INTERNATIONAL QUALIFICATIONS

AND ASSESSMENT CENTRE (IQAC)

«Approved»

2025 y. «16» 06

Programme	LEVEL 4 EXTENDED DIPLOMA IN DATA SCIENCE		
Unit Number/ Unit Title	UNIT 2 LINEAR ALGEBRA AND CALCULUS		
Cohort Code:	L04LAC-U2		
Unit Level	Level 4		
Total GLH	Total qualification time 200/ Total Guided learning hours 90/ Self-guided learning hours 110		
Credits	20 CATS/ 10 ECTS		
Lecturer			
Start Date		**End Date**	

Unit Aims	This module introduces the essential mathematical principles of linear algebra and calculus as applied in data science. These topics are critical for understanding machine learning algorithms, optimization methods, and advanced data analysis techniques. Learners will explore concepts through theoretical learning and practical applications.
Differentiation Strategies *(e.g. planned activities or support for individual learners according to their needs)*	The total number of students to be in the lesson is approximately 20. This is a multicultural group of students predominantly between the ages of 24 – 45, with numerous ethnic, gender, and creed background. These are UK academic level 5 students; hence it is assumed that they have practical, theoretical, or technological knowledge and understanding of a subject or field of work to find ways forward in broadly defined, complex contexts. These students must be able to generate information, evaluate, synthesise the use information from a variety of sources. Various approaches to addressing the various identified students needs will be adopted throughout the lesson. Such will include:- 1. Progressive tasks 2. Digital resources 3. Verbal support 4. Variable outcomes

	5. Collaborative learning 6. Ongoing assessment 7. Flexible-pace learning
Equality & Diversity	Variety of teaching techniques will be employed to ensure that the needs of each individual learner are met.
Safeguarding & Prevent	Safeguarding policies and the Prevent duty are strictly observed to ensure the safety, well-being, and inclusivity of all students and staff.
Health & Safety	SIRM H&S policies will be maintained.
Learning Resources	**Teaching and Learning Materials** • Strang, G. (2016). Introduction to Linear Algebra. Wellesley-Cambridge Press. • Stewart, J. (2015). Calculus: Early Transcendentals. Cengage Learning. • Lay, D. C., Lay, S. R., & McDonald, J. J. (2016). Linear Algebra and Its Applications. Pearson. • Raschka, S., & Mirjalili, V. (2019). Python Machine Learning. Packt Publishing.

Learning Outcome	Assessment Criteria
LO1. Understand fundamental concepts in linear algebra.	1.1 Define vectors, matrices, and basic operations. 1.2 Solve systems of linear equations and apply matrix factorization.
LO2. Apply linear algebra in machine learning contexts.	2.1 Use vector spaces and eigenvalues in dimensionality reduction. 2.2 Interpret the role of linear transformations in ML algorithms.
LO3. Understand core principles of calculus relevant to optimization.	3.1 Explain differentiation, partial derivatives, and gradients. 3.2 Apply calculus to optimization techniques such as gradient descent.
LO4. Link mathematical concepts to data science applications.	4.1 Analyze real-world data problems using mathematical models. 4.2 Translate mathematical problems into Python based solutions.
LO5. Demonstrate mathematical problem solving using computational tools.	5.1 Use Python or Jupyter notebooks to solve math-based exercises. 5.2 Visualize mathematical functions and operations.

No	Learning Outcome / Topic	Learning and Teaching Activities	Which assessment criteria does the session relate to?	Day/month/year/ signature
1.	**Vectors & Vector Operations**	**Vectors & Vector Operations** Definition, addition, scalar multiplication, dot product	LO1: Fundamental Linear Algebra	
2.	**Matrices & Basic Operations**	**Matrices & Basic Operations** Matrix addition, multiplication, transpose, properties	LO1: Fundamental Linear Algebra	
3.	**Systems of Linear Equations**	**Systems of Linear Equations** Gaussian elimination, row echelon form	LO1: Fundamental Linear Algebra	
4.	**Matrix Factorization**	**Matrix Factorization** LU decomposition, applications in solving linear systems	LO1: Fundamental Linear Algebra	
5.	**Determinants & Inverses**	**Determinants & Inverses** Properties, computation, and significance in linear algebra	LO1: Fundamental Linear Algebra	
6.	**Vector Spaces & Subspaces**	**Vector Spaces & Subspaces** Basis, dimension, linear independence	LO2: Linear Algebra in Machine Learning	
7.	**Eigenvalues & Eigenvectors**	**Eigenvalues & Eigenvectors** Definition, computation, geometric interpretation	LO2: Linear Algebra in Machine Learning	
8.	Half-Term Exam	- Review of LO1 topics - Practice questions and mock assessment - **Half-term assessment** based on LO1 (theory)	LO1 LO2	

9.	**Principal Component Analysis (PCA)**	**Principal Component Analysis (PCA)** Dimensionality reduction using eigenvectors	LO2: Linear Algebra in Machine Learning	
10.	**Singular Value Decomposition (SVD)**	**Singular Value Decomposition (SVD)** Applications in NLP (Latent Semantic Analysis) and image compression	LO2: Linear Algebra in Machine Learning	
11.	**Linear Transformations**	**Linear Transformations** Matrix representations, transformations in neural networks	LO2: Linear Algebra in Machine Learning	
12.	**Functions & Limits**	**Functions & Limits** Continuity, limits, and their importance in ML	LO3: Core Calculus for Optimization	
13.	**Differentiation Basics**	**Differentiation Basics** Derivatives, rules (chain rule, product rule)	LO3: Core Calculus for Optimization	
14.	Final Exam Preparation & Review	- Comprehensive review of all learning outcomes - Practice questions and revision of key topics		
15.	Final Exam	- **Final-term assessment** covering all learning outcomes (theory and practical elements)		
16.	Feedback & Reflection	- Review of final exam - Individual feedback on performance - Reflective discussion on key learning points		
17.	**Partial Derivatives & Gradients**	**Partial Derivatives & Gradients** Multivariable functions, gradient vectors	LO3: Core Calculus for Optimization	

18.	**Optimization Techniques**	**Optimization Techniques** Gradient descent, stochastic gradient descent (SGD)	LO3: Core Calculus for Optimization	
19.	**Convexity & Optimization**	**Convexity & Optimization** Convex functions, local vs. global minima	LO3: Core Calculus for Optimization	
20.	**Regression Models & Least Squares**	**Regression Models & Least Squares** Linear regression from a linear algebra perspective	LO4: Math-to-Data Science Applications	
21.	**Regularization (L1/L2 Norms)**	**Regularization (L1/L2 Norms)** Ridge and Lasso regression, geometric interpretation	LO4: Math-to-Data Science Applications	
22.	**Neural Networks & Backpropagation**	**Neural Networks & Backpropagation** Calculus in training deep learning models	LO4: Math-to-Data Science Applications	
23.	Half-Term Exam	**Capstone Project** Implement gradient descent from scratch for regression		
24.	**Markov Chains & Transition Matrices**	**Markov Chains & Transition Matrices** Applications in recommendation systems	LO4: Math-to-Data Science Applications	
25.	**Graph Theory Basics**	**Graph Theory Basics** Adjacency matrices, applications in social networks	LO4: Math-to-Data Science Applications	
26.	**Python for Linear Algebra**	**Python for Linear Algebra** NumPy (`np.linalg`), vectorized operations	LO5: Computational Problem Solving	
27.	**Solving Linear Systems in Python**	**Solving Linear Systems in Python** `np.solve`, `scipy.linalg.lu`	LO5: Computational Problem Solving	
28.	**Eigenvalue Computation** and **Calculus Visualization**	**Eigenvalue Computation** `np.linalg.eig`, PCA implementation	LO5: Computational Problem Solving	

		Calculus Visualization Plotting derivatives/gradients with Matplotlib		
29.	Final Exam Preparation & Review	LO1, LO2, LO3, LO4, LO5	LO1, LO2, LO3, LO4, LO5	
30.	Final Exam		LO1, LO2, LO3, LO4, LO5	