Module Descriptor

Title	Mathematics for Data Science		
Session	2024/25	**Status**	Published
Code	COMP09122	**SCQF Level**	9
Credit Points	20	**ECTS (European Credit Transfer Scheme)**	10
School	**Computing, Engineering and Physical Sciences**		
Module Co-ordinator	Ryan P Meeten		

Summary of Module

This module develops the underpinning mathematical knowledge for data scientists, covering key aspects and applications of linear algebra and multivariable calculus with a focus on optimisation.

The module will emphasise intuition and applications rather than a theorem and proof-based treatment.

Mathematics for Data Science is designed to be accessible to students who have a working knowledge of single-variable calculus and matrices. Revision and bridging material will be provided to aid recall and mastery of these prerequisite skills.

Teaching will begin with a self-contained ¬recap of matrix algebra, including the solution of systems of linear equations. The concepts of linear independence, span, basis and dimension will be motivated and discussed. The notion of eigenvectors and eigenvalues will be covered and applied to the diagonalisation of matrices. We will discover orthogonal matrices and explore their utility in numerical methods, such as QR factorisation for finding eigenvalues and eigenvectors numerically. The Gram-Schmidt orthogonalisation procedure and Householder transformations will be introduced. Each topic is broadly associated with a fundamental matrix factorisation, so decompositions into LU,QR,SDS^(-1) and the singular value decomposition (SVD) will arise organically. The SVD provides a natural vehicle for the discussion of principal component analysis (PCA).

The module will also provide an overview of some of the essential calculus of functions of several variables, such as partial derivatives and the gradient, as well as Jacobian and Hessian matrices which arise in optimisation. The technique of gradient descent and its variants will be introduced as a key optimisation procedure. The basic ideas of multivariate integration will be discussed, as well as numerical techniques for integration, including the Monte Carlo approach.

Throughout, all mathematics will be underpinned by computation in Python in tandem with the theory. This will allow students to develop expertise with the NumPy library at the same time as learning the requisite analytical skills.

The module will be delivered using an approach that prioritises freedom of choice in the student experience: the theory lectures will be presented by the lecturer in a classroom with a simultaneous broadcast, with the option for students to attend on site or online. Additionally, live recordings will be captured for asynchronous viewing.

Module Delivery Method	On-Campus[1] ☒	Hybrid[2] ☒	Online[3] ☐	Work -Based Learning[4] ☐
Campuses for Module Delivery	☐ Ayr ☐ Dumfries	☐ Lanarkshire ☒ London ☒ Paisley	☐ Online / Distance Learning ☐ Other (specify)	

Terms for Module Delivery	Term 1	☒	Term 2	☒	Term 3	☒
Long-thin Delivery over more than one Term	Term 1 – Term 2	☐	Term 2 – Term 3	☐	Term 3 – Term 1	☐

Learning Outcomes	
L1	Show fluency with the manipulation of matrices by hand
L2	Work with matrices and higher dimensional arrays in Python using NumPy.
L3	Formulate and solve problems using linear algebra techniques.
L4	Understand and apply optimisation techniques for functions of several variables
L5	Integrate functions of several variables by hand and computationally.

Employability Skills and Personal Development Planning (PDP) Skills	
SCQF Headings	**During completion of this module, there will be an opportunity to achieve core skills in:**
Knowledge and Understanding (K and U)	**SCQF 9** Linear algebra, multivariable calculus, numerical computation, Python programming
Practice: Applied Knowledge and Understanding	**SCQF 9** Applying the mathematical and computational techniques to solving real-world problems with data, such as the optimisation, integration and cleaning of data using numerical and statistical libraries
Generic Cognitive skills	**SCQF 9** Formulation of problems in mathematical language, interpreting complex information, making simplifying assumptions, justifying logical arguments, computational and mathematical skills.

[1] Where contact hours are synchronous/ live and take place fully on campus. Campus-based learning is focused on providing an interactive learning experience supported by a range of digitally-enabled asynchronous learning opportunities including learning materials, resources, and opportunities provided via the virtual learning environment. On-campus contact hours will be clearly articulated to students.

[2] The module includes a combination of synchronous/ live on-campus and online learning events. These will be supported by a range of digitally-enabled asynchronous learning opportunities including learning materials, resources, and opportunities provided via the virtual learning environment. On-campus and online contact hours will be clearly articulated to students.

[3] Where all learning is solely delivered by web-based or internet-based technologies and the participants can engage in all learning activities through these means. All required contact hours will be clearly articulated to students.

[4] Learning activities where the main location for the learning experience is in the workplace. All required contact hours, whether online or on campus, will be clearly articulated to students

Communication, ICT and Numeracy Skills	**SCQF 9** Setting out well justified mathematical arguments, writing clear pseudocode, explaining complex ideas in simple terms. Programming in python, the use of numerical and statistical libraries. Mathematical skills in calculus and linear algebra.
Autonomy, Accountability and Working with Others	**SCQF 9** Working to deadlines, being responsible for identifying and filling own knowledge gaps, engaging with bridging material, being self-motivated, displaying academic integrity, working as part of a team during problem solving sessions

Prerequisites	**Module Code**	**Module Title**
	Other	
Co-requisites	**Module Code**	**Module Title**

Learning and Teaching	
In line with current learning and teaching principles, a 20-credit module includes 200 learning hours, normally including a minimum of 36 contact hours and maximum of 48 contact hours.	
Learning Activities During completion of this module, the learning activities undertaken to achieve the module learning outcomes are stated below:	**Student Learning Hours** (Note: Learning hours include both contact hours and hours spent on other learning activities)
Lecture / Core Content Delivery	24
Laboratory / Practical Demonstration / Workshop	24
Independent Study	152
Please select	
Please select	
Please select	
TOTAL	200

Indicative Resources
The following materials form essential underpinning for the module content and ultimately for the learning outcomes: • openstax Calculus Volume 3 (freely available) • openstax College Algebra (freely available) • Strang, G. (2020) Linear Algebra for Everyone. Cambridge: CUP
(N.B. Although reading lists should include current publications, students are advised (particularly for material marked with an asterisk*) to wait until the start of session for confirmation of the most up-to-date material)

Attendance and Engagement Requirements
In line with the Student Attendance and Engagement Procedure, Students are academically engaged if they are regularly attending and participating in timetabled on-campus and online teaching sessions, asynchronous online learning activities, course-related learning resources, and complete assessments and submit these on time. **For the purposes of this module, academic engagement equates to the following:** Attending all timetabled synchronous classes and engagement with asynchronous learning activities and resources.

Equality and Diversity
The University's Equality, Diversity and Human Rights Procedure can be accessed at the following link: UWS Equality, Diversity and Human Rights Code. Aligned with the overall commitment to equality and diversity stated in the Programme Specifications, the module supports equality of opportunity for students from all backgrounds and with different learning needs. Using our VLE, learning materials will be presented electronically in formats that allow flexible access and manipulation of content (part-time and distant learning students should check with their programme leader for any queries). The module complies with University regulations and guidance on inclusive learning and teaching practice. Specialist assistive equipment, support provision and adjustments to assessment practice will be made in accordance with UWS policy and regulations.
(N.B. Every effort will be made by the University to accommodate any equality and diversity issues brought to the attention of the School)

Supplemental Information

Divisional Programme Board	**Computing**
Overall Assessment Results	☐ **Pass / Fail** ☒ **Graded**
Module Eligible for Compensation	☐ **Yes** ☒ **No** **If this module is eligible for compensation, there may be cases where compensation is not permitted due to programme accreditation requirements. Please check the associated programme specification for details.**
School Assessment Board	Business & Applied Computing
Moderator	TBA
External Examiner	A Jindal
Accreditation Details	N/A
Module Appears in CPD catalogue	☐ **Yes** ☒ **No**
Changes / Version Number	1.0

Assessment (also refer to Assessment Outcomes Grids below)
Assessment 1
A written class test in which students will need to demonstrate their understanding of the fundamental data science topics and methodologies. (30%)
Assessment 2

A portfolio (practical) in which students will use a real-life dataset and need to analyse, design, and apply data science methodology to gain insight into the data. (70%)
Assessment 3
(N.B. (i) Assessment Outcomes Grids for the module (one for each component) can be found below which clearly demonstrate how the learning outcomes of the module will be assessed. (ii) An indicative schedule listing approximate times within the academic calendar when assessment is likely to feature will be provided within the Student Module Handbook.)

Component 1							
Assessment Type	**LO1**	**LO2**	**LO3**	**LO4**	**LO5**	**Weighting of Assessment Element (%)**	**Timetabled Contact Hours**
Course work	☒	☒	☒	☐	☒	50	

Component 2							
Assessment Type	**LO1**	**LO2**	**LO3**	**LO4**	**LO5**	**Weighting of Assessment Element (%)**	**Timetabled Contact Hours**
Class test	☐	☒	☒	☒	☒	50	2

Component 3							
Assessment Type	**LO1**	**LO2**	**LO3**	**LO4**	**LO5**	**Weighting of Assessment Element (%)**	**Timetabled Contact Hours**
	☐	☐	☐	☐	☐		
Combined total for all components						100%	2 hours

Change Control

What	**When**	**Who**
Further guidance on aggregate regulation and application when completing template	16/01/2020	H McLean
Updated contact hours	14/09/21	H McLean
Updated Student Attendance and Engagement Procedure Updated UWS Equality, Diversity and Human Rights Code	19/10/2023	C Winter
Guidance Note 23-24 provided General housekeeping to text across sections.	12/12/23	D Taylor