University of Hertfordshire UH

Module Catalogue

School of Physics, Astronomy and Mathematics

A DIRECTORY OF UNDERGRADUATE MODULES FOR EXCHANGE AND STUDY ABROAD STUDENTS

SEMESTER A, B AND AB 2021/22

List of Modules

PLEASE CLICK ON THE MODULE NAME BELOW FOR MORE INFORMATION

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Module name: Partial Differential Equations

Module code: 6PAM1023

Module name: Linear Optimisation

Module code: 6PAM1024

Module name: Further Algebra

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Module name: Dynamics and Geometry

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Module name: Further Numerical Methods

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Module name: Nonlinear Optimisation

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Module name: Combinatorics

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Module name: Nonlinear Systems

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Module name: Complex Analysis

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Module name: Financial Mathematics & Derivative Pricing

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Module name: Cosmology and Large Scale Structure

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Module name: Investigations in Physics

Module code: 6PAM1016

Module name:

Module code:

INTRODUCTION

This module directory is specifically designed for exchange students to select modules at School of Physics, Astronomy and Mathematics, University of Hertfordshire.

1. Please see the box below explaining the module codes:

4PAM1034		
4	**PAM**	**1034**
Module level	School of study	Module code

2. As an exchange student you can choose modules from levels 5, 6 and exceptionally at level 4.

Level 4	**Level 5**	**Level 6**
First Year module	Second year module	Third Year module

3. Co-requisites, pre-requisites and prohibited combinations.

Some of the modules may have co-requisites or pre-requisites which you will find indicated in each module. Please note for you, as an exchange student, *if a module has co-requisites or pre-requisites you must have previously studied the subject and have completed the relevant module(s) at your home institution.* When sending your application, please include a copy of your transcript to show that you have taken the minimum required co-requisites or pre-requisites module(s) at your home institution. Additionally, we may require you to provide a module description in order to evidence prior study.

If you are in the process of completing the required module(s) at the time of the application and you do not have the final copy of the transcript, please include a letter from your home institution clearly listing the modules that you are registered on.

Prohibited combinations- please note if there are modules listed under prohibited combinations you can only study one of the modules.

Mathematics
Level 4

Module name: Mathematical Techniques 1

Module code: 4PAM1034

Semester: AB
Credits: 30

Module Aims:
Consolidate their knowledge of topics covered in different A-level syllabi and to be introduced to post A-level work.

Intended Learning Outcomes:
Successful students will typically:

- [I] understand methods and applications for differentiation and integration.

- [ii] understand algebra of complex numbers.

-[iii] understand analytical solution of ordinary linear differential equations.

- [iv] understand matrix and vector algebra and applications.

- [v] understand power and Fourier Series.

Successful students will typically:

- [I] be able to apply differential calculus to functions of one or more variables and integral calculus to functions of one variable.

- [ii] be able to manipulate matrices, solve systems of linear equations and determine eigenvalues and eigenvectors.

- [iii] be able to solve analytically first, second order constant coefficient, and linear systems of ordinary differential equations.

- [iv] find Fourier series of a periodic function.

- [v] determine the interval of convergence of a power series.

Module Content:
On entry students will have different mathematical knowledge and this module has been designed to standardise their mathematical knowledge. The module will initially review core areas of A-Level Mathematics which will be extended to improve students' knowledge. You will learn the standard mathematical techniques in calculus, matrices, vectors and series.

Pre and Co requisites:
None

Total hours: 300

Assessment:

Exam	Coursework	Practical
50%	50%	0%

Mathematics

Level 5

Module name: Linear Algebra

Module code: 4PAM1036

Semester: A

Credits: 15

Module Aims:

Solve linear systems. Understand basis of a vector space. Orthogonalize vectors. Determine eigenvalues and eigenvectors of a matrix.

Intended Learning Outcomes:

Successful students will typically:

- [I] be able to solve linear systems of the form Ax = b

- [ii] be able to find a basis of a vector space

- [iii] be able to understand orthogonalization by Gram-Schmidt

- [iv] be able to understand the properties of determinants

- [v] be able to determine the eigenvalues and eigenvectors of a matrix

Successful students will typically:

- [I] be able to determine solutions of linear systems

- [ii] - be able to find a basis for a given vector space

- [iii] be able to orthogonalize a given set of vectors

- [iv] be able to find determinants of a given vector

- [v] be able to determine eigenvalues and eigenvectors of a matrix A and factorise A = QR

Module Content:

Linear algebra is a fundamental area of mathematics and is arguably the most powerful mathematical tool ever

developed. It is a core topic of study with fields as diverse as business, economics, engineering, science etc.

For an example of linear algebra at work, one need look no further than the Google search engine, which relies

on linear algebra to rank the results of a search with respect to relevance.

Pre and Co requisites:

None

Academic year 2021-2022

Total hours: 150

Assessment:

Exam	Coursework	Practical
70%	30%	0%

Mathematics
Level 6

Module name: Financial and Actuarial Mathematics

Module code: 4PAM1030

Semester: A
Credits: 15

Module Aims:
Develop an understanding of financial markets and the securities traded on them.

Intended Learning Outcomes:
Successful students will typically:

- acquire knowledge of a range of financial products;

- understand how they are traded and priced;

- recognise the risks associated with them.

Successful students will typically:

- use mathematical and actuarial techniques to value the cashflows relating to an investment and quantify the

risks associated with it;

- be able to compare and assess different investment opportunities;

- gain a familiarity with company data and be able to draw simple conclusions from it.

Module Content:
The aim of this module is to introduce students to the fundamental concepts of finance. You will learn about the range of investments available and how these are traded in the markets. You will gain an understanding of

how to analyse and value these investments by applying mathematical and actuarial techniques such as

compound interest, rates of return, discounting and accumulating. You will also gain an understanding of the

risks involved, including the causes and categories of risk and methods of quantifying and mitigating risk. You

will use decision criteria to compare alternative investment opportunities. You will be introduced to company

data and the techniques used to analyse it.

This module is firmly rooted in the real world, giving examples of the information used by investors and financial analysts.

Refer to the teaching plan for a more detailed description.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
0%	100%	0%

Mathematics

Level 7

Module name: Numbers and Sets

Module code: 4PAM1040

Semester: B

Credits: 15

Module Aims:

Formulate basic mathematical statements involving numbers, sets and functions. Develop their mathematical reasoning skills and learn how to structure arguments and proofs.

Understand the concept of sequences and their basic properties.

Intended Learning Outcomes:

Successful students will typically:

* [i] formulate statements involving numbers, sets and functions

* [ii] how to structure proofs of simple mathematical statements

* [iii] basic properties of sequences in the real numbers

Successful students will typically:

* [i] formulate statements involving numbers, sets and functions

* [ii] establish proofs of simple mathematical statements

* [iii] recognise and prove basic properties of sequences in the real numbers

Module Content:

This module aims to present the really fundamental ideas and language on which the rest of mathematics is

based. This will give you a much better understanding of some of the ideas you may have met previously, such

as how mathematicians view sets, functions, different types of numbers. The course also investigates the

concept of sequences and the idea of tending to a limit, on which calculus is based.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical

Academic year 2021-2022

80%	20%	0%

Academic year 2021-2022

Mathematics

Level 8

Module name: Applications of Mathematics

Module code: 4PAM1042

Semester: B

Credits: 15

Module Aims:

Recognise the way in which mathematics can be used in a specific context. Discuss, explain and report on a selection of applications of mathematics.

See mathematicians as professionals working in a larger society.

Intended Learning Outcomes:

Successful students will typically:

* [i] mathematical techniques appropriate to the applications met in the course

* [ii] the way in which mathematics can be used in real world modelling

* [iii] how a modelling problem is often simplified or modified to permit a mathematical treatment

Successful students will typically:

* [i] to solve simplified mathematical models that represent real world systems

* [ii]to present the conclusions of their investigation in an oral presentation

* [iii]to present results of their investigation in a carefully written, appropriately referenced report

Module Content:

Mathematics has a role in describing and sometimes shaping many forms of societal activity – economics;

planning; theories of conflict; the spread and containment of disease, industrial design; logistics and many

others. Mathematical modelling is the process of finding the appropriate mathematical quantities and equations

to describe these applications; and then to study the implications of their solutions. In this model, you will meet

three case studies from different areas of applicable maths. You will see how the models are constructed and

then do some investigations of your own based around these models. You will present your results in three

different ways, as is often required in professional modelling: in the form of an oral presentation; as a wellwritten and referenced technical report for an expert audience; and as a report for a non-technical audience as

would be expected for a government briefing for instance.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
0%	100%	0%

Mathematics Level 5

Module name: Mathematical Techniques 2

Module code: 5PAM1022

Semester: A

Credits: 15

Module Aims:

Develop an understanding of multiple integrals and vector calculus.

* [ii] develop an understanding of the Fourier transform

* [iii] explore the concept of an analytic function and contour integration

Intended Learning Outcomes:

Successful students will typically:

* [i] multiple integrals and vector calculus,

* [ii] the Fourier transform, and

* [iii] analytic functions and contour integration

Successful students will typically:

* [i] perform multiple integrals in unfamiliar problems, including changing the order of integration and changing

coordinates.

* [ii] perform calculations involving vector calculus and analytic functions of complex variables.

* [iii] determine the Fourier transform of a function.

Module Content:

You will learn how to integrate functions of two and three variables along plane and space curves and how to

evaluate multiple integrals of such functions. You will learn about gradient, divergence and curl. You will be able

to obtain the Fourier transform of a function and perform calculations involving analytic functions of a complex

variable.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
80%	20%	0%

Mathematics Level 6

Module name: Real Analysis

Module code: 5PAM1031

Semester: B

Credits: 15

Module Aims:

Understand and work with the foundational concepts in real analysis – bounds, limits, continuity, and differentiability – in the context of real sequences and real-valued functions of one real variable; and to write rigorous mathematical arguments using these concepts.

Intended Learning Outcomes:

Successful students will typically:

* [i] Understand the key defining axiom of the real numbers concerning least upper bounds.

* [ii] Gain a good conceptual grasp of the definitions of convergence of a sequence of real numbers and

continuity of a real-valued function.

* [iii] Gain insight into what is meant by differentiability of a real-valued function, and learn standard theorems

(e.g. Rolle's theorem) concerning differentiable functions.

* [iv] Understand the power-series representation of a function about a given point, and the conditions for its

convergence.

Successful students will typically:

* [i] Improve their ability to formulate and correctly express mathematical proofs in general, and in particular.

* [ii] Gain a facility for working with the N-epsilon and epsilon-delta arguments that are ubiquitous in real

analysis.

* [iii] Be able to apply standard theorems (e.g. Rolle's Theorem) in ways novel to them.

* [iv] Find the Taylor series representation of a given function, and conditions for its convergence.

Module Content:

This module introduces Real Analysis, one of the core topics in pure mathematics. We deal mainly with realvalued

functions of a single real variable, and the central concept we introduce is the precise definition of what it means for such a function to be continuous. This definition is beautiful and yet notoriously subtle. In building up

to it, we review and extend concepts from Level 4 about the meaning of convergence of sequences of real

numbers, and we isolate the key property which distinguishes the real numbers from other number systems:

that of completeness. We go on to give a similarly precise treatment of differentiability of functions. In the

concluding section of the course, we look at power-series expansions of functions and discuss theorems about

their convergence properties.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
80%	20%	0%

Mathematics Level 7

Module name: Differential Equations

Module code: 5PAM1032

Semester: B

Credits: 15

Module Aims:

Demonstrate comprehension and understanding in the topics of differential equations;

Develop technical skills in comparing alternative methods and techniques for using differential equations in applications;

Consolidate the techniques for solving differential equations.

Intended Learning Outcomes:

Successful students will typically:

* [i] recognising the different forms of differential equations and select appropriate approaches to solving them

analytically.

Successful students will typically:

Have a knowledge and understanding of:

* [i] to construct appropriate (solvable) mathematical models using differential equations;

* [ii] to solve first, second and higher order differential equations analytically;

* [iii] to use the Laplace transforms to solve differential equations;

* [iv] to use matrix methods to represent and solve simultaneous differential equations;

* [v] to use power series to solve differential equations.

Module Content:

This module employs a variety of mathematical methods and techniques to explore, describe and predict the

behaviour of scientific, industrial and engineering phenomena. The subject appeals to individuals interested in

applying mathematics to real-word problems.

In this module, we focus on ordinary differential equations. The emphasis is on the development of methods

important in applications. Topics include:-

Theory and applications of first, second and higher order differential equations.

The Laplace transforms method.

Systems of linear differential equations and power series solutions to differential equations.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
80%	20%	0%

Mathematics Level 8

Module name: Programming

Module code: 5PAM1023

Semester: A

Credits: 15

Module Aims:

The aims of this module are to enable students to understand the general principles of computer programming and be able to apply them in an appropriate high-level programming language.

Intended Learning Outcomes:

Successful students will typically:

Have a knowledge and understanding of:

* [i] common features of high-level programming languages such as arithmetic operators and operations, built-in

functions, data structures e.g. arrays, loops, branching statements, input-output statements, subprograms and

file handling;

* [ii] simple program design methods;

* [iii] the importance of program clarity;

* [iv] debugging procedures;

* [v] program documentation.

Successful students will typically:

* [i] design, write, test and debug simple programs and produce documentation with limited supervision and

direction;

* [ii] apply a wide range of programming techniques and make an informed choice of solutions to unfamiliar

problems;

* [iii] appreciate how the general principles of computer programming are applied in other high-level

programming languages;

* [iv] understand and modify more complex programs.

Module Content:

You will learn how to design and write programs in an appropriate high-level programming language. The module

will cover control structures such as loops and logical statements. You will be shown how to build more

complex programs by linking separate functions and procedures. You will learn how to debug programs and

produce program documentation.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
0%	100%	0%

Mathematics Level 9

Module name: Algebra

Module code: 5PAM1028

Semester: A

Credits: 15

Module Aims:

The aims of this module are to enable students to understand and work with topics in abstract algebra, including permutations, relations on sets, and groups; and to write rigorous mathematical arguments using

these concepts.

Intended Learning Outcomes:

Successful students will typically:

Have a knowledge and understanding of:

* [i] Permutations of finite sets, and relations on sets.

* [ii] The definitions of a group, a subgroup, a group action on a set, and of a homomorphism of groups.

* [iii] Some concrete example of the above concepts, including matrix groups and symmetry groups.

* [iv] Results in group theory including Lagrange's theorem and the Orbit-Stabilizer theorem.

Successful students will typically:

* [i] Perform calculations with permutations in various notations, including disjoint cycle notation.

* [ii] Perform calculations with abstract groups and with concrete (e.g. matrix) groups.

* [iii] Write clear and accurate proofs in abstract algebra.

* [iv] Apply theorems in group theory to examples, to compute for example the orders of symmetry groups.

Module Content:

This module introduces several core topics in Algebra. A recurring theme is of building from concrete examples

to abstract and unifying mathematical ideas. We start with permutations on finite sets of objects, and develop

techniques for working with them. We then introduce the concepts of relations on sets; in particular we discuss

equivalence relations and the notion of a partition of a set. We proceed to introduce one of the most important concepts in mathematics: that of a group. We discuss the group axioms in detail and show how they are

motivated by means of various naturally-occurring examples; we stress the idea of groups as groups of

transformations of some object. Key results in group theory, including Lagrange's theorem and the orbitstabilizer

theorem, are stated and proved, and examples are given to show their utility and power.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
80%	20%	0%

Mathematics Level 10

Module name: Number Theory

Module code: 5PAM1026

Semester: A

Credits: 15

Module Aims:

Develop an understanding of number theory. Develop the concepts and techniques required to understand and to solve problems in number theory.

Intended Learning Outcomes:

Successful students will typically:

* [i] recognise the use of Euclid's algorithm for finding gcd and solving linear Diophantine equations;

* [ii] recognise natuer and problems concerning proofs and distribution of the primes;

* [iii] recognise modular arithmetic problems and uses.

Successful students will typically:

* [i] perform calculations to find gcd, and solve linear Diophantine equations;

* [ii] apply relevant techniques to solve problems in Modular arithmetic and congruences;

* [iii] use a suitable software applications package to solve suitable problems in Number Theory.

Module Content:

Number theory is one of the oldest branches of mathematics and is concerned with the properties of integers. Number theory has many practical applications including such topics as cryptography. This module will look at

divisibility among integers, the Euclidean algorithm and factorization into prime numbers. The distribution of the

primes will be investigated. Modular ("clock") arithmetic leads to the investigation of congruences, Fermat's

little theorem, Chinese remainder theorem, and quadratic reciprocity. We also consider Euler's phi function,

and other topics such as Diophantine equations and continued fractions.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
70%	30%	0%

Mathematics Level 11

Module name: Dynamics

Module code: 5PAM1024

Semester: B

Credits: 15

Module Aims:

Solve problems in dynamics using a range of mathematical structures;

Analyse a dynamical problem and provide an appropriate mathematical description of it;

Recognise that problems in dynamics are often dealt with in particular frames of reference.

Intended Learning Outcomes:

Successful students will typically:

Have a knowledge and understanding of:

* [i] Core concepts of dynamics – states, changes, equations of motion, symmetry;

* [ii] Specific applications of the core concepts to mechanics – generalised coordinates, momentum, energy,

oscillations;

* [iii] A range of mathematical structures to include: tensors, frames and transformations between frames,

introductory variational methods in dynamics, introductory phase portraits.

Successful students will typically:

* [i] to solve problems in dynamics using complementary approaches

* [ii] to manipulate tensors and apply them to both dynamical problems and changes of coordinates

* [iii]to set up equations to model problems in classical mechanics using the experience they have gained from

taught examples

Module Content:

Dynamics in mathematics has a broad meaning and describes states and state spaces and the transformation

or evolution of these states. In this module, we highlight these ideas whilst focusing on problems of classical

mechanics. The approach will emphasise the (historically accurate) way in which mathematical structures have often been devised to solve particular mechanical problems. You will learn how to work in different frames (e.g.

rotating coordinates, body-centred coordinates). You will use tensors to solve problems locally and then see

how non-local variational methods can also be powerful tools, both in solving complex problems and revealing

their intrinsic symmetries. Throughout the module, you will learn and practice new techniques on a weekly

basis, building up a useful armoury of skills. These can be turned on more advanced problems of dynamics and

have wider application in mathematical physics.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
70%	30%	0%

Mathematics Level 12

Module name: Numerical Methods

Module code: 5PAM1029

Semester: B

Credits: 15

Module Aims:

Appreciate the need for numerical algorithms for solving problems; Understand a range of numerical algorithms and be able to use them.

Intended Learning Outcomes:

Successful students will typically:

* [i] rounding to a specified precision;

* [ii] standard algorithms f or solving numerical problems both by hand and by computer;

* [iii] appreciate the relative merits and limitations of methods for particular problems.

Successful students will typically:

* [i] describe, compare and select appropriate numerical methods f or particular problems;

* [ii] apply numerical methods by hand calculation;

* [iii] solve problems using computer implementations of numerical methods.

Module Content:

You discover how to use numerical methods to solve mathematical problems and to discuss the relative performance of different methods in terms of accuracy and efficiency. You also learn about the theoretical

background to the methods.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
80%	20%	0%

Mathematics Level 13

Module name: Financial Markets and Portfolio Theory

Module code: 5PAM1030

Semester: AB

Credits: 30

Module Aims:

Gain an understanding of modern financial theories relating to portfolio selection and market models. Analyse the performance of a portfolio of risky securities and fixed income securities.

Intended Learning Outcomes:

Successful students will typically:

* [i] a range of techniques for the analysis of portfolios of securities

* [ii] the concepts of investment risk and expected return, building on their earlier understanding

* [ii] the principles and theories underlying the behaviour of markets and investors

Successful students will typically:

* [i] to use software to construct optimal portfolios

* [ii] to demonstrate a familiarity with market data and use appropriate techniques to analyse it

* [iii] to communicate their findings effectively

Module Content:

The first half of this module focuses on the mathematical analysis of portfolios of securities. A variety of techniques are introduced to analyse the risk and expected return of a portfolio, leading to the construction of

efficient portfolios. Live financial data will be downloaded from the internet and used to illustrate the methods

and ideas discussed in lectures.

The second half of the module investigates the wider principles and theories underlying financial markets.

Concepts such as market efficiency, utility theory and behavioural finance, and various different asset pricing

models will be introduced and discussed.

Pre and Co requisites:

None

Total hours: 300

Assessment:

Exam	Coursework	Practical
60%	40%	0%

Mathematics Level 6

Module name: Partial Differential Equations

Module code: 6PAM1023

Semester: A

Credits: 15

Module Aims:

Able to recognise partial differential equations and choose appropriate method for its solution; Know where and how PDEs arise in applications.

Intended Learning Outcomes:

Successful students will typically:

Have a knowledge and understanding of:

* [i] describing real-world systems using Partial Differential Equations;

* [ii] the derivations of some important partial differential equations.

Successful students will typically:

* [i] to solve partial differential equations by characteristic methods;

* [ii] to solve partial differential equations by separation variables;

* [iii] to understand and recognise Sturm Liouville systems;

* [iv] to use Green's functions in the solution of differential equations.

Module Content:

PDEs arise as part of the mathematical modeling of real life problems connected to many areas of science.

These connections must be exploited to find a solution to these problems.

PDEs provide the foundation for a robust and important field concerned with applied mathematics. In this

module we will be look at the derivation of some important PDEs and their classifications scheme. The different

methods for solving first- and second-order PDEs using method of characteristics for linear and quasi-linear

PDEs, d'Alembert's solution to the wave equation and propagation of discontinuities; Separation of Variables:

homogeneous equations, examples from the heat, wave, and Laplace equations, Sturm-Liouville Theory, Adjoint

Operators, Non-Homogeneous PDEs, Method of Eigenfunction Expansion.

Introduction to Green's functions.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
80%	20%	0%

Mathematics Level 7

Module name: Linear Optimisation

Module code: 6PAM1024

Semester: A

Credits: 15

Module Aims:

The aims of this module are to enable students to understand linear programming and to be able to solve associated problems.

Intended Learning Outcomes:

Successful students will typically:

Have a knowledge and understanding of:

* [i] the modelling process in relation to linear programming;

* [ii] a range of LP algorithms and their relative merits;

* [iii] the problem cases that arise when solving LP problems.

Successful students will typically:

* [i] formulate LP models from given data;

* [ii] critically select and then apply algorithms to LP models;

* [iii] interpret solutions of LP models.

Module Content:

You learn to extract the relevant information from business problems and to develop linear programming models

to represent them. A number of different solution methods are developed and used to solve these problems.

You will develop the ability to interpret the solutions in practical terms and deal with the problem cases that

sometimes arise when solving LP problems.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
80%	20%	0%

Academic year 2021-2022

Mathematics Level 8

Module name: Further Algebra

Module code: 6PAM1025

Semester: A

Credits: 15

Module Aims:

Deepen their mathematical abstract way of thinking and problem solving skills; Understand and apply abstract algebra ideas and results; Be aware of the applications of modern algebra in areas outside mathematics.

Intended Learning Outcomes:

Successful students will typically:

Have a knowledge and understanding of:

* [I] some abstract topics in algebra;

* [ii] development of an area of abstract algebra and its application to other disciplines.

Successful students will typically:

* [i] to formalise abstract generalisations of number systems and sets;

* [ii] to express coherent step-by-step mathematical arguments in the field of abstract algebra;

* [iii] critically analyse connections of abstract algebra with other areas of mathematics.

Module Content:

This course builds on the level 5 course Algebra. We aim at deepening results on known algebraic structures

by focusing on some of the following topics: polynomial rings; field extensions and introduction to Galois

theory; finite fields and applications in crytography; group theory and group presentations. Also to introduce

new structures such as ordered sets, lattices and universal algebra, and their applications.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
50%	50%	0%

Academic year 2021-2022

Mathematics Level 9

Module name: Dynamics and Geometry

Module code: 6PAM1026

Semester: A

Credits: 15

Module Aims:

The aims of this module are to enable students to understand and work with the powerful formalisms of Lagrangian and Hamiltonian dynamics. Beginning with the calculus of variations we will introduce the ideas of Action, Lagrangian, Hamiltonian, Poisson brackets and finally the geometry of phase space.

Intended Learning Outcomes:

Successful students will typically:

Have a knowledge and understanding of:

* [i] The calculus of variations.

* [ii] Lagrangian mechanics.

* [iii] Hamiltonian mechanics and phase space.

Successful students will typically:

* [I] to derive the Euler-Lagrange equations and to use them to solve problems in the calculus of variations;

* [ii] to compute the Lagrangian of simple dynamical systems;

* [iii] to identify cyclic coordinates and their corresponding conservation laws;

* [iv] to pass between the Lagrangian and Hamiltonian formalisms in concrete examples;

* [v] to manipulate Poisson brackets and perform computations involving the equations of motion on phase

space

Module Content:

This module introduces the powerful mathematics used in the study of dynamical systems. We start with the

calculus of variations, a topic which deals with “extremization” questions in geometry – for example, “What

shape does a soap-film form?”, or “What curve is formed by a heavy chain hanging under its own weight?”. We

go on to show how these techniques can be applied to mechanical systems: it turns out that the laws of motion themselves arise from extremizing some quantity: the action. This Lagrangian perspective gives a

powerful way to compute the equations of motion of a system and to understand its symmetries. Typically the

equations are second-order differential equations. In the final section of the module we will describe how the

Hamiltonian formalism reduces them to first-order equations. In so doing we introduce the concept of phase

space, and will be able to touch briefly on the rich topic of symplectic geometry.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
80%	20%	0%

Mathematics Level 10

Module name: Further Numerical Methods

Module code: 6PAM1027

Semester: B

Credits: 15

Module Aims:

Appreciate the need for numerical algorithms for solving problems; Understand a range of advanced numerical algorithms and be able to use them.

Intended Learning Outcomes:

Successful students will typically:

* [i] the factors that effect the accuracy of numerical solutions;

* [ii] advanced algorithms for solving numerical problems both by hand and by computer;

* [iii] appreciate the relative merits and limitations of methods f or particular problems.

Successful students will typically:

* [i] describe, compare and select appropriate numerical methods for particular problems;

* [ii] apply numerical methods by hand calculation;

* [iii] solve problems using computer implementations of numerical methods.

Module Content:

You discover how to use advanced numerical methods to solve mathematical problems and to discuss the relative performance of different methods in terms of accuracy and efficiency. You also learn about the

theoretical background to the methods.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
80%	20%	0%

Mathematics Level 11

Module name: Nonlinear Optimisation

Module code: 6PAM1028

Semester: B

Credits: 15

Module Aims:

Understand how optimization problems arise in real world and identify appropriate solution methods to solve them; Develop an understanding of the fundamentals of nonlinear optimization.

Intended Learning Outcomes:

Successful students will typically:

* [i] unconstrained and constrained formulations of nonlinear optimisation problems

* [ii] fundamental methods and use of software for nonlinear optimisation.

Successful students will typically:

* [i] to apply an appropriate algorithm or numerical method for solving a particular problem;

* [ii] to discuss the relative advantages and limitations of the various algorithms;

* [iii] to understand the derivation and uses of the optimality conditions;

* [iv] to use given implementations of these algorithms in Matlab and analyse results;.

Module Content:

You will learn and explore the fundamentals of nonlinear optimisation problems, both unconstrained and

constrained and how to solve them using a number of different iterative techniques. Blending theory and

algorithms for solving nonlinear optimisation problems with applications to real world problems such as in

finance. You will study the convergence properties of these iterative methods and learn how to use software

implementations of them.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical

80%	20%	0%

Academic year 2021-2022

Mathematics Level 12

Module name: Combinatorics

Module code: 6PAM1029

Semester: B

Credits: 15

Module Aims:

Identify and define a range of discrete mathematical structures and their properties. Apply various combinatorial techniques. Recognise and solve combinatorial problems.

Intended Learning Outcomes:

Successful students will typically:

Have a knowledge and understanding of:

* [i] several important types of discrete mathematical structures;

* [ii] key properties of such structures;

* [iii] common problems and questions relating to these structures and properties;

* [iv] techniques to solve and answer those problems and questions, respectively.

Successful students will typically:

* [i] to express and identify discrete problems in terms of the appropriate mathematical language;

* [ii] to apply different combinatorial techniques;

* [iii] to analyse, explore and solve unseen problems by comparing them to known problems.

Module Content:

Combinatorics is the study of finite or countable, discrete structures; as opposed to uncountable, continuous

structures such as the real or complex numbers studied in Analysis and Calculus.

Graphs (think of a system of islands connected by bridges) and Latin Squares (a completed Sudoku puzzle is

an example of a Latin Square) are two examples of the kind of object Combinatorists are particularly interested

in, but there are many more.

Combinatorial problems are just as varied as Combinatorial objects and include questions such as “How many

different number plates can there be?”, “If you shuffle a playlist, what are the odds that at least one song is in its original position”, or “Can you find six people so that no three of them are all mutual friends, but no three of

them are all mutual strangers?”.

Pre and Co requisites:
None

Total hours: 150
Assessment:

Exam	Coursework	Practical
80%	20%	0%

Mathematics Level 13

Module name: Nonlinear Systems

Module code: 6PAM1030

Semester: B

Credits: 15

Module Aims:

Investigate problems modeled by nonlinear differential equations and evaluate the qualitative behaviour of their solutions.

Intended Learning Outcomes:

Successful students will typically:

- [I] have an understanding of phase portraits.

- [II] have a systematic understanding of the bi-functional behaviour of families of 1-dimensional differential

systems.

Successful students will typically:

- [i] be able to evaluate, analyse and determine the qualitative behaviour of the solution of differential equations

via phase portraits.

- [ii] be able to evaluate, interpret and explore the behaviour of differential systems using local linearisations

about fixed points

- [iii] be able to explore and analyse the behaviour of nonlinear systems by application of appropriate software

Module Content:

You will learn how to investigate and evaluate the qualitative behaviour of the solutions of differential equations

which relate to problems in a wide variety of application areas. You will recognise that the behaviour of the

solution of a differential equation can be drastically altered by a small change in a parameter. These

observations have important contributions in improving the applications of mathematics in industry, business

and the physical sciences.

The module provides the student with an understanding of differential equations by the construction, analyse and interpretation of phase portraits. In particular you will be able to identify if and when periodic solutions and

other types of behaviour exist.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
80%	20%	0%

Mathematics Level 14

Module name: Complex Analysis

Module code: 6PAM1020

Semester: A

Credits: 15

Module Aims:

Become familiar with fundamental ideas of complex analysis; Extend the ideas developed in Real Analysis from real to complex numbers; Develop the theory of analytic functions, and to apply this theory to understand problems arising in real analysis or calculus.

Intended Learning Outcomes:

Successful students will typically:

* [I] functions of a complex variable, and how they differ from their real counterparts;

* [ii] ideas of continuity and differentiability on the complex plane;

* [iii] path and contour integrals.

Successful students will typically:

* [I] to describe geometrically and work with sets of complex numbers;

* [ii]to investigate the properties of complex functions;

* [ii]to perform integration of complex functions, and apply this to solve real integrals

Module Content:

Complex Numbers are two dimensional, and are an unordered set. This leads to many startling and bizarre

ideas. We apply the ideas of continuity and differentiability to functions of a complex variable, and reach some

surprising conclusions. However, it is when applying the ideas of integration that the most beautiful and

impressive results emerge, with many practical applications.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
80%	20%	0%

Academic year 2021-2022

Mathematics Level 15

Module name: Financial Mathematics & Derivative Pricing

Module code: 6PAM1031

Semester: AB

Credits: 30

Module Aims:

Value financial derivatives; Critically evaluate financial models for securities and derivative pricing.

Intended Learning Outcomes:

Successful students will typically:

Have a knowledge and understanding of:

* [i] stochastic models for the behaviour of security prices and the concepts of Brownian motion;

* [ii] the properties of option prices, valuation methods and hedging techniques;

* [iii] models for credit risk.

Successful students will typically:

* [i] critically evaluate and apply stochastic pricing models;

* [ii] analyse and apply valuation techniques and hedging strategies;

* [iii] derive, evaluate and apply Black-Scholes model;

* [iv] critically evaluate approaches to credit risk.

Module Content:

The aim of the module is develop, analyse and implement financial models for security prices and the valuation

of derivative contracts. Initially the concept and techniques of stochastic processes will be introduced. This will

lead to the analysis of the lognormal random walk which is used to model the behaviour of security prices. This

model will be compared and contrasted with alternative models. The notion of stochastic calculus will be

introduced and in particular Ito’s lemma which is a fundamental technique used in evaluating the change in a

function of a random variable.

The financial concepts of arbitrage and hedging will be defined and applied to the Black-Scholes model to develop the infamous associated partial differential equation. Analytical solutions will be developed and used to

price derivative contracts. The binomial option pricing model will be constructed and used to price a variety of

option contracts and compared with the Black-Scholes model. Finally Credit Risk models will be defined,

compared and contrasted.

Pre and Co requisites:

None

Total hours: 300

Assessment:

Exam	Coursework	Practical
60%	40%	0%

Mathematics Level 16

Module name: Investigations in Mathematics

Module code: 6PAM1021

Semester: B

Credits: 15

Module Aims:

Study an aspect of mathematics to a depth appropriate to Level 6; Develop skills in researching, synthesising and communicating mathematical ideas; Expand and mature their abilities as an independent learner.

Intended Learning Outcomes:

Successful students will typically:

Have a knowledge and understanding of:

* [I] the research techniques to use while investigating an open ended topic;

* [ii] a focused area of mathematics.

Successful students will typically:

* [I] to independently plan and execute a substantial open ended investigation in Mathematics;

* [ii] to apply previously gained knowledge in an unfamiliar context;

* [iii] to critically analyse their findings;

* [iv] to demonstrate effective verbal and written communication skills;

* [v] to reference their work accurately.

Module Content:

Students will choose a topic from a list of typically 5-10 different mathematics topics offered by School staff

(tutors), and will conduct an open-ended investigation into that topic. The students working on each topic will

work independently on their investigations, under the guidance of a tutor. They will be required to produce an

original, substantial and professionally presented printed report on their findings, and to prepare a presentation

to summarise their findings. Students will be interviewed about their report and presentation.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
0%	100%	0%

Mathematics Level 17

Module name: Investigations in Financial Mathematics

Module code: 6PAM1022

Semester: A

Credits: 15

Module Aims:

Study an aspect of financial mathematics to a depth appropriate to Level 6; Develop skills in researching, synthesising and communicating mathematical ideas;

Expand and mature their abilities as an independent learner.

Intended Learning Outcomes:

Successful students will typically:

Have a knowledge and understanding of:

* [i] the research techniques to use while investigating an open ended topic;

* [ii] a focused area of financial mathematics.

Successful students will typically:

* [i] to independently plan and execute a substantial open ended investigation in financial mathematics

* [ii] to apply previously gained knowledge in an unfamiliar context

* [iii] to critically analyse their findings

* [iv] to demonstrate effective verbal and written communication skills

* [v] to reference their work accurately

Module Content:

Students will choose a topic from a list of typically 5-10 different financial mathematics topics offered by PAM

staff (tutors), and will conduct an open ended investigation into that topic. The students working on each topic

will work independently on their investigations, under the guidance of a tutor. They will be required to produce

an original, substantial and professionally presented printed report on their findings, and to prepare a

presentation to summarise their findings. Students will be interviewed about their report and presentation.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
0%	100%	0%

Physics and Astrophysics

Level 4

Module name: Contemporary Physics

Module code: 4PAM09

Semester: AB

Credits: 30

Module Aims:

Comprehend the significance of the major developments in physics during the last century.

- understand the modern physical concepts underlying special relativity and quantum physics

- apply their knowledge to analyse a number of situations in relativity and quantum physics including relativistic

motion, diffraction of matter waves, a particle in a box, quantum tunnelling, the structure of atomic systems (the

hydrogen atom, many electron atoms and molecules), models of the nucleus, nuclear binding energy and

nuclear reactions

Intended Learning Outcomes:

Successful students will typically:

- understand the basic concepts and theoretical models in modern physics including relativistic effects such

as time dilation, relativistic mass, matter waves, particle-wave duality, quantization of energy and angular

momentum, the quantum model of the atom, spectra, the structure and properties of nuclei, radioactivity and

molecules

Successful students will typically:

- be able to analyse the behaviour of simple physical systems undergoing relativistic motion and predict the

properties of simple quantum systems such as a particle in a box, single electron atoms, diatomic molecules

and nuclei.

- be able to carry out, analyse and report on simple experiments involving the physical concepts taught in the

course.

Module Content:

The module introduces students to the fundamental developments in relativistic and quantum physics of the

last century. Students will learn about the special relativistic effects. They will trace the development of

quantum physics and learn about the structure of matter. They will uncover strange and bizarre phenomena

including the twins paradox, the pole and barn paradox, matter waves, quantum tunnelling, particle-wave duality

and the quantum superposition principle.

Pre and Co requisites:

None

Total hours: 300

Assessment:

Exam	Coursework	Practical
60%	40%	0%

Physics and Astrophysics

Level 5

Module name: The Physical Universe

Module code: 4PAM1013

Semester: AB

Credits: 30

Module Aims:

Learn and apply concepts, principles and nomenclature underpinning physics and astrophysics. Develop the skills of observation, measurement and interpretation.

Intended Learning Outcomes:

Successful students will typically:

- understand mechanics and gravity, waves and optics, thermodynamics and the structure of matter;

- understand the broad structure and evolution of the universe and the physical nature of planets, stars and

galaxies.

Successful students will typically:

- formulate and solve problems in classical physics and astrophysics, in clear mathematical terms;

- apply laboratory/observatory skills to the study of physical/celestial phenomena;

- carry out independent background research and communicate their findings.

Module Content:

The module will provide students in physics and astrophysics with a quantitative introduction to the Physical

Universe. It will provide a broad survey of the universe and the structure of matter. It will show how physics and

mathematics are used as theoretical tools to interpret data collected in the laboratory or at the telescope. It will

introduce students to practical skills.

Pre and Co requisites:

None

Total hours: 300

Assessment:

Exam	Coursework	Practical

60%	40%	0%

Academic year 2021-2022

Physics and Astrophysics

Level 5

Module name: Programming

Module code: 5PAM1023

Semester: A

Credits: 15

Module Aims:

The aims of this module are to enable students to understand the general principles of computer programming and be able to apply them in an appropriate high-level programming language.

Intended Learning Outcomes:

Successful students will typically:

Have a knowledge and understanding of:

* [i] common features of high-level programming languages such as arithmetic operators and operations, built-in

functions, data structures e.g. arrays, loops, branching statements, input-output statements, subprograms and

file handling;

* [ii] simple program design methods;

* [iii] the importance of program clarity;

* [iv] debugging procedures;

* [v] program documentation.

Successful students will typically:

* [i] design, write, test and debug simple programs and produce documentation with limited supervision and

direction;

* [ii] apply a wide range of programming techniques and make an informed choice of solutions to unfamiliar

problems;

* [iii] appreciate how the general principles of computer programming are applied in other high-level

programming languages;

* [iv] understand and modify more complex programs.

Module Content:

You will learn how to design and write programs in an appropriate high-level programming language. The module

will cover control structures such as loops and logical statements. You will be shown how to build more

complex programs by linking separate functions and procedures. You will learn how to debug programs and

produce program documentation.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
0%	100%	0%

Physics and Astrophysics

Level 6

Module name: Quantum Physics

Module code: 5PAM27

Semester: B

Credits: 15

Module Aims:

Appreciate the fundamental nature of the well established but conceptually challenging theory of quantum physics. Gain experience in solving the time-independent and time-dependent Schrodinger equation. Understand the physics of atoms and experimental results in atomic physics

- understand the physics of nuclei and experimental results in nuclear physics

- appreciate modern developments in quantum physics, and the difference between competing classical and

quantum models.

Intended Learning Outcomes:

Successful students will typically:

- have a detailed knowledge and understanding of the conceptually challenging principles of quantum physics,

how it contrasts with classical physics, and its areas of application

- differentiate between quantum and classical interpretations of theoretical and experimental results in atomic

and nuclear physics

Successful students will typically:

- be able to apply Schrodinger's equation to relevant problems

- be able to determine the properties of atoms and nuclei, and intepret experimental results using the

competing classical and quantum theories

Module Content:

The module will study the principles of quantum physics and its applications in atomic and nuclear physics. It

will build on the quantum physics taught at Level 1, covering operator and eigenvalue formalisms, solutions to

Schrodingers equation for atomic and nuclear potentials, conservation rules, selection rules, quantum numbers, Pauli exclusion principle, energy levels, binding energy, mass defect, radioactivity and thermonuclear fusion.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
60%	40%	0%

Physics and Astrophysics

Level 7

Module name: Thermal and Condensed Matter Physics

Module code: 5PAM13

Semester: AB

Credits: 30

Module Aims:

Gain an understanding of thermal and statistical physics concepts of equilibrium systems and phenomenological condensed matter physics.

Intended Learning Outcomes:

Successful students will typically:

- understand well-established thermal and statistical physics concepts of equilibrium thermodynamics;

- understand phenomenological condensed matter physics.

Successful students will typically:

- demonstrate a good understanding of the principles of thermal and condensed matter physics;

- apply their knowledge of these principles to the formulation and solution of familiar and unfamiliar problems;

- carry out unsupervised reading in order to solve unfamiliar problems and gain understanding;

- undertake and analyse laboratory work.

Module Content:

The module introduces the concepts of thermal and statistical physics. These include the concepts of entropy,

heat, temperature, and thermal equilibrium. Reversible, irreversible, cyclic and non-cyclic processes are treated. Applications, such as the operation and efficiency of heat engines, are considered. The module also

introduces the principles of condensed matter physics. This includes a study of dielectric and magnetic

materials, the electronic structure of solids and thermal and electrical conduction.

Refer to the teaching for a more detailed description.

Pre and Co requisites:

None

Total hours: 300

Assessment:

Exam	Coursework	Practical
80%	20%	0%

Physics and Astrophysics

Level 8

Module name: Optical Physics & Electromagnetism

Module code: 5PAM26

Semester: AB

Credits: 30

Module Aims:

Appreciate physical phenomena relating to optical physics and electromagnetism. Gain experience in solving numeric problems in optical and electromagnetic systems.

- understand the physics of light and its interaction with optical systems.

- understand the physics of electromagnetism leading up to Maxwell's Equations.

- appreciate modern developments in optical physics & electromagnetism.

Intended Learning Outcomes:

Successful students will typically:

- have a detailed knowledge and understanding of core concepts in optical physics and its areas of

application.

- have a deep knowledge and understanding of well established electromagnetic principles and their

applications, and a developing knowledge of new (modern) information.

Successful students will typically:

- be able to evaluate the electric and magnetic fields due to different distributions of charges and currents.

- be able to apply the concept of light as an electromagnetic wave to solve Maxwell's Equations in familiar and

unfamiliar cases.

Module Content:

The module consists of a study of optical physics and electromagnetism, leading from the early classical

studies of optical physics to the development of a modern electromagnetic theory of light. Wider applications

and modern developments will also be considered.

Pre and Co requisites:

None

Total hours: 300

Assessment:

Exam	Coursework	Practical
60%	40%	0%

Physics and Astrophysics

Level 9

Module name: Solar System Physics

Module code: 5PAM25

Semester: AB

Credits: 30

Module Aims:

Understand and apply core concepts in physics (kinetic theory, thermodynamics, radiation processes, atomic and molecular physics, nucleosynthesis, electromagnetic fields, rotational and linear dynamics, and basic hydrodynamics) in the context of solar and planetary processes. Develop greater independence in experimentation through observational and practical sessions.

Intended Learning Outcomes:

Successful students will typically:

- have a detailed knowledge and understanding of well-established core physics concepts and their application

in the new context of Solar System science.

- have a knowledge and understanding of practical techniques in astronomical observation and modelling.

Successful students will typically:

- be able to explain the physical processes that govern the state and evolution of Solar System bodies

- be able to model Solar System processes in a variety of ways (analytically and numerically)

- be able to make careful observations and maintain an accurate record of their acquisition, reduction and

analysis, using appropriate theoretical models with limited supervision.

Module Content:

Solar System processes are studied using core physical ideas, practical observations and analytical modelling

techniques.

Pre and Co requisites:

None

Total hours: 300

Assessment:

Exam	Coursework	Practical
60%	40%	0%

Physics and Astrophysics

Level 6

Module name: Computational Physics

Module code: 6PAM1014

Semester: A

Credits: 15

Module Aims:

Use computers to study and model physical problems.

Intended Learning Outcomes:

Successful students will typically:

- develop in depth knowledge and understanding of various physical systems by advanced computer modeling;

- understand the advanced computational techniques used to study realistic physical problems.

Successful students will typically:

- be able to model various physical systems in detail by applying computational techniques;

- be able to analyse the results of a computer model and present findings in a professional manner.

Module Content:

The module will provide students with a range of self contained case studies in computational physics. Each

case study will investigate a physical problem, using the computer as an investigative tool. Students will learn

how to formulate and model a physical problem and how to analyse and present the results of their investigation. A variety of appropriate computer techniques are used.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
0%	100%	0%

Physics and Astrophysics

Level 7

Module name: Contemporary Quantum Physics

Module code: 6PAM17

Semester: B

Credits: 15

Module Aims:

Understand the time evolution of quantum systems and the interaction of light and atoms; Understand the quantization of the radiation field; Understand the quantum behavior of lasers, laser cooling of atoms and atom cavity interactions; Discuss modern experimental tests of quantum mechanics and conceptual problems.

Intended Learning Outcomes:

Successful students will typically:

- have deep knowledge and understanding of time dependent perturbation theory and be able to apply it to

quantum systems;

- be able to apply principles of quantum optics to inter-related fields of lasers and atomic systems;

- have knowledge and understanding of modern experimental quantum mechanics and its application at the

forefront of research in fields such as cold atoms, entangled states and non-locality.

Successful students will typically:

- be able to perform time dependent perturbation calculations;

- be able to apply operator methods to the harmonic oscillator, particle spin and quantization of the radiation

field;

- be able to discuss and interpret modern experimental work in quantum physics

Module Content:

This module will cover advanced concepts in contemporary quantum physics and discuss some modern

applications.

Content is a selection of topics from the following, or similar:

- The time evolution of quantum systems

- Time dependent perturbation theory

- Interaction of an atom with an electromagnetic wave

- The time-energy uncertainty relation

- The quantum states of light

- The harmonic oscillator

- Quantization of the radiation field

- Zero point energy and the Casimir force

- Experiments and applications

- Interferometry and indistinguishability

- Entangled states and quantum correlations

- Lasers and Cold atoms

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
0%	100%	0%

Physics and Astrophysics

Level 8

Module name: Waves & Fluids

Module code: 6PAM14

Semester: AB

Credits: 30

Module Aims:

Broaden their knowledge of waves and gain a problem based introduction to physical hydrodynamics.

Intended Learning Outcomes:

Successful students will typically:

* LO1 - Broaden their knowledge and understanding of wave physics

* LO2 - Obtain a coherent introduction to physical hydrodynamics

Successful students will typically:

* LO3 - Be able to investigate practically and theoretically, wave and fluid systems

* LO4 - Be able to apply their knowledge and understanding to the analysis and interpretation of experimental

results.

Module Content:

This module develops the basic physics required to understand core topics in wave and fluid physics.

Pre and Co requisites:

None

Total hours: 300

Assessment:

Exam	Coursework	Practical
60%	40%	0%

Physics and Astrophysics

Level 9

Module name: Space Dynamics

Module code: 6PAM27

Semester: B

Credits: 15

Module Aims:

Understand and apply core physics concepts to the area of space dynamics, including orbital trajectories,

orbital stability, the influence of non-gravitational forces, and the spin dynamics of spacecraft; Gain experience in numerical methods and the visualisation of dynamical problems.

Intended Learning Outcomes:

Successful students will typically:

- summarise the core physics concepts and their application in orbital and rotational dynamics;

- explore practical techniques in numerical modelling of dynamics applied to astronautics;

- explain the physical processes that govern the orbits of spacecraft.

Successful students will typically:

- select appropriately between analytical and numerical approaches to solving problems in space dynamics;

- model the orbital and rotational physics of spacecraft using computational methods;

- take responsibility for their own learning via the group space mission development project, appraising

alternative plans and communicating the conclusions effectively.

Module Content:

Space dynamics is a coursework-only module. Students work in a computer lab supervised by the module

facilitator. There are no formal lectures. Instead, students work their way through a set of computer exercises

using Matlab. The exercises allow the student to tackle problems in different ways and develop their own style

of problem-solving. The module covers various aspects in spacecraft dynamics including: atmospheric drag;

aerobraking; transfer orbits; injection orbits; spacecraft spin; the stability of spinning motion – Euler’s equations; three-dimensional spin motion and mass models of irregular objects.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
0%	100%	0%

Physics and Astrophysics

Level 10

Module name: Physics of Stars

Module code: 6PAM15

Semester: AB

Credits: 30

Module Aims:

Develop a systematic understanding of the physics relating to stellar evolution and explore its key aspects.

Intended Learning Outcomes:

Successful students will typically:

- develop a systematic understanding of the physical theories and principles relating to star formation, stellar

evolution and stellar atmospheres.

- develop a critical understanding of the key observational evidence which inform the subject

Successful students will typically:

- Synthesise the key stages of stellar evolution and its underlying physics.

- Calculate key observational parameters used in stellar astrophysics.

- Confidently apply their knowledge and understanding of appropriate astronomical techniques to the analysis

and interpretation of observational data, assessing the reliability and validity of the evidence to support their

conclusions.

Module Content:

The module will cover elements of the foundations of:

- stellar physics (hydrostatic equilibrium, equation of state, opacity, heat transfer mechanisms, degenerate

matter);

- star formation (gravitational collapse, low mass star formation, the signatures and classification of star

formation);

- stellar evolution (stellar structure, post-main sequence evolution, mass loss, end states of stellar evolution);

Assessment is based on class tests, numerical problems, observatory practicals and an exam.

Pre and Co requisites:
None

Total hours: 300

Assessment:

Exam	Coursework	Practical
60%	40%	0%

Physics and Astrophysics

Level 11

Module name: Cosmology and Large Scale Structure

Module code: 6PAM11

Semester: AB

Credits: 30

Module Aims:

Gain a physical understanding of contemporary cosmology and large-scale structure.

Intended Learning Outcomes:

Successful students will typically:

- have a deep understanding of the structure and evolution of the physical universe, its origin and contents;

- have a detailed understanding of the concepts underlying the formulation of cosmic structure, informed by

current research.

Successful students will typically:

- formulate and solve problems in cosmology and large scale structure using appropriate mathematical

treatments;

- carry out independent background research, systematically and unsupervised, and communicate its findings;

- report on work carried out at the observatory/laboratory in a clear and accurate manner, interpreting results

and their inter-relationship with other fields of study where appropriate.

Module Content:

This module develops the physical ideas required to understand core topics in contemporary cosmology.

Refer to the teaching plan for a more detailed description.

Pre and Co requisites:

None

Total hours: 300

Assessment:

Exam	Coursework	Practical
60%	40%	0%

Physics and Astrophysics
Level 12

Module name: Investigations in Physics

Module code: 6PAM1016

Semester: B
Credits: 15

Module Aims:

Study an aspect of physics/astrophysics requiring the selection and application of a range of techniques and a deep understanding of the inter-relationship of areas of physics/astrophysics.

- develop professional levels of skills in communication.

- act with minimal supervision or direction, taking responsibility for their achievement and for accessing support

when needed.

Intended Learning Outcomes:

Successful students will typically:

- have knowledge and understanding of how to plan and undertake an open-ended investigation into a

physics/astrophysics topic, taking and exercising responsibility for its outcomes with minimal supervision.

- have deep knowledge and understanding of a focused area of physics/astronomy and its inter-relationship

with other areas.

Successful students will typically:

- be able to plan and execute independently an open-ended investigation into an advanced

physics/astrophysics topic.

- be able to evaluate their findings critically and propose requirements for further investigation.

- be able to communicate their findings professionally.

Module Content:

Students will choose a topic from a list of typically ten different physics/astrophysics topics offered by school

staff (tutors), and will conduct an open-ended investigation into that topic. The students working on each topic

will work independently on their investigations with minimal supervision, under the guidance of a tutor. They will be required to produce an original, substantial and professionally presented report typically 25-30 pages in

length. Students will be interviewed about their work and will defend it in a question and answer session.

Pre and Co requisites:

None

Total hours: 150

Assessment:

Exam	Coursework	Practical
0%	100%	0%

Module name:

Module code:

Semester:

Credits:

Module Aims:

Intended Learning Outcomes:

Module Content:

Pre and Co requisites:

Total hours:

Assessment:

Exam	Coursework	Practical
%	%	%