INTERNATIONAL QUALIFICATIONS

AND ASSESSMENT CENTRE (IQAC)

«Approved»

2025 y. «____» _____

Programme	**Level 6 Diploma in Artificial Intelligence**		
Unit Number/ Unit Title	UNIT 2 ADVANCED MACHINE LEARNING AND DEEP LEARNING		
Cohort Code:	L06AMDL-U2		
Unit Level	6		
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 unit advances learners' knowledge of machine learning and deep learning architectures. Students will work on real-world problems using ensemble learning, CNNs, RNNs, and transformers. The course emphasizes practical implementation, model evaluation, and optimization
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** • Géron, A. (2019). Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow. • Chollet, F. (2021). Deep Learning with Python. • Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. • Raschka, S., & Mirjalili, V. (2019). Python Machine Learning.

Learning Outcome	Assessment Criteria
LO1. 1. Develop advanced machine learning models.	1.1 Implement and evaluate ensemble models (Random Forest, XGBoost). 1.1 Perform hyperparameter tuning and cross- validation.
LO2. 2. Build and apply deep learning architectures.	2.1 Construct CNNs for image data. 2.1 Design RNNs and LSTM networks for time series/NLP.
LO3. 3. Evaluate and optimize model performance.	3.1 Use evaluation metrics (AUC, F1-score, etc.). 3.1 Apply regularization and dropout.
LO4. 4. Implement transfer learning and fine-tuning.	4.1 Fine-tune pretrained models on custom datasets. 4.1 Evaluate computational efficiency of different approaches.
LO5. 5. Critically compare deep learning frameworks.	5.1 Contrast TensorFlow, PyTorch, and Keras. 5.1 Justify framework choice for a given task.

No	Learning Outcome / Topic	Learning and Teaching Activities	Which assessment criteria does the session relate to?	Day/month/year/ signature
1.	**Introduction to Ensemble Learning**	**Introduction to Ensemble Learning** Bias-variance tradeoff, bagging vs. boosting.	LO1: Develop Advanced Machine Learning Models	
2.	**Random Forest**	**Random Forest** Algorithm, feature importance, OOB error.	LO1: Develop Advanced Machine Learning Models	
3.	**Gradient Boosting (XGBoost, LightGBM, CatBoost)**	**Gradient Boosting (XGBoost, LightGBM, CatBoost)** Loss functions, tree pruning, SHAP values.	LO1: Develop Advanced Machine Learning Models	
4.	**Hyperparameter Tuning**	**Hyperparameter Tuning** Grid search, random search, Bayesian optimization.	LO1: Develop Advanced Machine Learning Models	
5.	**Cross-Validation Strategies**	**Cross-Validation Strategies** k-fold, stratified, time-series CV (e.g., TimeSeriesSplit).	LO1: Develop Advanced Machine Learning Models	
6.	**Neural Networks Fundamentals**	**Neural Networks Fundamentals** Perceptrons, activation functions (ReLU, Sigmoid), backpropagation.	LO2: Build and Apply Deep Learning Architectures	
7.	**Optimization Algorithms**	**Optimization Algorithms** SGD, Adam, RMSprop, learning rate scheduling.	LO2: Build and Apply Deep Learning Architectures	
8.	Half-Term Exam	- Review of LO1 topics - Practice questions and mock assessment - **Half-term assessment** based on LO1 (theory)	LO1 LO2	
9.	**Convolutional Neural Networks (CNNs)**	**Convolutional Neural Networks (CNNs)** Filters, pooling, architectures (LeNet, ResNet).	LO2: Build and Apply Deep Learning Architectures	
10.	**Transfer Learning with CNNs**	**Transfer Learning with CNNs** Fine-tuning pretrained models (VGG, EfficientNet).	LO2: Build and Apply Deep Learning Architectures	

11.	**Recurrent Neural Networks (RNNs)**	**Recurrent Neural Networks (RNNs)** Vanishing gradients, sequential data handling.	LO2: Build and Apply Deep Learning Architectures	
12.	**Long Short-Term Memory (LSTM) & GRUs**	**Long Short-Term Memory (LSTM) & GRUs** Cell states, gates, applications in NLP/time series	LO2: Build and Apply Deep Learning Architectures	
13.	**Attention Mechanisms & Transformers**	**Attention Mechanisms & Transformers** Self-attention, BERT, GPT overview.	LO2: Build and Apply Deep Learning Architectures	
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.	**Advanced Evaluation Metrics**	**Advanced Evaluation Metrics** AUC-ROC, precision-recall curves, F1-score.	LO3: Evaluate and Optimize Model Performance	
18.	**Confusion Matrix Analysis**	**Confusion Matrix Analysis** Per-class metrics (sensitivity, specificity).	LO3: Evaluate and Optimize Model Performance	
19.	**Regularization Techniques**	**Regularization Techniques** L1/L2 regularization, early stopping.	LO3: Evaluate and Optimize Model Performance	
20.	**Dropout & Batch Normalization**	**Dropout & Batch Normalization** Reducing overfitting in deep networks.	LO3: Evaluate and Optimize Model Performance	
21.	**Model Interpretability**	**Model Interpretability** LIME, SHAP, Grad-CAM for CNNs.	LO3: Evaluate and Optimize Model Performance	

22.	**Pretrained Models Overview**	**Pretrained Models Overview** ImageNet models (ResNet, MobileNet), Hugging Face (NLP).	LO4: Implement Transfer Learning and Fine-Tuning	
23.	Half-Term Exam	**Capstone Project** End-to-end pipeline: From data to deployed model (e.g., Flask/Django API).		
24.	**Fine-Tuning Strategies**	**Fine-Tuning Strategies** Freezing layers, differential learning rates.	LO4: Implement Transfer Learning and Fine-Tuning	
25.	**Data Augmentation Techniques**	**Data Augmentation Techniques** Image transformations, NLP augmentations (Synonym Replacement).	LO4: Implement Transfer Learning and Fine-Tuning	
26.	**Computational Efficiency**	**Computational Efficiency** Model pruning, quantization, edge deployment (TensorFlow Lite).	LO4: Implement Transfer Learning and Fine-Tuning	
27.	**TensorFlow vs. PyTorch**	**TensorFlow vs. PyTorch** Graph vs. eager execution, ecosystem comparison.	LO5: Compare Deep Learning Frameworks	
28.	**Keras & High-Level APIs**	**Keras & High-Level APIs** Simplifying model building in TF/PyTorch. **Framework Selection Criteria** Scalability, community support, production readiness.	LO5: Compare Deep Learning Frameworks	
29.	Final Exam Preparation & Review	LO1, LO2, LO3, LO4	LO1, LO2, LO3, LO4	
30.	Final Exam		LO1, LO2, LO3, LO4	