Swansea University
Prifysgol Abertawe

FACULTY OF SCIENCE AND ENGINEERING

UNDERGRADUATE STUDENT HANDBOOK

YEAR 3 (FHEQ LEVEL 6)

MATHEMATICS

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 26 September 2022

Full term dates can be found here

DATES OF 22-23 TERMS

26 September 2022 – 16 December 2022

9 January 2023 – 31 March 2023

24 April 2023 – 09 June 2023

SEMESTER 1

26 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 Mathematics and Computer Science **Head of School: Professor Elaine Crooks**	
School Education Lead	Dr Neal Harman
Head of Mathematics	Professor Vitaly Moroz
Mathematics Programme Director	Dr Kristian Evans
Year Coordinators	Year 0 – Dr Zeev Sobol Year 1 – Dr Noemi Picco Year 2 – Professor Jiang-Lun Wu Year 3 – Dr Grigory Garkusha Year 4/MSc – Professor Chenggui Yuan

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
Mathematics
MMath Mathematics[G103]
MMath Mathematics with a Year Abroad[G105]

Coordinator: Dr G Garkusha

Compulsory Modules

Semester 1 Modules	Semester 2 Modules
MA-301 **Complex Analysis** **15 Credits** **Dr K Evans**	**MA-312** **Higher Algebra** **15 Credits** **Dr MD Crossley**
Total 120 Credits	

Optional Modules
Choose exactly 90 credits

MA-302	Numerics of ODEs and PDEs	Prof IM Davies	TB2	15
MA-308	Machine Learning	Prof B Lucini	TB2	15
MA-322	Topology	Dr MD Crossley	TB1	15
MA-345	Cashflows and Interest Rates	Dr Z Sobol	TB1	15
MA-346	Assurance and annuity	Dr Z Sobol	TB2	15
MA-358	Financial Mathematics in Discrete Time	Dr I Rodionova	TB1	15
MA-359	Financial Mathematics in Continuous Time	Prof E Lytvynov	TB2	15
MA-364	Markov Processes and Applications	Prof J Wu	TB1	15
MA-365	Risk and Survival Models	Dr DL Finkelshtein	TB2	15
MA-375	Dynamical Systems	Dr DL Finkelshtein	TB1	15
MA-384	Fourier Analysis	Prof E Lytvynov	TB1	15
MA-386	Calculus of Variations	Prof V Moroz/Prof ECM Crooks	TB2	15
MA-393	Lie Theory	Dr I Rodionova	TB2	15
MA-395	Teaching Mathematics via a School Placement	Dr S Lyakhova	TB2	15

Year 3 (FHEQ Level 6) 2022/23
Mathematics
BSc Mathematics[G100,G101]
BSc Mathematics with a Year Abroad[G104]
BSc Mathematics with a Year in Industry[G327]

Coordinator: Dr G Garkusha

Compulsory Modules

Semester 1 Modules	Semester 2 Modules
MA-301 **Complex Analysis** **15 Credits** **Dr K Evans**	**MA-312** **Higher Algebra** **15 Credits** **Dr MD Crossley**
MA-300 **Project** **30 Credits** **Dr C Mercuri**	
Total 120 Credits	

Optional Modules
Choose exactly 60 credits

MA-302	Numerics of ODEs and PDEs	Prof IM Davies	TB2	15
MA-308	Machine Learning	Prof B Lucini	TB2	15
MA-322	Topology	Dr MD Crossley	TB1	15
MA-345	Cashflows and Interest Rates	Dr Z Sobol	TB1	15
MA-346	Assurance and annuity	Dr Z Sobol	TB2	15
MA-358	Financial Mathematics in Discrete Time	Dr I Rodionova	TB1	15
MA-359	Financial Mathematics in Continuous Time	Prof E Lytvynov	TB2	15
MA-364	Markov Processes and Applications	Prof J Wu	TB1	15
MA-365	Risk and Survival Models	Dr DL Finkelshtein	TB2	15
MA-375	Dynamical Systems	Dr DL Finkelshtein	TB1	15
MA-384	Fourier Analysis	Prof E Lytvynov	TB1	15
MA-386	Calculus of Variations	Prof V Moroz/Prof ECM Crooks	TB2	15
MA-393	Lie Theory	Dr I Rodionova	TB2	15
MA-395	Teaching Mathematics via a School Placement	Dr S Lyakhova	TB2	15

MA-300 Project

Credits: 30 Session: 2022/23 September-June

Pre-requisite Modules: MA-201; MA-202; MA-211; MA-212

Co-requisite Modules:

Lecturer(s): Dr C Mercuri

Format: 10 lecture, 4 supervision

Delivery Method: Primarily on Campus

Module Aims: This module provides the opportunity to explore a mathematical topic and learn new subjects without instruction, but under the supervision of a member of staff.

Module Content: Researching a mathematical topic, planning a large project, presentation skills, enhancing employability, mathematical writing, structuring a long report, use of IT in oral and written presentation

Intended Learning Outcomes: At the end of this module students should be able to:
1) Search the literature effectively, and synthesize different sources,
2) Plan a project, and exercise time-management skills,
3) Prepare and delivery written reports and oral presentations,
4) Make effective use of IT in all of the above.

Assessment: Assignment 1 (10%)
Presentation (10%)
Report (70%)
Presentation (10%)

Assessment Description: The assessment is based on four components:
1) A project preparation document
2) A whiteboard-based presentation during Teaching Block 1
3) A written report, submitted at the stated deadline near the end of Teaching Block 2
4) A powerpoint-based presentation during Teaching Block 2

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

Assessment Feedback: Lecturer feedback

Failure Redemption: Redemption of failure is not possible for this module (for finalists).

Additional Notes:
Each student is to write a report on a specific mathematical topic, under the supervision of a member of staff. A list of areas within mathematics will be circulated at the start of the year. Students must select two areas that they are interested in. These selections will then be used to allocate each student a supervisor with the aim of ensuring that everyone can complete a project in one of the areas that they have selected. Once a supervisor has been allocated, students will have a first meeting at which there will be a discussion about the project in the chosen area. A title and outline for the project is agreed, and supervisors will provide some initial reading that must be completed.

There will be a number of mandatory lectures throughout the year; a schedule for these will be distributed in the first teaching week. These classes will provide full details about what students are expected to do, how to research and write the project, and how the supervision will function.

There are four assessment components. The exact deadlines for each component will be announced in the first teaching week of the year, and also published on Blackboard; the time-frame given here is merely indicative, and should not be taken as definitive.

1) Project Preparation Form. The Project Preparation form is to be completed during the first part of Teaching Block 1, and submitted electronically. This component counts for 10% of the final mark.

2) Presentation. Near the start of Teaching Block 2, the student will give a presentation to their supervisor and a small group of students, based on the work done so far. The presentation should be of 10 minutes in length. This component counts for 10% of the final mark. Questions may be asked following the presentation, but these will not affect the mark.

3) Project Report. The main written project must be word-processed, preferably in TeX or LaTeX. Submission of this written report takes place over two deadlines. The first deadline will be early in the second semester. At this point you are required to submit at least 4 pages of your project, although you can choose to submit more. This first submission is to be made electronically, and we will provide feedback on your work submitted at this stage, including your referencing. You can then use this feedback in revising and extending your work, before submitting the final version by the second deadline, which will take place before the Easter vacation. This final version should be a comprehensive, self-contained report on the chosen topic, of 7,000-8,000 words in length. This should be submitted electronically. The project report counts for 70% of the final mark. It is important to note that a final submission can only be made if at least 4 pages have been submitted for the first deadline. If you fail to meet this first deadline then you will be awarded a mark of 0% for the report component no matter what you submit for the second deadline.

4) Presentation. At the end of Teaching Block 2, the student will give a presentation to a group of students and staff on their completed project. The presentation should be of 15 minutes in length. The component counts for 10% of the final mark. Questions may be asked following the presentation, but these will not affect the mark.

Failure to give either presentation will result in an overall mark of zero for the module.

MA-301 Complex Analysis

Credits: 15 Session: 2022/23 September-January

Pre-requisite Modules: MA-201; MA-202; MA-211; MA-212

Co-requisite Modules:

Lecturer(s): Dr K Evans

Format: 44

Delivery Method: Primarily on campus

Module Aims: The module approaches the theory of complex analytic functions; including concepts of Cauchy-Riemann equations, power series, Laurent series and residue calculus.

Module Content: Complex differentiability, the Cauchy-Riemann equations, holomorphic functions.
Power series. Functions defined by power series. The exponential and trigonometric functions; their definition and fundamental properties.
Paths in the complex plane, the length of a path. Contour integration. Fundamental theorem of contour integration.
Cauchy's Theorem. Cauchy's integral formulas.
Taylor theorem. Cauchy estimates. Liouville's Theorem, the Fundamental Theorem of Algebra.
Laurent's Theorem and Laurent series. Isolated singularities. Removable singularities, poles, essential singularities.
The Residue Theorem. Residue calculus, evaluation of definite integrals.

Intended Learning Outcomes: At the end of this module students should be able to:
1) understand the concept of a holomorphic function and apply the Cauchy-Riemann equations;
2) define the complex exponential and trigonometric functions and prove their basic properties;
3) manipulate power series, express a holomorphic function as a power series;
4) understand the residue calculus and calculate residues;
5) evaluate contour integrals using the Residue Theorem;
6) understand Laurent's Theorem and its applications.

Assessment:	Examination (80%)
	Assignment 1 (20%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Component 1 is a written, closed-book examination at the end of the module.
Component 2 is formed of a number of coursework assignments during the semester.

Moderation approach to main assessment: Universal second marking as check or audit

Assessment Feedback: For the homework assignments, students will receive feedback in the form of marks, model solutions, overall feedback on the cohort performance, and some individual comments on their work.
For the exam, students will receive feedback in the form of marks and overall feedback on the cohort performance.
Further, individualised feedback, can be provided upon request.

Failure Redemption: Supplementary examination.

Additional Notes: Delivery of the teaching will be on-campus. Continuous assessment submission will be online.

Available to visiting and exchange students

MA-302 Numerics of ODEs and PDEs

Credits: 15 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof IM Davies

Format: 33 hours of traditional lectures, narrating and expanding upon the online notes.
11 hours of Matlab support and examples classes (alternating weekly)

Delivery Method: The in-person lectures will focus on developing the theory and the implementation of that theory into practice. Weekly formative homework will supplement the understanding of key properties of methods and their behaviour (good or bad). The weekly Matlab worksheets will enable students to work the methods ‘for real’ as opposed to the ‘toy problems’ that can be worked by hand (and calculator).

Module Aims: This module is focused on numerical schemes suitable for the approximate solution of ODEs and PDEs. Whilst the methods may look different the underlying principles and convergence issues are remarkably similar. Many standard algorithms will be presented along with an analysis of their behaviour.

Module Content: - ODEs;
- overview of LMMs, weak instability, strong stability, boundary value problems.
- PDEs;
- finite difference representation of partial derivatives, explicit and implicit finite difference schemes, consistency, stability,
- convergence, finite element methods, finite difference methods for elliptic problems, iterative methods, non-flat boundaries.

Intended Learning Outcomes: At the end of this module students should be able to:

1) determine the properties of a linear multistep method
2) to select appropriate methods for solving BVPs
3) to analyse the nature of finite difference schemes
4) to construct algorithms suitable for numerical solution of PDEs

Assessment: Examination (80%)
Assignment 1 (20%)
Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Examination is a written, closed-book examination at the end of the module.
Assignment 1 is formed of a number of coursework assignments during the semester.

Moderation approach to main assessment: Universal second marking as check or audit

Assessment Feedback: For the homework assignments, students will receive feedback in the form of marks, model solutions, overall feedback on the cohort performance, and some individual comments on their work.
For the exam, students will receive feedback in the form of marks and overall feedback on the cohort performance.
Further, individualised feedback, can be provided upon request.

Failure Redemption: Supplementary (resit) examination not available for B.Sc. students

For others including deferrals; closed book examination in August combined with existing coursework component

Additional Notes: Available to visiting and exchange students.

MA-308 Machine Learning

Credits: 15 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof B Lucini

Format: 44 hours consisting of a mixture of lectures and computer lab classes

Delivery Method: Lectures supported by regular computer lab sessions.

Module Aims: The module introduces basic concepts of machine learning and some of its popular methods in a practical manner from a mathematical perspective.

Module Content: - Concept of learning, linear perceptron
- Types of learning: supervised learning, reinforcement learning and unsupervised learning
- Use of probability in learning and noisy data
- VC dimension, generalization, complexity, bias-variance tradeoff
- Linear classification, linear regression, logistic regression, gradient descent and stochastic gradient descent
- Overfitting, regularization, cross validation
- Support vector machines, kernel methods
- Decision trees, random forests
- K-means clustering and mixture models
- Neural networks

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

1) Explain conceptually why machine learning is feasible.
2) Explain the fundamental mathematical ideas behind the standard approaches to machine learning.
3) Apply methods of machine learning to data sets using appropriate programming languages.
4) Analyse the strengths and weaknesses of different approaches to machine learning.
5) Determine appropriate methods to apply to given data sets.

Assessment: Examination (60%)
Assignment 1 (40%)
Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Component 1 is a written, closed-book examination at the end of the module.
Component 2 is formed of a number of coursework assignments during the semester.

Moderation approach to main assessment: Universal second marking as check or audit

Assessment Feedback: For the homework assignments, students will receive feedback in the form of marks, model solutions, overall feedback on the cohort performance, and some individual comments on their work.
For the exam, students will receive feedback in the form of marks and overall feedback on the cohort performance.
Further, individualised feedback, can be provided upon request.

Failure Redemption: Supplementary examination.

Additional Notes: Delivery of teaching will be on-campus. Continuous assessment will be submitted online.

Available to visiting and exchange students.

MA-312 Higher Algebra

Credits: 15 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr MD Crossley

Format: 44

Delivery Method: Primarily on campus

Module Aims: This course approaches the theory of groups, rings and modules as abstract algebraic objects.
The course also introduces categories as a language and unifying force in modern mathematics.

Module Content: Review of group theory. Definition of rings and maps of rings. Ideals, quotient rings. Domains, fields. Examples: integers, polynomials, matrices. Definition of modules and module homomorphisms. Generators, submodules and quotient modules. Irreducible modules. Direct sums and free modules. Bases of free modules, matrices. Short exact sequences. Projective modules. Modern uses of projective modules in (non-commutative) geometry and theoretical physics. Modules with additional properties and modules over special rings.
Finite abelian groups and their decompositions. Elementary divisors and invariant factors. Torsion free abelian groups. Free generators and unimodular matrices. Classification of finitely generated abelian groups.
Categories. Definition and motivation: categories as a language and unifying force in modern mathematics.
Categories of modules.

Intended Learning Outcomes: At the end of this module students should be able to:
recognise the differences between groups;
construct proofs of abstract results;
characterise all finite abelian groups;
determine the structure of all groups of small order;

Assessment: Examination (80%)
Assignment 1 (20%)
Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Component 1 is a written, closed-book examination at the end of the module.
Component 2 is formed of a number of coursework assignments during the semester.

Moderation approach to main assessment: Universal second marking as check or audit

Assessment Feedback: For the homework assignments, students will receive feedback in the form of marks, model solutions, overall feedback on the cohort performance, and some individual comments on their work.
For the exam, students will receive feedback in the form of marks and overall feedback on the cohort performance.
Further, individualised feedback, can be provided upon request.

Failure Redemption: Supplementary examination.

Additional Notes: Delivery of teaching will be on-campus. Continuous assessment will be submitted online.

Available to visiting and exchange students

MA-322 Topology

Credits: 15 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr MD Crossley

Format: 44

Delivery Method: Primarily on campus

Module Aims: This module explores the topological approach to continuity and the study of objects via their topological structure

Module Content: - Continuity by open sets;
- Topological spaces, examples of spaces and maps;
- Connectivity, compactness, the Hausdorff condition;
- Constructions: disjoint unions, products quotients;
- Homotopy and homotopy equivalence;
- Simplicial complexes and the Euler number;
- Homology

Intended Learning Outcomes: At the end of this module students should be able to:
1) work with the topological approach to continuity and check continuity for elementary functions
2) verify topological properties such as connectedness
3) understand topological constructions such as products and quotients
4) establish when functions are homotopic
5) calculate the Euler number of a cellular space
6) handle basic algebro-topological invariants such as simplicial homology groups

Assessment: Examination (80%)
Assignment 1 (20%)

Assessment Description: Component 1 is a written, closed-book examination at the end of the module.
Component 2 is formed of a number of coursework assignments during the semester.

Moderation approach to main assessment: Universal second marking as check or audit

Assessment Feedback: For the homework assignments, students will receive feedback in the form of marks, model solutions, overall feedback on the cohort performance, and some individual comments on their work.
For the exam, students will receive feedback in the form of marks and overall feedback on the cohort performance. Further, individualised feedback, can be provided upon request.

Failure Redemption: Supplementary examination. The original coursework mark will be retained, and these two will be combined in the way detailed above under 'Component descriptions'.

Additional Notes: Delivery of teaching will be on-campus. Continuous assessment will be submitted online.

Available to visiting and exchange students

MA-345 Cashflows and Interest Rates

Credits: 15 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr Z Sobol

Format: There will be weekly delivery, each week having 3 lectures and 1 examples class.

Delivery Method: The module will be delivered on bay Campus, with a traditional mix of lectures and example classes underpinned with weekly assessments of a formative/summative mix.

Module Aims: This module will introduce students to sections 1, 2 and 3 of the Institute and Faculty of Actuaries CM1 syllabus. This module covers a detailed analysis of cashflows and interest rates with actuarial applications.

Module Content: i) Data Analysis

ii) Actuarial Modelling

iii) Generalised Cashflows

iv) Interest Rates

v) Present and Accumulated values

vi) Interest Functions

vii) Term Structures

viii) Equation of Value and applications

ix) Project Appraisal

Intended Learning Outcomes: After completion of the module, the student should be able to;

choose an appropriate actuarial model and apply it in a real world situation,

demonstrate a deep understanding of generalised cashflow models and their use,

apply their knowledge of interest rates and the interest functions in a range of settings,

employ the equation of value as a means to solve problems.

Assessment:	Examination (80%)
	Coursework 1 (20%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Component 1 is a written, closed-book examination at the end of the module.

Component 2 is formed of a number of coursework assignments during the semester.

Moderation approach to main assessment: Universal second marking as check or audit

Assessment Feedback: For the homework assignments, students will receive feedback in the form of marks, model solutions, overall
feedback on the cohort performance, and some individual comments on their work.

For the exam, students will receive feedback in the form of marks and overall feedback on the cohort performance.

Further, individualised feedback, can be provided upon request.

Failure Redemption: Supplementary examination.

Additional Notes: Available to visiting and exchange students.

MA-346 Assurance and annuity

Credits: 15 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules: MA-345

Lecturer(s): Dr Z Sobol

Format: There be weekly delivery, with each week have 3 lectures and 1 examples class.

Delivery Method: The module will be delivered on Bay Campus, with a traditional mix of lectures and example classes underpinned
with weekly assessments of a formative/summative mix.

Module Aims: This module will introduce students to sections 4, 5 and 6 of the Institute and Faculty of Actuaries CM1 syllabus.
This module covers the actuarial pricing structure of life assurance and annuity contracts, including a variety of payment and premium structures as well as two-life policies.

Module Content: i) Assurance and annuity contracts

ii) Payments – means and variances

iii) Two life policies

iv) Multiple transitions

v) Multiple decrements

vi) Future loss

vii) Gross premiums and reserves

viii) Death strains

ix) Future cashflows

Intended Learning Outcomes: After completion of the module, the student should be able to;

define assurance and annuity contracts,

demonstrate a detailed understanding of the operation of with-profits contracts,

elucidate upon the differences between assurance and annuity contracts,

value cashflows contingent upon the nature of transitions,

calculate gross premiums and reserves for assurance and annuity contracts,

project future cashflows for a variety of typical contracts.

Assessment: Examination (80%)
Coursework 1 (20%)

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

Assessment Description: Component 1 is a written, closed-book examination at the end of the module.

Component 2 is formed of a number of coursework assignments during the semester.

Moderation approach to main assessment: Universal second marking as check or audit

Assessment Feedback: For the homework assignments, students will receive feedback in the form of marks, model solutions, overall
feedback on the cohort performance, and some individual comments on their work.

For the exam, students will receive feedback in the form of marks and overall feedback on the cohort performance.

Further, individualised feedback, can be provided upon request.

Failure Redemption: Supplementary Examination.

Additional Notes: Available to visiting and exchange students.

MA-358 Financial Mathematics in Discrete Time

Credits: 15 Session: 2022/23 September-January

Pre-requisite Modules: MA-252

Co-requisite Modules:

Lecturer(s): Dr I Rodionova

Format: There be weekly delivery, with each week have 3 lectures and 1 examples class.

Delivery Method: The module will be delivered on Bay Campus, with a traditional mix of lectures and example classes underpinned
with weekly assessments of a formative/summative mix.

Module Aims: This module will introduce students to section 6 of the Institute and Faculty of Actuaries (IFoA) CM2 syllabus.

This module serves as an introduction to the theory of martingales and their applications to a discrete-time dynamics of a financial market containing a bank account and several kinds of stocks. Special attention is paid to the applications of the theory of martingales to the absence of arbitrage in a discrete-time financial market and pricing and hedging of the options.

Module Content: - A first encounter with stochastic processes, filtration, the natural filtration of a stochastic process;
- Conditional expectation;
- Martingales, including submartingales and supermartingales;
- Stopping times and hitting times, optional sampling, optional stopping;
- Discrete time financial market, self-financing trading strategies;
- Discounted price processes, equivalent martingale measures and arbitrage opportunities;
- Contingent claim, European, American and Asian options, valuation and hedging, complete and incomplete markets;
- The binomial (Cox-Ross-Rubinstein) model;
- The Black-Scholes discrete-time pricing formula.

Intended Learning Outcomes: At the end of this module students should be able to:
1) Demonstrate a comprehensive knowledge of the theory of martingales;
2) Be able to apply the optional stopping theorem to practical examples;
3) Demonstrate an understanding the main concepts of discrete-time models of financial markets;
4) Be able to apply the theory of martingales to study of financial markets;
5) Demonstrate a comprehensive knowledge of the binomial model.

Assessment: Examination (80%)
Assignment 1 (20%)
Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Component 1 is a written, closed-book examination at the end of the module.
Component 2 is formed of a number of coursework assignments during the semester.

Moderation approach to main assessment: Universal second marking as check or audit

Assessment Feedback: For the homework assignments, students will receive feedback in the form of marks, model solutions, overall feedback on the cohort performance, and some individual comments on their work.
For the exam, students will receive feedback in the form of marks and overall feedback on the cohort performance.
Further, individualised feedback, can be provided upon request.

Failure Redemption: Supplementary Examination.

Additional Notes: Available to visiting and exchange students

MA-359 Financial Mathematics in Continuous Time

Credits: 15 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules: MA-358

Lecturer(s): Prof E Lytvynov

Format: There be weekly delivery, with each week have 3 lectures and 1 examples class.

Delivery Method: The module will be delivered on Bay Campus, with a traditional mix of lectures and example classes underpinned
with weekly assessments of a formative/summative mix.

Module Aims: This module will introduce students to sections 3, 4 and 6 of the Institute and Faculty of Actuaries CM2 syllabus.

This module serves as an introduction to the Black-Scholes model for the continuous-time dynamics of a financial market containing a bank account and several kinds of stocks. This theory is based on stochastic (Itô) calculus for Brownian motion. Special attention is paid to the applications of stochastic calculus to the absence of arbitrage in a financial market and pricing and hedging of the options.

Module Content: - Introduction to Brownian motion;
- Stochastic integral with respect to Brownian motion;
- Itô process and Itô formula;
- Product rule for Itô processes (integration by parts formula);
- Stochastic differential equations;
- Models of a financial market in continuous time;
- European call and put options, American call and put options;
- Put-call parity and other model-independent results;
- Self-financing trading strategies;
- Equivalent martingale measures and arbitrage opportunities;
- Attainability and completeness;
- Pricing and hedging of an option;
- The Black-Scholes pricing formulas for European call and put options;
- The Black-Scholes partial deferential equation;
- Dividend-paying stocks;
- The Garman-Kohlhagen pricing formulas;

Intended Learning Outcomes: At the end of this module students should be able to:
1) Systematically work with the Itô stochastic integral with respect to Brownian motion;
2) Demonstrate an understanding of Itô's formula and be able to apply it for the purposes in financial mathematics;
3) Demonstrate an understanding of the main notions related to financial markets in continuous time;
4) Demonstrate understanding of the completeness of a financial market, hedging and pricing of attainable options with the help of the equivalent martingale measures;
5) Be able to derive the Black-Scholes partial differential equation by using stochastic calculus.

Assessment: Examination (80%)
Assignment 1 (20%)
Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Component 1 is a written, closed-book examination at the end of the module.
Component 2 is formed of a number of coursework assignments during the semester.

Moderation approach to main assessment: Universal second marking as check or audit

Assessment Feedback: For the homework assignments, students will receive feedback in the form of marks, model solutions, overall feedback on the cohort performance, and some individual comments on their work.
For the exam, students will receive feedback in the form of marks and overall feedback on the cohort performance.
Further, individualised feedback, can be provided upon request.

Failure Redemption: Supplementary Examination.

Additional Notes: Available to visiting and exchange students

MA-364 Markov Processes and Applications

Credits: 15 Session: 2022/23 September-January

Pre-requisite Modules: MA-252

Co-requisite Modules:

Lecturer(s): Prof J Wu

Format: There be weekly delivery, with each week have 3 lectures and 1 examples class.

Delivery Method: The module will be delivered on Bay Campus, with a traditional mix of lectures and example classes underpinned with weekly assessments of a formative/summative mix.

Module Aims: The module will introduce students to section 3 of the Institute and Faculty of Actuaries CS2 syllabus. This module serves as an introduction to the theory of Markov processes, in both discrete and continuous times. A special attention is drawn to the theory of Markov chains and Markov jump processes (including the Poisson process) and their applications.

Module Content: - Stochastic processes, filtration, conditional expectation, independence.
- Stochastic process with prescribed finite-dimensional distributions.
- Kolmogorov's existence theorem.
- Markov semigroups of kernels.
- Markov processes.
- Markov chains.
- Poisson process.
- Markov jump process.
- Brownian motion, continuity of paths.

Intended Learning Outcomes: At the end of this module students should be able to:
1) demonstrate a comprehensive knowledge of the theory of stochastic processes, in particular, Markov processes;
2) demonstrate understanding of Kolmogorov's construction of stochastic processes;
3) design and employ Markov chain models;
4) derive and use Kolmogorov’s differential equations for Markov processes;
5) demonstrate knowledge of the construction and basic properties of Brownian motion and Poisson processes.

Assessment: Examination (80%)
Assignment 1 (20%)
Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Component 1 is a written, closed-book examination at the end of the module.
Component 2 is formed of a number of coursework assignments during the semester.

Moderation approach to main assessment: Universal second marking as check or audit

Assessment Feedback: For the homework assignments, students will receive feedback in the form of marks, model solutions, overall feedback on the cohort performance, and some individual comments on their work.
For the exam, students will receive feedback in the form of marks and overall feedback on the cohort performance.
Further, individualised feedback, can be provided upon request.

Failure Redemption: Supplementary Examination.

Additional Notes: Available to visiting and exchange students

MA-365 Risk and Survival Models

Credits: 15 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules: MA-364

Lecturer(s): Dr DL Finkelshtein

Format: There be weekly delivery, with each week have 3 lectures and 1 lab/examples class.

Delivery Method: The module will be delivered on Bay Campus, with a traditional mix of lectures and lab/example classes underpinned with weekly assessments of a formative/summative mix.

Module Aims: This module will introduce students to sections 1, 2 and 4 of the Institute and Faculty of Actuaries CS2 syllabus.

The module covers insurance risk modelling based on loss and compound distributions, time series and their applications, survival models and the estimations of their distributions and transition intensities, and future mortality projection.

Module Content: - Loss distributions
- Compound distributions
- Risk modelling
- Copulas
- Extreme value
- Concepts of time series
- Applications of time series
- Survival models
- Estimation of lifetime distributions
- Maximum likelihood estimation
- Estimation of transition intensities
- Graduation
- Mortality projection

Intended Learning Outcomes: Learning Outcomes:
At the end of this module students should be able to:
- fit statistical distributions to datasets and calculate the goodness of fit,
- demonstrate an understanding of copulas (both Gaussian and Archimedean),
- explain the central concepts and properties of time series (AR, MA, ARMA, ARIMA),
- develop appropriate deterministic forecasts from time series data,
- describe and apply a two-state model, in the case of a single decrement,
- describe and apply the Cox model for proportional hazards,
- derive maximum (partial) likelihood estimates for various quantities,
- calculate graduation estimates of transition intensities (or probabilities) and specify their properties.

Assessment: Examination (70%)
Assignment 1 (20%)
Assignment 2 (10%)

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

Assessment Description: Component 1 is a written, closed-book examination at the end of the module.
Component 2 is formed of a number of coursework assignments during the semester.
Component 3 is a lab test during the semester.

Moderation approach to main assessment: Universal second marking as check or audit

Assessment Feedback: For the homework assignments, students will receive feedback in the form of marks, model solutions, overall feedback on the cohort performance, and some individual comments on their work.
For the lab test, students will receive feedback in the form of marks, model solutions, overall feedback on the cohort performance, and some individual comments on their work.
For the exam, students will receive feedback in the form of marks and overall feedback on the cohort performance. Further, individualised feedback, can be provided upon request.

Failure Redemption: Supplementary Examination.

Additional Notes: Available to visiting and exchange students

MA-375 Dynamical Systems

Credits: 15 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr DL Finkelshtein

Format: Formal lectures and support classes

Delivery Method: Lectures on campus

Module Aims: An introduction to the concepts and principles of dynamical systems from the analytical perspective. The course starts with the difference between discrete- and continuous time dynamical systems. It describes then the basic object of dynamical systems for the classical first-order differential equations, considers planar linear and non-linear systems, their phase portraits and classification. Applications in Biology, Mechanics and Physics will be considered.

Module Content: 1) Malthus and Verhulst models. Explosion and extinction, stationary and periodic solutions.
2) Second-order differential equations, eigenvalues end eigenvectors, linearity principle.
3) Phase portrait for planar systems.
4) Classification of planar systems.
5) Equilibria and their stability.
6) Bifurcations.
7) Infectious diseases, predator/prey and competitive systems.
8) Central force fields, two-body problems, the Lorenz attractor.

Intended Learning Outcomes: At the end of this module, the student should be able to:
1) describe the qualitative behaviour of the solution to a first-order differential equation with separable variables depending on the relations between parameters,
2) find and use eigenvalues and eigenvectors to describe the behaviour of a planar linear system,
3) sketch the phase portrait for a planar (nonlinear) system and describe its behaviour accordingly,
4) classify equilibria of a planar (nonlinear) system,
5) explain the meaning of and study the stability of the equilibria of a planar system,
6) apply theoretical results to models in biology (e.g. infectious diseases, predator-preys, competitive systems), mechanics and physics, and draw conclusions about the long-time behaviour in such applications.

Assessment: Examination (80%)
Coursework 1 (20%)

Assessment Description: Component 1 is a written, closed-book examination at the end of the module. Component 2 is formed of a number of coursework assignments during the semester.

Moderation approach to main assessment: Universal second marking as check or audit

Assessment Feedback: For the homework assignments, students will receive feedback in the form of marks, model solutions, overall feedback on the cohort performance, and some individual comments on their work.
For the exam, students will receive feedback in the form of marks and overall feedback on the cohort performance. Further, individualized feedback, can be provided upon request.

Failure Redemption: Supplementary examination.

Additional Notes: Available to visiting and exchange students

MA-384 Fourier Analysis

Credits: 15 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof E Lytvynov

Format: 44

Delivery Method: Primarily on campus

Module Aims: The module serves as an introduction to the main concepts, results and examples related to Fourier series of a function. The students will study in depth how, for a given periodic function, one finds its Fourier series and studies convergence of this series – pointwise convergence, uniform convergence, absolute convergence, convergence in the L^1 space. The concept of the Schwartz space of smooth, rapidly decreasing functions will be introduced and the students will learn how the Fourier transform acts on this space. Finally, the students will study how Fourier series and Fourier transform is applicable for solving ordinary and partial differential equations.

Module Content: - Fourier series of a periodic function;
- Applications to ordinary and partial differential equations
- Pointwise convergence, uniform convergence and absolute convergence;
- Weierstrass M-test;
- Convergence of Fourier series of an integrable function;
- Convergence of Fourier series of a smooth periodic function;
- Hilbert spaces;
- Orthonormal system, orthonormal basis in a Hilbert space;
- L^2 spaces;
- Convergence of Fourier series in L^2 space;
- Fourier transform and its basic properties;
- Fourier transform acting in the Schwartz space.

Intended Learning Outcomes: At the end of the module the student should be able to:
1) Demonstrate an understanding of various types of convergence of a functional series and be able to analyse convergence of a given functional series;
2) Demonstrate an understanding of convergence problems and results for Fourier series of a given function;
3) Demonstrate an understanding of the concept and examples of Hilbert spaces and orthonormal systems and bases in them;
4) Be able to apply the theory of Hilbert spaces to convergence of Fourier series in L^2-space;
5) Demonstrate an understanding of the theory of Fourier transform in the Schwartz space and its interplay with differentiation, multiplication by the variable, and translation;
6) Apply Fourier series and Fourier transform to solve problems related to ordinary and partial differential equations.

Assessment: Examination (80%)
Assignment 1 (20%)

Assessment Description: Component 1 is a written, closed-book examination at the end of the module.
Component 2 is formed of a number of coursework assignments during the semester.

Moderation approach to main assessment: Universal second marking as check or audit

Assessment Feedback: For the homework assignments, students will receive feedback in the form of marks, model solutions, overall feedback on the cohort performance, and some individual comments on their work.
For the exam, students will receive feedback in the form of marks and overall feedback on the cohort performance. Further, individualised feedback, can be provided upon request.

Failure Redemption: Supplementary examination.

Additional Notes: Available to visiting and exchange students

MA-393 Lie Theory

Credits: 15 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr I Rodionova

Format: 44

Delivery Method: Primarily on campus

Module Aims: This course provides an introduction to the theory of Lie groups and Lie algebras building on examples of matrix groups.

Module Content: Review of group theory,
Matrix Groups: O(n) SO(n) U(n) SU(n) Sp(n)
Matrix groups as manifolds
One parameter subgroups, the exponential mapping
Lie groups,
The Lie algebra of a Lie group - basic construction, properties.
The classification and representation problems
Lie groups in geometry, Symmetric spaces.

Intended Learning Outcomes: At the end of the module the student should be able to:
1) identify and work with the classical matrix groups
2) demonstrate a knowledge of the basic properties of Lie groups
3) demonstrate a knowledge of the properties of Lie algebras
4) explain the importance of Lie algebras in the study of Lie groups
5) apply the theory to problems in geometry

Assessment: Examination (80%)
Coursework 1 (20%)

Assessment Description: Component 1 is a written, closed-book examination at the end of the module.
Component 2 is formed of a number of coursework assignments during the semester.

Moderation approach to main assessment: Universal second marking as check or audit

Assessment Feedback: For the homework assignments, students will receive feedback in the form of marks, model solutions, overall
feedback on the cohort performance, and some individual comments on their work.
For the exam, students will receive feedback in the form of marks and overall feedback on the cohort performance.
Further, individualised feedback, can be provided upon request.

Failure Redemption: Supplementary examination.

Additional Notes: Delivery of teaching will be on-campus. Continuous assessment will be submitted online.

Available to visiting and exchange students

MA-395 Teaching Mathematics via a School Placement

Credits: 15 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr S Lyakhova

Format: 1 day preparatory training on campus.

8 half days on placement

Delivery Method: 1 day preparatory training on campus

8 half days on placement in a local school under supervision of an approved teacher-mentor (see attached proposal for further details)

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 mathematics 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, on written project work and a final presentation.

Module Content: No formal syllabus - students will have an introductory training day to provide basic information and practical advice. Students will then spend 8 half-days in schools under the supervison of a teacher-mentor, first mainly observing, and then progressing to small-scale teaching activities.

Intended Learning Outcomes: After completing this module, students will have:
First-hand experience of teaching in a secondary-school environment.
Demonstrated the interpersonal and improvisational skills necessary to work in a secondary-school environment.
Demonstrated ability to confidently present to an audience.
Demonstrated ability to interact with and educate secondary-school age children in a pedagogical environment.

Assessment: Other (100%)

Assessment Description: (a) written assessment by teacher mentor (20%)
(b) continuous assessment based on student log of activities within schools (20%)
(c) assignment (preparation of learning materials) (40%)
(d) 15 minute presentation (20%)

Moderation approach to main assessment: Universal second marking as check or audit

Assessment Feedback: Cover sheets for continuous assessment.

Failure Redemption: resubmission of project work

Additional Notes: Not available to visiting and exchange students.

Requires an enhanced Criminal Records Bureau check.

Students cannot go on a placement at their former school.