Swansea University
Prifysgol Abertawe

FACULTY OF SCIENCE AND ENGINEERING

UNDERGRADUATE STUDENT HANDBOOK

YEAR 3 (FHEQ LEVEL 6)

MATHEMATICS AND COMPUTER SCIENCE

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 and Computer Science
BSc Mathematics and Computer Science[GS08,GS10]
BSc Mathematics and Computer Science with a Year Abroad[GS14]
BSc Mathematics and Computer Science with a Year in Industry[GS12]

Coordinator: Dr G Garkusha

Compulsory Modules

Semester 1 Modules	Semester 2 Modules
CSC318 **Cryptography and IT-Security** **15 Credits** **Dr P Kumar/Dr PD James/Dr P Kumar**	**MA-308** **Machine Learning** **15 Credits** **Prof B Lucini**
CSC385 **Modelling and Verification Techniques** **15 Credits** **Dr U Berger**	
MA-322 **Topology** **15 Credits** **Dr MD Crossley**	
MA-360 **Dissertation in Mathematics and Computer Science** **30 Credits** **Dr C Mercuri**	
Total 120 Credits	

Optional Modules
Choose exactly 15 credits

CSC375	Logic for Computer Science	Dr U Berger	TB2	15
MA-364	Markov Processes and Applications	Prof J Wu	TB1	15
MA-375	Dynamical Systems	Dr DL Finkelshtein	TB1	15

And
Choose exactly 15 credits

CSC325	Artificial Intelligence	Dr AZ Wyner/Dr B Muller	TB2	15
MA-302	Numerics of ODEs and PDEs	Prof IM Davies	TB2	15
MA-365	Risk and Survival Models	Dr DL Finkelshtein	TB2	15

CSC318 Cryptography and IT-Security

Credits: 15 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr P Kumar, Dr PD James

Format: 30 hours lectures and labs

Delivery Method: On-campus/virtual lectures and lab sessions.

Module Aims: The aim of this course is to examine theoretical and practical aspects of computer and network security.

Module Content: Security threats and their causes.
Security criteria and models.
Cryptography: including basic encryption, DES, AES, hash functions.
Access Control.
Security tools and frameworks: including IPSec, TLS, SSL, SSH and related tools.
Vulnerabilities and attacks: including port scanning, packet sniffing, SQL injection.
Security issues in wireless networks.
Security on the cloud..
Block Chain Technology and Bitcoin
Penetration Testing.
Tor Network.

Intended Learning Outcomes: Students will have the ability to identify security threats and their causes in today's computing infrastructures.
Students will be able to understand and apply techniques from Crytography and Cryptanalysis.
Students will gain experience in building secure systems.
Students will be able to apply techniques to enhance the security of existing systems, and gain a critical awareness of the limits of these techniques.

Assessment:	Examination 1 (70%)
	Coursework 1 (10%)
	Coursework 2 (10%)
	Laboratory work (10%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Standard Computer Science format unseen examination (70%).
1 Coursework and work done in a lab.

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

Assessment Feedback: Outline solutions provided along with group and individual analytical feedback for courseworks.
Examination feedback summarising strengths and weaknesses of the class.

Failure Redemption: Resit exam.

Additional Notes:

Available to visiting and exchange students.
Updated july 2019.

CSC325 Artificial Intelligence

Credits: 15 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr AZ Wyner, Dr B Muller

Format: 20 hours lectures, 10 hours lab.

Delivery Method: On-campus/virtual lectures and lab sessions.

Module Aims: CSC325 is an introduction to Artificial Intelligence, focusing primarily on reasoning and problem solving as a search for a solution rather than on statistical techniques for classification. The course may cover topics from amongst: search techniques; knowledge representation and expert systems; planning; scheduling; qualitative reasoning; language processing with grammar rules; and meta-programming, as well as agents, multi-agent systems, and agent collaboration.

Module Content: • Fundamental Issues in AI
• Basic Search Strategies
• Advanced Search
• Reasoning Under Uncertainty
• Programming for AI
• Basic Knowledge Representation and Reasoning
• Advanced Representation and Reasoning
• Natural Language Processing
• Advanced: Application of NLP and Explainable AI
• Concept of rational agent
• Multi-Agent Systems
• Agent communication and collaboration

Intended Learning Outcomes: On completion of this module, students will
1. be able to demonstrate a systematic knowledge of the fundamental concepts in AI.
2. be able to apply a wider range of AI techniques and to evaluate their advantages and disadvantages.
3. be able to identify problems that are amenable to solution by AI methods and methods which may be suited to solve a given problem.
4. be able to demonstrate competency in developing programs to address problems in AI automatically.

Assessment:	Examination 1 (60%)
	Coursework 1 (15%)
	Coursework 2 (15%)
	Laboratory work (10%)
Resit Assessment:	Examination (Resit instrument) (100%)

Assessment Description: Standard format Computer Science exam.
Practical programming assignments.
Laboratory work.

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

Assessment Feedback: Outline solutions provided along with analytical individual feedback for assignment. Examination feedback summarising strengths and weaknesses of the class.

Failure Redemption: Resit examination

Additional Notes:

Created July 2019.
Updated September 2021

CSC375 Logic for Computer Science

Credits: 15 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr U Berger

Format: 20 hours lectures,
2 x 3 hours practicals,
4 problem consultation hours.

Delivery Method: On campus.

Module Aims: This module provides an introduction to logic and its applications to computer science, in particular to the formal specification and verification of computer programs.

Module Content: Propositional logic (syntax, semantics, proof system).
Predicate logic (syntax, semantics, proof system).
Applications of logic to program specification and verification.
Application of tools to carry out formal proofs.

Intended Learning Outcomes: At the end of this module students will understand the syntax, semantics and proof rules of first-order
predicate logic, be aware of other logics that serve special purpose in computer science (e.g. modal logic, process logic), understand the importance of logic for computer science, be able to express informal statements as formulas in predicate logic and to understand formal proofs.
Students will have used an interactive logic tool to carry out formal proofs of varying difficulty.

Assessment: Examination (70%)
Coursework 1 (10%)
Laboratory work (10%)
Coursework 2 (10%)

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

Assessment Description: Standard Computer Science format unseen examination, duration 2hrs.
Coursework consist of 1 assignment and work in computer labs:
Assignment: Syntax and semantics of propositional logic.
Lab: Formal proofs in natural deduction using an interactive proof tool.

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

Assessment Feedback: Outline solutions provided along with group and individual analytical feedback for courseworks.
Examination feedback summarising strengths and weaknesses of the class.
Individual feedback on submissions from lecturer and/or demonstrators in laboratory sessions.

Failure Redemption: Resit examination and/or resubmit coursework(s) as appropriate.

Additional Notes:

Available to visiting and exchange students.

CSC385 Modelling and Verification Techniques

Credits: 15 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr U Berger

Format: 20 lectures,
2 x 3 practicals,
4 problem consultation hours.

Delivery Method: On-campus/virtual lectures and lab sessions.

Module Aims: This module will give an overview of the landscape and the state of the art of current modelling and verification techniques. Students will gain hands-on experience in using a tool for modelling and verification.

Module Content: Overview of techniques for formal verification.

Interactive theorem proving, automated theorem proving and model checking.

Introduction to one specific logic for modelling and verification.

Techniques for modelling of software using verification tools.

Practical verification of software examples.

Intended Learning Outcomes: After completing this module a student will be able to:
- Explain the current state of the art of modelling and verification techniques;
- Use a verification tool and translate mathematical notation into the input language of that tool;
- Apply a verification tool to practical examples.

Assessment: Examination 1 (70%)
Coursework 1 (15%)
Laboratory work (15%)

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

Assessment Description: Standard format Computer Science exam (2 hours).
Coursework consists of one assignment and lab work.
Assignment: Mathematical and logical foundations of concurrent processes.
Lab: Modelling and verification in CSP using the process tools ProBE and FDR.

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

Assessment Feedback: Outline solution provided along with group and individual analytical feedback for coursework.

Examination feedback summarising strengths and weaknesses of the class.

Individual feedback on submissions from lecturer and/or demonstrators in laboratory sessions.

Failure Redemption: Resit examination and/or resubmit coursework(s) and /or redo lab exercise as appropriate

Additional Notes:

Available to visiting 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-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-360 Dissertation in Mathematics and Computer Science

Credits: 30 Session: 2022/23 September-June

Pre-requisite Modules:

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 topic within Mathematics and Computer Science and independently learn new subjects with the guidance 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%)
Project (70%)
Presentation (10%)

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

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

Assessment Feedback: Verbal feedback from their supervisor

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

Additional Notes: Each student is to write a report on a specific topic in Mathematics and Computer Science, under the supervision of a member of staff. Once a supervisor has been allocated, students will have a first meeting at which there will be a discussion about the project. 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-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