demonstrate that they have mastered the content of the module by being able to define and summarize important terms and concepts, recall key formulae without the aid of text books or other sources.

Assessment: Coursework 1 (30%)
Examination 1 (70%)
Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Examination (70%): 2 hour written exam.
Continuous Assessment (30%): 2 pieces of coursework

Moderation approach to main assessment: Second marking as sampling or moderation

Assessment Feedback: Students receive assessed work back with the point of error indicated.
Students have a feedback session to go through solutions to the problems.
Students can arrange with lecturer to have personal feedback on their assessments.

Failure Redemption: Re-sit if applicable.

Additional Notes: Delivery of both teaching and assessment will be blended including live and self-directed activities online and on-campus.

Available to visiting and exchange students.