Swansea University
Prifysgol Abertawe

FACULTY OF SCIENCE AND ENGINEERING

UNDERGRADUATE STUDENT HANDBOOK

YEAR 2 (FHEQ LEVEL 5)

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 2 (FHEQ Level 5) 2022/23
Mathematics and Computer Science
BSc Mathematics and Computer Science[GS08,GS10]
BSc Mathematics and Computer Science with a Year Abroad[GS14]

Coordinator: Dr G Garkusha

Compulsory Modules

Semester 1 Modules	Semester 2 Modules
CS-250 **Database Systems** **15 Credits** **Dr KL Tam**	**CS-255** **Computer Graphics** **15 Credits** **Prof MW Jones**
MA-201 **Multi-variable analysis** **15 Credits** **Prof V Moroz** **CORE**	**MA-212** **Groups and Rings** **15 Credits** **Dr EJ Beggs** **CORE**
MA-211 **Vector Spaces** **15 Credits** **Prof T Brzezinski** **CORE**	**MA-282** **Game Theory and Optimization** **15 Credits** **Dr AJ Bruce**
Total 120 Credits	

Optional Modules
Choose exactly 15 credits

CS-205	Declarative Programming	Dr M Seisenberger/Dr PRA Pradic	TB1	15
MA-203	Professional Development and Career Planning	Miss VV Wislocka/Mr N Clarke	TB1	0
MA-241	Differential Equations	Dr C Mercuri/Dr AJ Bruce	TB1	15
MA-252	Probability Theory	Prof C Yuan	TB1	15

And
Choose exactly 15 credits

CS-275	Automata and Formal Language Theory	Dr AM Pauly	TB2	15
MA-243	Mathematical Modelling: Theory and Practice	Dr GG Powathil	TB2	15
MA-292	Statistical Data Analysis	Dr K Evans	TB2	15

Year 2 (FHEQ Level 5) 2022/23
Mathematics and Computer Science
BSc Mathematics and Computer Science with a Year in Industry[GS12]

Coordinator: Dr G Garkusha

Compulsory Modules

Semester 1 Modules	Semester 2 Modules
CS-250 **Database Systems** **15 Credits** **Dr KL Tam**	**CS-255** **Computer Graphics** **15 Credits** **Prof MW Jones**
MA-201 **Multi-variable analysis** **15 Credits** **Prof V Moroz** **CORE**	**MA-212** **Groups and Rings** **15 Credits** **Dr EJ Beggs** **CORE**
MA-203 **Professional Development and Career Planning** **0 Credits** **Miss VV Wislocka/Mr N Clarke** **CORE**	**MA-282** **Game Theory and Optimization** **15 Credits** **Dr AJ Bruce**
MA-211 **Vector Spaces** **15 Credits** **Prof T Brzezinski** **CORE**	
Total 120 Credits	

Optional Modules
Choose exactly 15 credits

CS-205	Declarative Programming	Dr M Seisenberger/Dr PRA Pradic	TB1	15
MA-241	Differential Equations	Dr C Mercuri/Dr AJ Bruce	TB1	15
MA-252	Probability Theory	Prof C Yuan	TB1	15

And
Choose exactly 15 credits

CS-275	Automata and Formal Language Theory	Dr AM Pauly	TB2	15
MA-243	Mathematical Modelling: Theory and Practice	Dr GG Powathil	TB2	15
MA-292	Statistical Data Analysis	Dr K Evans	TB2	15

CS-205 Declarative Programming

Credits: 15 Session: 2022/23 September-January

Pre-requisite Modules: CS-110; CS-115

Co-requisite Modules:

Lecturer(s): Dr M Seisenberger, Dr PRA Pradic

Format: 20 hours lectures and 20 hours practicals

Delivery Method: Lectures and laboratory sessions

Module Aims: This module provides an introduction to the functional and logic programming paradigms and gives students the opportunity to gain practical experience in using both.

Module Content: Functional Programming in Haskell:
The functional programming paradigm and its relation to other programming paradigms.
Functions, definitions and types.
Solving simple algorithmic problems using iteration and recursion.
Polymorphism and higher-order functions.
Programming with lists.
Verification of programs in Haskell.

Logic Programming in Prolog:
The essence of logic programming.
Pattern matching, recursion, backtracking and resolution.
Database programming
Extralogical aspects of Prolog.
Data structure terms and lists.

Intended Learning Outcomes: Students will be able to specify and write programs in functional and logic programming languages. They will be able to develop solutions to simple algorithmic problems using declarative rather than procedural concepts.

Assessment: Examination 1 (70%)
Coursework 1 (15%)
Laboratory work (15%)
Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Standard Computer Science format unseen examination, duration 2hrs.
Guided and Supported Laboratory Sessions.
Coursework - functional programming exercise.

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: Exam resit instrument.

Additional Notes:

Updated July 2021. Available to visiting and exchange students

CS-250 Database Systems

Credits: 15 Session: 2022/23 September-January

Pre-requisite Modules: CS-110; CS-115

Co-requisite Modules:

Lecturer(s): Dr KL Tam

Format: 30 hours (20 lectures, 10 problem classes)

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

Module Aims: This module will discuss the theory, design and implementation of databases.

Module Content: What is a database? What is data? Database software and benefits. ANSI/SPARC model, database structure.

Relational databases - properties, designing, problems. Normalisation - normal forms, functional dependence, primary keys, integrity constraints and rules, validation.

Real world examples - SQL and practical sessions using a relational database. Client/server technology, web and database programming (eg. PHP/MySQL), including examples and applications.

ER Model - entities, relationships, modelling, attributes, converting to relational model.

Relational calculus, relational algebra - select, project, join, union, intersection, difference, cartesian product, query optimisation, and its application to databases

Recovery and concurrency - transaction processing, locking, detecting deadlocks. Multi-user databases - client/server, distributed, commit protocols.

Security - managing users and passwords, SQL injection, data security in a database environment, e.g. cryptography (RSA/SSL), preventive measures and responses to security breach.

Intended Learning Outcomes: Students will be aware of relational databases and the need for the normalisation of data. Students will have been exposed to transaction processing and how to detect and avoid problems that can arise in a multi-user and/or distributed environment. Students will have designed a database using the ER model, and have practical experience of a relational database.

Assessment: Examination 1 (70%)
Coursework 1 (10%)
Coursework 2 (10%)
Coursework 3 (10%)

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

Assessment Description: Standard Computer Science format unseen examination, duration 2hrs (70%).
Database Coursework 1 10%
Database Coursework 2 (PartA) 10%
Database Coursework 2 (PartB) 10%

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 and/or resubmit assignments as appropriate.

Additional Notes:

Updated July 2014. Available to visiting and exchange students.

CS-255 Computer Graphics

Credits: 15 Session: 2022/23 January-June

Pre-requisite Modules: CS-110; CS-115

Co-requisite Modules:

Lecturer(s): Prof MW Jones

Format: 30 hours lectures and problem classes

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

Module Aims: This module will provide an introduction to the use of computer graphics and its applications particularly for image processing and the production of realistic representations.

Module Content: Fundamentals: Image sampling and quantization. Digital images. Storage and pixels. Perception, human visual system. Gamma correction. Mathematical background.

Image Processing: Representation — sizing, re-scaling, rotation, colour components, brightness and colour models, histograms, histogram equalization, nearest neighbour, bilinear and tricubic interpolation. Processing techniques — JPEG compression, quantization, antialiasing, filtering, convolution, dithering, edge detection and denoising.

Image Synthesis: Ray tracing — modelling scenes, accelerating ray tracing using bounding volumes and octrees, fundamental primitives, lighting and illumination, shadows, reflections and transparency.

Applications: Volume data and rendering — isosurfacing, volume rendering, Maximum Intensity Projection.

Intended Learning Outcomes: Students will be aware of different forms of computer imagery; methods for synthesizing images from data; and the post-processing of images. Students will have experienced programming a graphical application and carrying out operations on a digital image.

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

Assessment Description: Standard Computer Science format unseen examination, duration 2hrs.
Coursework - graphics programming assignment.

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 and/or resubmit assignments as appropriate.

Additional Notes:

Updated July 2014. Available to visiting and exchange students.

CS-275 Automata and Formal Language Theory

Credits: 15 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr AM Pauly

Format: 30 (20 hours lectures, 10 hours problem classes)

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

Module Aims: This module introduces the notion of grammars for defining the syntax of formal languages, especially programming languages. It introduces the limits of computation using Turing Machines and other models of computation.

Module Content: • Use of Grammars for defining syntax. The Chomsky hierarchy and the language recognition (parsing) problem.

• Finite-state automata, regular languages and regular expression: equivalences between formalisms, methods for determining when a language is or is not regular.

• Context-free languages and context-free grammars: methods for determining when a language is or is not context-free.

• Turing analysis of computation. Turing machines. Algorithmically decidable languages. Equivalences between formalisms. Methods for determining when a language is or is not computable. Register machines. Hierarchy and compilation.

Intended Learning Outcomes: Students will know the key steps in the historical development of programming languages and the basic techniques for defining the syntax of languages. They will be familiar with the standard hierarchy of formal languages and their various characterisations. They will be aware of the limits of description and computation.

Assessment: Examination 1 (65%)
Coursework 1 (20%)
In class test (non-invigilated) (15%)

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

Assessment Description: Standard Computer Science format unseen examination, duration 2hrs.
Coursework 1: theoretical questions about the module content.

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 and/or resubmit assignments as appropriate.

Additional Notes:

Updated July 2017. Available to visiting and exchange students.

MA-201 Multi-variable analysis

Credits: 15 Session: 2022/23 September-January

Pre-requisite Modules: MA-101; MA-102; MA-111; MA-112

Co-requisite Modules:

Lecturer(s): Prof V Moroz

Format: 44

Delivery Method: All programmes will employ a blended approach to delivery using the Canvas digital learning platform.

On campus

Module Aims: The module introduces fundamental concepts of the analysis in n-dimensional spaces such convergence, continuity, differentiability, integrability and elements of vector calculus.

Module Content: • The space R^n: inner product, norm, Schwarz inequality
• Topology of R^n: interior and boundary points, open and closed sets
• Sequences in R^n: convergence, sub-sequences, Cauchy sequences
• Sequential compactness, Heine-Borel theorem
• Functions: limits, continuity, preservation of compactness, maxima and minima
• Partial derivatives, directional derivative, Jacobi matrix
• Differentiation on R^n: definition, properties, chain rule
• Mean value theorem, implicit and inverse function theorems
• Optimization: gradient, Hessian, maxima and minima of functions on R^n
• Curves in R^n
• Iterated integrals, Fubini theorem
• Volume integrals, integrable sets, integrable functions
• Oriented line integral of a vector field
• Green’s theorem on the plane
• Conservative vector fields, area formula on the plane

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

1) understand basic concepts of topology, distinguish open and close sets in R^n
2) analyse convergence of sequences in R^n and continuity of multidimensional mappings
3) handle partial derivatives and Jacobians
4) discuss basic properties of differentiable functions of several variables
5) compute iterated and volume integrals
6) apply Green's theorem on the plane

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

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

Assessment Description: Examination: A closed book examination to take place at the end of the module.
Assignment 1: formed of a number of coursework assignments along with participation in the module during the semester. The assignments will develop student's skills in abstract thinking, advanced problem solving, and developing complex logical arguments.

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-203 Professional Development and Career Planning

Credits: 0 **Session:** 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Miss VV Wislocka, Mr N Clarke

Format: 6 hours consisting of a mix of podcasts, recorded lectures and Zoom sessions and optional 1-2-1 meetings and weekly drop-in sessions. Prior to the change it was 6 hours of face to face delivery via PC labs, and a 1-2-1 meeting where applicable / requested.

Delivery Method: Students are required to attend all taught sessions and the one to one meeting (if required). These modules have no credit attached. However to ensure engagement with the content a compulsory quiz will be added in session 5. These modules are delivered through online resources, scheduled Zoom sessions and 1-2-1 meetings. There is self-directed learning required using online resources provided.

Module Aims: This module is a mandatory module for all students who have enrolled (or transferred) onto the Science Industrial Placement Year but is also available to all other maths students. The module focuses on the underpinning and fundamental requisites required to gain, enter and progress through a successful career. Learners will be introduced to (a) sourcing placements, CV writing, and application techniques; (b) Interview techniques, how to pitch yourself and be successful; (c) workplace fundamentals and IP awareness, behaviors and expectations; and, (d) Key employability skills; getting the most from your job or Industrial Placement.

Module Content: The module will focus on the key requirements to gain and be successful whilst on a placement or in work. Directed and self -directed activity will address the following topics:

1) Science Industrial Placements - What they are, how to search and how to apply.

2) CV writing, cover letters and application processes.

3) Assessment centres, interview techniques and a mock interview.

4) Recognizing and developing employability skills.

5) reflecting and maximising your placement experience.

6) one to one meeting with careers and employability officers.

Intended Learning Outcomes: By the end of this module, students will be able to:

1) Be aware of and possess the essential skills needed to secure placement opportunities; alongside having the skills to apply for relevant jobs and placements.

2) Have a general understanding of an interview process and what tools and attributes make a good interview.

3) Discuss and share what is expected within the workplace including behavioral and professional conduct.

4) Identify personal employability skills and how these will be used in a workplace setting.

5) Understand the need to reflect and maximise the placement experience in future career decisions.

Assessment: Other (100%)

Assessment Description: These modules are delivered through online resources, scheduled Zoom sessions and 1-2-1 meetings. There is self-directed learning required using online resources provided. Students who do not attend and have no valid reason will not be permitted to continue on a Science Industrial Placement Year programme of study.

Moderation approach to main assessment: Not applicable

Assessment Feedback: N/A

However feedback on progress and the progression through the module will be provided in the one to one mandatory meeting, and via the quiz.

Failure Redemption: Successful completion of this module depends upon satisfactory attendance at, and engagement with, all sessions. Therefore there will normally be no opportunity to redeem failure. However, special provision will be made for students with extenuating or special circumstances.

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

Module code reserved by s.j.toomey on 10/02/2015 09:40:10

MA-211 Vector Spaces

Credits: 15 Session: 2022/23 September-January

Pre-requisite Modules: MA-101; MA-102; MA-111; MA-112

Co-requisite Modules: MA-201

Lecturer(s): Prof T Brzezinski

Format: 44

Delivery Method: On campus

Module Aims: This module covers the abstract theory of vector spaces and inner product spaces together with the theory of linear transformations.

Module Content: Review of formal definition of vector spaces. Subspaces.
Linear independence, spanning sets, bases and dimension.
Linear transformations and their relation to matrices.
Dual space and dual bases.
Rank and nullity; the formal definition and properties of a determinant.
Eigenvalues, eigenvectors, characteristic equation and diagonalizability.
Inner products and norms (for real and complex vector spaces).
Orthogonal and orthonormal sets.
The Gram-Schmidt orthonormalization process.
Orthogonal matrices, complements and projections.
Bilinear transformations and tensor products.

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

1) explain the concepts of linear independence, bases and dimension in a vector space,
2) manipulate and characterise linear transformations,
3) find eigenvalues and eigenvectors for a given linear transformation,
4) explain the diagonalisation of a linear transformation,
5) define the concept of an inner product and an inner product space,
6) explain the abstract concept of orthogonal vectors,
8) prove standard results involving vector spaces and inner product spaces.

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

Assessment Description: Examination: A closed book examination to take place at the end of the module.
Assignment 1: formed of a number of coursework assignments along with participation in the module during the semester. The assignments will develop student's skills in abstract thinking, advanced problem solving, and developing complex logical arguments.

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-212 Groups and Rings

Credits: 15 Session: 2022/23 January-June

Pre-requisite Modules: MA-101; MA-102; MA-111; MA-112

Co-requisite Modules: MA-201; MA-202; MA-211

Lecturer(s): Dr EJ Beggs

Format: 44

Delivery Method: On campus

Module Aims: This course approaches the theory of groups and rings as abstract algebraic objects.

Module Content: Binary operations and monoids. Groups, order of a group, order of an element.
Subgroups, cosets, Lagrange's theorem.
Homomorphisms, kernels, first isomorphism theorem.
Representations and actions. Invariant subspaces, G-maps, Schur's lemma.
Cyclic groups, products of groups.
Permutations, cycles, signs, symmetry.
Rings, homomorphisms, zero divisors and cancellation.
Quaternions, ideals and quotient rings.
Unique factorization domains and Euclidean rings.

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

1) recognize and manipulate examples of groups and rings,
2) calculate orders of group elements, recognize units in rings,
3) apply and exploit standard definitions in abstract algebra, e.g. normal subgroup, maximal ideal,
4) calculate with coset decompositions,
5) recognize and establish basic properties of representations,
6) describe products of cyclic groups, manipulate permutations in terms of cycles,
7) compare and contrast the structure of different groups and rings,

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

Assessment Description: Examination: A closed book examination to take place at the end of the module.
Assignment 1: formed of a number of coursework assignments along with participation in the module during the semester. The assignments will develop student's skills in abstract thinking, advanced problem solving, and developing complex logical arguments.

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-241 Differential Equations

Credits: 15 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr C Mercuri, Dr AJ Bruce

Format: Lectures and support classes

Delivery Method: Lectures, reinforced by support classes and regular formative/summative coursework assignments

Module Aims: This module is an elementary course on the theory and methods for ordinary differential equations (ODEs). It combines a rigorous approach to the existence and uniqueness of solutions with methods for finding explicit solutions to ODEs. Applications are discussed to concrete problems in Physics and Biology.

Module Content: This module focuses on ordinary differential equations (ODEs). It combines questions about existence, uniqueness and properties of solutions to ODEs with finding explicit solutions to linear and nonlinear ODEs.

1. Ordinary Differential Equations and real world problems
2. Lipschitz condition versus Differentiability
3. Existence and Uniqueness of solutions
4. The Cauchy Problem for higher order ODEs
5. Linear equations with constant coefficients
6. Linear equations with variable coefficients
7. Some elementary nonlinear ODEs
8. Boundary value problems
9. Solutions by infinite series
10. Qualitative properties of solutions - Sturm theorems

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

1) recognise standard forms of ODEs and find solutions
2) identify existence and uniqueness issues for ODEs
3) connect the theory of ODEs with related topics in Linear Algebra and Mathematical Analysis

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

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

Assessment Description: Examination: is a written, closed-book examination at the end of the module.
Coursework 1: is formed of a number of coursework assignments during the semester along with participation in the module during the semester. The assignments will develop skills in problem solving and constructing logically structured written arguments.

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

Available to visiting and exchange students

MA-243 Mathematical Modelling: Theory and Practice

Credits: 15 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules: MA-241

Lecturer(s): Dr GG Powathil

Format: 22 Lectures, 11 PC labs, 11 modelling workshops

Delivery Method: Lectures, interactive modelling workshops and PC labs where there will be a focus on model formation and analysis.

Module Aims: This module focusses on developing mathematical models of real world problems. It considers how to create a model, how to simulate and analyse the model and how to use the model to answer questions about the world around us. It will consider a diverse selection of examples from a range of areas including biology, mechanics, medicine and physics. There will be weekly modelling workshops and PC labs in which students will actively create and analyse their own models. The module will culminate in a group project in which students will create, analyse and simulate a model of their own.

Module Content: The module will have a clear practical modelling focus and will be predominantly taught through examples taken from biology, mechanics, medicine and physics as well as other areas of science. Specific techniques and approaches covered will depend on the examples covered.

Revision of modelling: Modelling cycle, simple model examples, use of differential equations, use of MATLAB.
Differential Equations: Classification of differential equations - ordinary vs partial, linear vs non-linear, order, homogeneous vs non-homogeneous, boundary value problems, initial value problems; Identifying if an analytical or numerical approach is appropriate; Importance of the existence and uniqueness of solutions; Systems of equations; Phase portraits. (Other techniques as appropriate to the models studied).
Numerical methods: Use of MATLAB to simulate differential equations, revision of numerical methods, the Euler-Method for ODEs. (Other example methods as appropriate to the models studied.)

Intended Learning Outcomes: By the end of this module students should be able to:
1) Analyse a real world problem to extract essential information for model formation.
2) Select appropriate modelling approaches based on the scenario to be modelled and the information required from the model.
3) Evaluate the strengths and weaknesses of a particular model for a given scenario.
4) Formulate a suitable differential equation to describe a scenario.
5) Simulate a differential equation based model using appropriate computational techniques.
6) Analyse a differential equation based model using suitable analytical approaches.

Assessment: Examination (40%)
Group Work - Project (40%)
Coursework 1 (20%)
Resit Assessment: Examination (Resit instrument) (100%)

Assessment Description: Exam: A closed book exam at the end of the module to assess students understanding of mathematical techniques, their ability to analyse real world problems and their ability to select appropriate computational techniques.
Group Work Project: A group project to construct, analyse and simulate a real world problem and investigate some aspect using MATLAB. The work will be presented as a written report.
Coursework 1: Composed of a number of small problem solving, modelling and computing assignments spread through the term.

Resit: A closed book exam assessing mathematical techniques, skills at model building and analysis, skills in computing in MATLAB.

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

Assessment Feedback: For the coursework assignments and computing 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-252 Probability Theory

Credits: 15 Session: 2022/23 September-January

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Prof C Yuan

Format: 44

Delivery Method: On campus

Module Aims: An introduction to fundamental probabilistic concepts and methods such as probability spaces, expectation and variance of random variables, independence, law of large numbers.

Module Content: - Independent random variables, expectation, including additive and multiplicative properties of expectation;
- Moments, variance, covariance;
- sigma-algebras, minimal sigma-algebra containing a given collection of sets, Borel sigma-algebra;
- Measures, Lebesgue measure, probability measures;
- Random variables (measurable functions), sufficient conditions of measurability, operations with random variables preserving measurability, image measure, joint distribution of a collection of random variables;
- Expectation of a random variable, integration of a random variable in terms of integration with respect to its distribution;
- Continuous random variables, examples: uniform distribution, Gaussian (normal) distribution, gamma distributions, in particular, exponential distribution, Laplace distribution, Cauchy distribution;
- Moments of a random variable, variance, Chebyshev and Markov inequalities, characteristic function (Fourier transform);
- Independence of random variables, expectation of a product of independent random variables, Bienaymé's identity;
- Weak law of large numbers.
- Central Limit Theorem.

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

1) explain the fundamentals of probability theory;
2) know that probability theory is based on measure theory;
3) understand the concept of a random variable;
4) formulate given problems in terms of probabilities;
5) discuss expectation and integral;
6) understand independence.

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

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

Assessment Description: Examination: is a written, closed-book examination at the end of the module.
Coursework 1: is formed of a number of coursework assignments during the semester along with participation in the module during the semester. The assignments will develop skills in problem solving and constructing complex logical written arguments.

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-282 Game Theory and Optimization

Credits: 15 Session: 2022/23 January-June

Pre-requisite Modules:

Co-requisite Modules:

Lecturer(s): Dr AJ Bruce

Format: Lectures and support classes

Delivery Method: On campus

Module Aims: Game theory is about strategies for making decisions, in cases where there are two or more players. The complication is that the possible choices for the other players may influence a particular player's choice of strategy. Economics has many examples of the application of game theory, but it has also been applied to areas as diverse as global politics (e.g. the Cuban missile crisis) and evolutionary biology (e.g. the hawks and doves game).

Optimisation is about finding the optimum strategy (e.g. maximising profit for a company) by maximising or minimising a function in a specified domain. Again it has applications in economics, but it has also been used in engineering design (e.g. genetic algorithms were used to design the superconducting magnets in the CERN particle accelerator) and molecular biology (modelling shapes of molecules by minimising energy).

Module Content: Cooperative and non-cooperative games.
Strategies.
Examples of games, including prisoners dilemma and the Cuban missile crisis.
The Nash equilibrium.
Games in economics - modelling competing agents.
Changing strategies over time - the Hawk / Dove / Retaliator game.
Optimisation problems and methods.
Linear programming.
Flow maximisation on networks.

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

1) recognise when a game theory analysis of a situation is appropriate.
2) analyse strategies for games.
3) find optimal strategies (e.g. Nash equlibria) in simple cases.
4) recognise optimisation problems, and assess what methods might be used to solve them.
5) use linear programming to solve appropriate optimisation problems.

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

Assessment Description: Examination: this is a written, closed book examination at the end of the module. Exam questions deal with both theoretical concepts and concrete calculations in a variety of real-world application-based settings, including business and economics, biology, and networks.

Coursework 1: comprises 3 coursework assignments during the semester along with components for participation and carrying out reflective exercises based on feedback. The coursework assignments are also drawn from real-world applications.

Both the examination and the coursework incorporate significant authentic assessment components by asking the students to analyze novel problems, select and apply appropriate methods, and explain the resulting calculations.

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

Available to visiting and exchange students

MA-292 Statistical Data Analysis

Credits: 15 Session: 2022/23 January-June

Pre-requisite Modules: MA-192

Co-requisite Modules:

Lecturer(s): Dr K Evans

Format: Primarily lectures, additional support classes and lab classes.

Delivery Method: Lectures and lab classes on campus: 3 lectures and 1 lab class weekly.

Module Aims: This module concentrates on non-parametric statistics and techniques used to treat categorical data. In particular, the module covers a variety of statistical tests, criteria for choosing appropriate tests and the use of statistical software in order to deal with large data sets.

Module Content: The module will cover the following topics:

Non-parametric techniques including bootstrapping, the Wilcoxon Signed-Rank test, the Mann-Whitney U test, the Kruskal Wallis test and the Friedman test;

Chi-square tests for goodness-of-fit and association, Fisher's exact test;

Generalised linear models;

Factor analysis and principal component analysis;

Statistical computing.

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

1) Use non-parametric methods to construct confidence intervals;
2) Test hypotheses in the non-parametric setting using the Wilcoxon Signed-Rank test, the Mann-Whitney U test, the Kruskal Wallis test and the Friedman test;
3) Perform chi-square tests for goodness-of-fit and association;
4) Use Fisher's exact test where appropriate;
5) Perform generalised linear models;
6) Reduce appropriate large data sets using factor analysis and principal component analysis.
7) Choose the appropriate statistical test;
8) Use statistical software to deal with large data sets.

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 to take place at the end of the module.
Component 2 is formed of a number of coursework assignments along with participation in classes during the semester. The assignments will develop skills in problem solving, applying techniques to real world problems and understanding the use of computers to investigate problems.
Component 3 is formed of a computing based controlled test to assess skills in the use of computers to investigate and analyse real world problems.

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

Assessment Feedback: For the coursework 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