Swansea University
Prifysgol Abertawe

FACULTY OF SCIENCE AND ENGINEERING

POSTGRADUATE STUDENT HANDBOOK

MSC (FHEQ LEVEL 7)

MATHEMATICS

DEGREE PROGRAMMES

SUBJECT SPECIFIC
PART TWO OF TWO
MODULE AND COURSE STRUCTURE
2023-24

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 23-24 academic year begins on 25 September 2023

Full term dates can be found here

DATES OF 23-24 TERMS
25 September 2023 – 15 December 2023
8 January 2024 – 22 March 2024
15 April 2024 – 07 June 2024

SEMESTER 1
25 September 2023 – 29 January 2024
SEMESTER 2
29 January 2024 – 07 June 2024
SUMMER
10 June 2024 – 20 September 2024

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.

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.

At Swansea University and in the Faculty of Science and 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, technical and administrative staff, administrators - I'm sure you will find many friendly helping hands ready to assist you. And make the most of living and working alongside your fellow students.

During your time with us, please learn, create, collaborate, and most of all – enjoy yourself!

Professor David Smith
Pro-Vice-Chancellor and Executive Dean
Faculty of Science and Engineering

Faculty of Science and Engineering	
Pro-Vice-Chancellor and Executive Dean	Professor David Smith
Director of Faculty Operations	Mrs Ruth Bunting
Associate Dean – Student Learning and Experience (SLE)	Professor Laura Roberts
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 Nelly Villamizar Year 2 – Professor Chenggui Yuan Year 3 – Professor Grigory Garkusha Year 4 – Professor Grigory Garkusha MSc – Dr Guo Liu

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 8.30am-4pm.

The **Student Support Team** provides dedicated and professional support to all students in 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 (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 other resources:

https://myuni.swansea.ac.uk/fse/

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 23-24 handbooks to ensure that you have access to the most up-to-date versions. 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/essentialinfo-taught-students/your-programme-explained/

MSc (FHEQ Level 7) 2023/24
Mathematics (MSc)
MSc Mathematics

Coordinator: Dr G Liu

Dissertation
MA-D00 **Mathematics Masters Dissertation** **60 Credits** **Prof C Yuan**
Total 180 Credits

Optional Modules
Choose a maximum of 120 credits
Students must take 120 credits of taught modules, chosen either from the list below, or from Mathematics modules in other departments, such as Computer Science or Engineering.

MA-M08	Machine Learning	Prof B Lucini	TB2	15
MA-M11	Partial Differential Equations	Prof E Lytvynov/Prof E Lytvynov	TB1	15
MA-M24	Differential Geometry	Dr I Rodionova	TB2	15
MA-M25	Applied Algebra: Coding Theory	Prof T Brzezinski	TB1	15
MA-M31	Numerical Analysis	Dr V Giunta	TB2	15
MA-M45	Cashflows and Interest Rates	Dr G Liu	TB1	15
MA-M46	Assurance and Annuity	Dr G Liu	TB2	15
MA-M58	Financial Mathematics in Discrete Time	Dr I Rodionova	TB1	15
MA-M59	Financial Mathematics in Continuous Time	Prof E Lytvynov	TB2	15
MA-M64	Markov Processes and Applications	Prof C Yuan	TB1	15
MA-M65	Risk and Survival Models	Dr DL Finkelshtein	TB2	15
MA-M73	Biomathematics	Prof GG Powathil	TB1	15

MA-D00 Mathematics Masters Dissertation

Credits: 60 Session: 2023/24 September-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof C Yuan

Format: 12

Delivery Method: Individual project supervision

Module Aims: A research project selected from an area of expertise of a member of staff in the Department of Mathematics. It will enable the students to develop an enquiring, analytical critical and creative approach to problem identification and solution. The project will typically focus on a subject area related to one of the taught modules in the MSc scheme.

Module Content: The student will study an area of mathematics related to the content of the taught part of the MSc scheme, drawing together material from different published sources, and their own investigations, to product a substantial written report on the topic.

Intended Learning Outcomes: At the end of this module, the student should be able to:
plan and undertake a significant project with a high degree of independence,
synthesize information and ideas;
independently evaluate alternative approaches to a given problem;
accurately report on and evaluate their own work, and work of others;
communicate complex mathematical ideas to both mathematicians and non-mathematicians.

Assessment: Dissertation (100%)

Assessment Description: Written dissertation, including presentation, subject to the regulations for an MSc dissertation.

Moderation approach to main assessment: Universal Non-Blind Double Marking of the whole cohort

Assessment Feedback: Students will receive ongoing feedback during the meetings with their supervisor. The official result of the MSc dissertation will be communicated to the student by the University in the usual way. The student can receive individual feedback on their dissertation from their supervisor, informed by the views of both markers.

Failure Redemption: Resubmission of the dissertation, in accordance with the University regulations.

Additional Notes: Dissertation for the MSc Mathematics scheme. Only available to students on the MSc Mathematics programme.

Each student will be assigned a member of staff as a supervisor who will help to choose the topic to be studied, and guide the student. Each student will be required to produce a word-processed thesis of 15,000-20,000 words, based on topics covered in the taught part of the MSc scheme, and on published research in the field.

MA-M08 Machine Learning

Credits: 15 Session: 2023/24 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: 1. Introduction to Machine Learning – Machine learning: methods and terminology; classification and regression problems; binary classification; categorical and continuous variables; the general process of a machine learning analysis: data collection, feature design, choice of model, model training, model validation; types of learning: supervised, unsupervised, reinforcement.
2. Optimisation for Machine Learning – Cost function and its optimisation; zeroth-order optimisation methods: grid search, random and coordinate search; the curse of dimensionality; first-order methods: gradient descent, batch gradient descent, stochastic gradient descent; ADAM acceleration; hyperparameters in Machine Learning.
3. Linear regression – Linear regression as a machine learning problem; the mean square cost function; the absolute deviation cost function.
4. Classification – Two-class classification; classification methods in machine learning: logistic regression, perceptron, and support vector machine; introduction to multi-class classification and the k-Nearest-Neighbour (kNN) classifier.
5. Robustness metrics – Model error on new data; training error and generalisation gap; bias, variance and their trade-off; k-fold cross-validation; the VC dimension; additional tools for evaluating the performance of binary classifiers: classification errors, confusion matrix, precision, recall, F1-score, ROC curve and Area Under the Curve (AUC).
6. Unsupervised linear learning – Linear autoencoders; Principal Component Analysis; k-Means Clustering.
7. Principles of non-linear learning – Non-linear regression; non-linear classification.
8. Regularisation – Ridge regression (L2 regularisation); lasso regression (L1 regularisation).
9. Tree-based learners – Introductions to trees; from stumps to regression trees; classification trees; random forests.
10. Introduction to deep learning – From the perceptron to fully connected neural networks (FCNN); FCNN architectures; activation functions; the computation graph; automatic differentiation; backward propagation.

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

1) Critically analyse the feasibility of approaches to machine learning .
2) Demonstrate a comprehensive understanding of the fundamental mathematical ideas behind the standard approaches to machine learning.
3) Apply a broad range of machine learning techniques to data sets using appropriate programming languages.
4) Analyse the strengths and weaknesses of a wide range of different approaches to machine learning.
5) Determine appropriate methods to apply to given data sets.

Assessment:	Examination (60%)
	Coursework 1 (10%)
	Coursework 2 (10%)
	Coursework 3 (20%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Examination: A closed book examination to take place at the end of the module.
Courseworks 1-3: This coursework will develop skills in problem solving, applying techniques to real world problems and understanding the use of computers to investigate problems.

Moderation approach to main assessment: Moderation of the entire cohort 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-M11 Partial Differential Equations

Credits: 15 Session: 2023/24 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof E Lytvynov, Prof E Lytvynov

Format: 33 lectures, 11 examples classes

Delivery Method: Traditional mix of lectures supported by examples classes.

Module Aims: This course provides an introduction to the theory of partial differential equations form an analytical perspective.

Module Content: Basic results on linear and quasilinear first order equations.
Method of characteristics. Formation of singularities.
Characterisation of second order equations in two independent variables.
The wave equation. Solvability of the Cauchy problem with boundary conditions.
Fourier series expansions and separation of variables.
The heat equation. Basic properties the Gauss kernel.
The Laplace equation and Newton potentials.
Harmonic functions. Maximum principle. Green function of the ball.

Intended Learning Outcomes: At the end of the module the student should be able to:
1) Demonstrate a thorough understanding of the properties of first order equations and hyperbolic conservation laws.
2) Apply the method of characteristics to a range of first order equations;
3) Demonstrate a comprehensive knowledge of the behaviour of solutions of the one-dimensional wave equation and the Cauchy problem;
4) Demonstrate a thorough knowledge of the fundamental properties of harmonic functions and Newtonian potentials;
5) identify the types of second order linear differential operators.

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

Assessment Description: The summative assessment consists of one written, closed-book examination at the end of the module.
A number of homework assignments will be set during the semester, approximately weekly, constituting formative assessment in preparation for the final summative assessment event.

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: Lecturer feedback, narrative analysis on Blackboard.

Failure Redemption: Resit examination

Additional Notes: This module is not available to students who have previously taken MA-311.
Available to visiting and exchange students

MA-M24 Differential Geometry

Credits: 15 Session: 2023/24 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr I Rodionova

Format: 44

Delivery Method: Primarily on campus

Module Aims: An introduction to differential geometry

Module Content: - Parametric curves in the plane and in space;
- The Frenet formulae;
- The fundamental theorem of the local theory of curves;
- Some global considerations for plane curves: rotation index, regular surfaces in space;
- Tangent bundle and normal line bundle of a smooth surface;
- First and second fundamental form and applications;
- Curvature
- Special surfaces (for example surfaces of rotation)
- The idea of a differential manifold

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

1) Demonstrate extensive familiarity with the Frenet formulae
2) Understand and work with plane curves and tangent bundles
3) Demonstrate a deep understanding of the idea of a differentiable manifold

Assessment:	Examination 1 (80%)
	Coursework 1 (6%)
	Coursework 2 (7%)
	Coursework 3 (7%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Examination: A closed book examination to take place at the end of the module.
Courseworks 1-3: This coursework will develop students' skills in problem solving, and developing and writing logical arguments.

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: Lecturer feedback

Failure Redemption: Resit examination

Additional Notes: This module is not available to students who have previously taken MA-324.
Available to visiting and exchange students.

MA-M25 Applied Algebra: Coding Theory

Credits: 15 Session: 2023/24 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof T Brzezinski

Format: 44

Delivery Method: Primarily on campus.

Module Aims: This module is an introduction to modern algebraic coding theory.

Module Content: Error detection and correction.
Reed-Solomon codes.
Finite fields: construction and uniqueness.
The Hamming metric, Sphere-Packing Bounds.
Linear Codes, Reed-Muller code.
Syndrome decoding and Hamming codes.
Classification of cyclic codes.
Golay and BCH codes.

Intended Learning Outcomes: At the end of the module the student should be able to:
1) manipulate key concepts of error detection and correction, building proofs on these concepts;
2) state, prove and apply the basic properties of linear codes;
3) state, prove and apply a variety of bounds on the size and capacity of codes;
4) demonstrate a thorough understanding of the construction and properties of various families of codes;
5) demonstrate a thorough understanding of cyclic codes as ideals of a polynomial quotient ring;
6) demonstrate a thorough understanding of the construction and classification of finite fields, and their applications in coding theory;
7) demonstrate a thorough understanding of the basic concepts of, and mathematics underlying, cryptography

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

Assessment Description: The summative assessment consists of one written, closed-book examination at the end of the module.
A number of homework assignments will be set during the semester, approximately weekly, constituting formative assessment in preparation for the final summative assessment event.

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: 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: This module is not available to students who have previously taken MA-325.
Available to visiting and exchange students.

MA-M31 Numerical Analysis

Credits: 15 Session: 2023/24 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr V Giunta

Format: 44

Delivery Method: Primarily on campus

Module Aims: The techniques developed take the cost of computation into account, an important consideration even with immense computational capability available on modern laptop computers.

Module Content: - systems of linear equations; Gaussian elimination, pivoting strategies, PLU decompositions, residuals and error correction, iterative methods.

- eigenvalues and eigenvectors; Gerschgorin theorems, power methods (PM/IPM/SIPM), Rayleigh quotient method, Householder transformation, Hessenberg form, QR decomposition, QR iteration.

- numerical integration; Adams-Bashforth methods, Monte-Carlo methods

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

1) Demonstrate extensive familiarity with techniques appropriate to the efficient solution of large linear systems
2) Compute and critically evaluate requirements on accuracy and error bounds
3) Demonstrate a clear knowledge of methods for the calculation of eigenvalues and eigenvectors for large matrices
4) Critically evaluate quadrature methods and apply them in the approximation of integrals

Assessment:	Examination 1 (80%)
	Coursework 1 (6%)
	Coursework 2 (7%)
	Coursework 3 (7%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Examination: A closed book examination to take place at the end of the module.
Courseworks 1-3: This coursework will develop students' skills in problem solving, and developing and writing logical arguments.

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: Lecturer feedback

Failure Redemption: Resit examination

Additional Notes: This module is not available to students who have previously taken MA-331.
Available to visiting and exchange students.

MA-M45 Cashflows and Interest Rates

Credits: 15 Session: 2023/24 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr G Liu

Format: 40 hours: 30 hours of lectures and 10 hours of examples classes.

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

Module Aims: This module covers a detailed analysis of cashflows and interest rates with actuarial applications.

It covers material relating to sections 1, 2 and 3 of the Institute and Faculty of Actuaries CM1 syllabus.

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: At the end of this module, the student should be able to:
1) analyse and critically evaluate a selection of actuarial models,
2) analyse real world problems using specialist techniques and actuarial models,
3) demonstrate a systematic understanding and advanced skills in generalised cashflow models and their use,
4) demonstrate advanced skills with interest rates and interest functions in a range of settings,
5) analyse complex business scenarios using the equation of value.

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 composed of a number of coursework assignments spread through the term.

Moderation approach to main assessment: Moderation of the entire cohort as Check or Audit

Assessment Feedback: For 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-M46 Assurance and Annuity

Credits: 15 Session: 2023/24 January-June

Pre-requisite Modules:

Co-requisite Modules: MA-M45

Lecturer(s): Dr G Liu

Format: 40 hours: 30 hours of lectures and 10 hours of examples classes

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

Module Aims: 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. It covers material related to sections 4, 5 and 6 of the Institute and Faculty of Actuaries CM1 syllabus.

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: At the end of this module, a student should be able to:
1) critically evaluate a range of assurance and annuity contracts,
2) demonstrate advanced skills with payments under various assurance and annuity contracts,
3) calculate using advanced techniques cashflows contingent upon the nature of transitions,
4) demonstrate advanced skills calculating gross premiums and reserves for assurance and annuity contracts and projecting future cashflows for a variety of typical contracts.

Assessment:	Examination (80%)
	Coursework 1 (6%)
	Coursework 2 (7%)
	Coursework 3 (7%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Examination: A closed book examination to take place at the end of the module.
Courseworks 1-3: This coursework will develop skills in problem solving, applying techniques to real world problems and understanding the use of computers to investigate problems.

Moderation approach to main assessment: Moderation of the entire cohort 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: Module available to visiting and exchange students.

MA-M58 Financial Mathematics in Discrete Time

Credits: 15 Session: 2023/24 September-January

Pre-requisite Modules:

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 1 of the Institute and Faculty of Actuaries (IFoA) CS1 syllabus, section 3 of the IFoA CS2 syllabus and sections 4 and 6 of the 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: Moderation of the entire cohort 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-M59 Financial Mathematics in Continuous Time

Credits: 15 Session: 2023/24 January-June

Pre-requisite Modules:

Co-requisite Modules: MA-M58; MA-M64

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 a comprehensive understanding of Itô's formula and be able to apply it for the purposes in financial mathematics;
3) Demonstrate comprehensive 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%)
	Coursework 1 (6%)
	Coursework 2 (7%)
	Coursework 3 (7%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Examination - A closed book examination to take place at the end of the module.
Courseworks 1-3: This coursework will develop students' skills in problem solving, and developing and writing logical arguments.

Moderation approach to main assessment: Moderation of the entire cohort 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-M64 Markov Processes and Applications

Credits: 15 Session: 2023/24 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof C Yuan

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 comprehensive understanding of Kolmogorov's construction of stochastic processes;
3) design and systematically employ Markov chain models;
4) derive and systematically use Kolmogorov’s differential equations for Markov processes;
5) demonstrate comprehensive 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: Moderation of the entire cohort 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-M65 Risk and Survival Models

Credits: 15 Session: 2023/24 January-June

Pre-requisite Modules:

Co-requisite Modules: MA-M64

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 a comprehensive 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 systematically apply a two-state model, in the case of a single decrement,
- describe and systematically 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%)
	Coursework 1 (6%)
	Coursework 2 (7%)
	Coursework 3 (7%)
	Laboratory work (10%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Examination: A closed book examination to take place at the end of the module.
Courseworks 1-3: This coursework will develop skills in problem solving, applying techniques to real world problems and understanding the use of computers to investigate problems.
Lab Assessment: Computing based controlled assessment to assess skills in the use of computers to investigate and analyse real world problems.

Moderation approach to main assessment: Moderation of the entire cohort 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-M73 Biomathematics

Credits: 15 Session: 2023/24 September-January	
Pre-requisite Modules:	
Co-requisite Modules:	
Lecturer(s): Prof GG Powathil	
Format: 44	
Delivery Method: Primarily on campus	

Module Aims: Mathematical biology has become a vast research area, spanning many sub-fields from mathematical ecology to systems biology and medicine. Building on introductory biomathematical and modelling modules, this module gives further insights into mathematical modelling applied to the biomedical problems, with no previous knowledge of biology assumed. The focus is on modelling biological phenomena (incorporating temporal or/and spatial effects) and applying mathematical and numerical techniques to solve the model problems, which largely comprise systems of ordinary and partial differential equations.

Module Content: Revision with biochemical reaction modelling mass action kinetics, equilibrium, Michaelis-Menten kinetics and quasi-steady-state analysis.
Modelling metabolic networks and pathways (Metabolic networks, Stoichiometric network analysis, modelling signalling pathways etc)
Modelling biological oscillators (FitzHugh–Nagumo model)
Modelling biological problems using partial differential equation (introduction, derivation of reaction-diffusion equation, role of diffusion, convection, and attraction, travelling waves)
Pattern formation in biological systems (Turing instability, activator-inhibitor systems, examples)
Modelling tumour growth (basic model, treatments)

Intended Learning Outcomes: At the end of the module, the student should be able to:
• Systematically translate a biological problem into a mathematical model.
• Critically analyse the role of parameters and their effects on model behaviour.
• Systematically select and apply an appropriate solution technique for a given mathematical model.
• Demonstrate the knowledge of numerical methods to investigate model behaviour.
• Critically analyse models in terms of their steady-states and pseudo-steady-states.
• Demonstrate an understanding of models for population growth, biochemical reactions, pattern formation and tumour growth.
• Understand the role of partial differential equation in modelling biological systems.

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

Assessment Description: The summative assessment consists of one written, closed-book examination at the end of the module.
A number of homework assignments will be set during the semester, approximately weekly, constituting formative assessment in preparation for the final summative assessment event.

Moderation approach to main assessment: Moderation of the entire cohort 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: This module is not available to students who have previously taken MA-371.
Available to visiting and exchange students.