INTERNATIONAL QUALIFICATIONS

AND ASSESSMENT CENTRE (IQAC)

«Approved»

2025 y. «16» avgust

Programme	LEVEL 4 EXTENDED DIPLOMA IN ARTIFICIAL INTELLIGENCE		
Unit Number/ Unit Title	UNIT 3 MATHEMATICS & LOGICAL REASONING		
Cohort Code:	L04MLR-U3		
Unit 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	The unit aims to equip students with the programming skills necessary to implement AI algorithms, using Python as the primary programming language. Students will gain hands-on experience in designing, implementing, and testing AI-based solutions, including the application of machine learning techniques and the use of popular AI development tools and libraries. The ultimate goal is to enable learners to become proficient in translating AI concepts and theories into practical, working AI applications that can address real-world problems. In addition, the unit aims to build a solid foundation in mathematical concepts and logical reasoning critical for understanding and developing AI algorithms. Learners will explore topics such as linear algebra, probability, and optimization, which form the backbone of many AI techniques. By mastering these foundational mathematical skills, students will be better equipped to comprehend the intricate underpinnings of AI systems and to design more robust and effective AI-powered solutions.
Differentiation Strategies	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

(e.g. planned activities or support for individual learners according to their needs)	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** • "Mathematics for Machine Learning" by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong • "Linear Algebra and Its Applications" by Gilbert Strang • "Probability and Statistics for Engineers and Scientists" by Ronald E. Walpole.

Learning Outcome	Assessment Criteria
LO1. Understand essential mathematical concepts for AI	1.1: Explain the role of linear algebra in AI. 1.2: Discuss the importance of probability and statistics in machine learning.
LO2. Apply mathematical techniques to solve AI problems.	2.1: Utilize calculus in the optimization of AI models. 2.2: Apply probability theory to model uncertainty in AI.
LO3. Develop logical reasoning and problem-solving skills.	3.1: Solve problems using formal logic and set theory. 3.2: Implement algorithms to solve computational problems logically.
LO4. Integrate mathematical tools in AI development.	4.1: Use matrix operations in AI algorithm development. 4.2: Apply statistical methods to evaluate AI model performance.

No	Learning Outcome / Topic	Learning and Teaching Activities	Which assessment criteria does the session relate to?	Day/month/year/ signature
1.	**Mathematics in AI: Overview**	**Mathematics in AI: Overview** – Why math is foundational for AI.	LO1: Essential Mathematical Concepts for AI	
2.	**Linear Algebra Basics**	**Linear Algebra Basics** – Vectors, matrices, tensors, and their notation.	LO1: Essential Mathematical Concepts for AI	
3.	**Matrix Operations**	**Matrix Operations** – Addition, multiplication, transposition, and inverses.	LO1: Essential Mathematical Concepts for AI	
4.	**Eigenvalues & Eigenvectors**	**Eigenvalues & Eigenvectors** – Geometric interpretation and applications in AI.	LO1: Essential Mathematical Concepts for AI	
5.	**Probability Fundamentals**	**Probability Fundamentals** – Sample spaces, Bayes' theorem, conditional probability.	LO1: Essential Mathematical Concepts for AI	
6.	**Descriptive Statistics**	**Descriptive Statistics** – Mean, variance, standard deviation, and distributions.	LO1: Essential Mathematical Concepts for AI	
7.	**Statistical Inference**	**Statistical Inference** – Hypothesis testing, p-values, and confidence intervals.	LO1: Essential Mathematical Concepts for AI	
8.	Half-Term Exam	- Review of LO1 topics - Practice questions and mock assessment - **Half-term assessment** based on LO1 (theory)		
9.	**Calculus for AI**, **Optimization in AI**	**Calculus for AI** – Derivatives, gradients, and partial differentiation. **Optimization in AI** – Gradient descent, convexity, and loss functions.	*LO2: Mathematical Techniques for AI Problems*	
10.	**Multivariable Calculus**. **Probability Distributions**	**Multivariable Calculus** – Jacobians, Hessians, and their role in deep learning. **Probability**	LO2: Mathematical Techniques for AI Problems	

		Distributions – Gaussian, binomial, Poisson, and their AI use cases.		
11.	**Bayesian Networks**	**Bayesian Networks** – Probabilistic graphical models for reasoning under uncertainty.	LO2: Mathematical Techniques for AI Problems	
12.	**Markov Chains & HMMs**	**Markov Chains & HMMs** – Stochastic processes in NLP and robotics.	LO2: Mathematical Techniques for AI Problems	
13.	**Information Theory**	**Information Theory** – Entropy, KL divergence, and applications in AI.	LO2: Mathematical Techniques for AI Problems	
14.	Final Exam Preparation & Review	- Comprehensive review of all learning outcomes - Practice questions and revision of key topics	LO1, LO2	
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.	**Propositional & Predicate Logic**	**Propositional & Predicate Logic** – Logical operators, truth tables, quantifiers.	LO3: Logical Reasoning & Problem-Solving	
18.	**First-Order Logic in AI**	**First-Order Logic in AI** – Knowledge representation (e.g., rule-based systems).	LO3: Logical Reasoning & Problem-Solving	
19.	**Set Theory & Relations**	**Set Theory & Relations** – Unions, intersections, functions, and equivalence relations.	LO3: Logical Reasoning & Problem-Solving	
20.	**Graph Theory Basics**	**Graph Theory Basics** – Trees, cycles, and graph traversals (BFS/DFS).	LO3: Logical Reasoning & Problem-Solving	
21.	**Algorithmic Thinking**	**Algorithmic Thinking** – Time complexity (Big-O notation) and space complexity.	LO3: Logical Reasoning & Problem-Solving	
22.	**Recursion & Dynamic Programming**	**Recursion & Dynamic Programming** – Solving problems like Fibonacci or knapsack.	LO3: Logical Reasoning & Problem-Solving	

		Constraint Satisfaction Problems – Backtracking, heuristics (e.g., sudoku solvers).		
23.	Half-Term Exam	Project work outcoming from LO1,2,3		
24.	**Matrix Factorization**	**Matrix Factorization** – SVD, PCA for dimensionality reduction.	LO4: Integrating Math Tools in AI Development	
25.	**Linear Regression from Scratch and Statistical Evaluation of Models**	**Linear Regression from Scratch** – Deriving least squares with calculus. **Statistical Evaluation of Models** – MSE, R^2, confusion matrices, ROC curves.	LO4: Integrating Math Tools in AI Development	
26.	**Covariance & Correlation and Probability in ML**	**Covariance & Correlation** – Measuring feature relationships in datasets. **Probability in ML** – Naïve Bayes classifiers and probabilistic ML models.	LO4: Integrating Math Tools in AI Development	
27.	**Neural Network Math, Hyperparameter Tuning**	**Neural Network Math** – Forward/backward propagation, chain rule. **Hyperparameter Tuning** – Grid search, random search, Bayesian optimization.	LO4: Integrating Math Tools in AI Development	
28.	**Case Study: Math in AI** – Implementing a logistic regression model from scratch. **Capstone Project** – Solve an AI problem (e.g., recommendation system) using math tools.	LO4: Integrating Math Tools in AI Development		
29.	Final Exam Preparation & Review	LO3, LO4	LO1, LO2, LO3, LO4	
30.	Final Exam	LO1, LO2, LO3, LO4	LO1, LO2, LO3, LO4	