

PAPUR ARHOLIAD / EXAMINATION PAPER

LLEOLIAD / LOCATION:	ABERTAWE / SWANSEA
CYFNOD ARHOLIADAU / EXAMINATION PERIOD:	IONAWR 2026 / JANUARY 2026
LEFEL / LEVEL:	6

MODIWL / MODULE: ACCA6011 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

AMSER / TIME:	2 HOURS (Use 1 ½ Not 1.5 for time)
CYFARWYDDIADAU / INSTRUCTIONS:	ANSWER <u>THREE</u> QUESTION OUT OF <u>FOUR</u>

Adnoddau neu ddefnyddiau sydd eu hangen / Equipment or materials required:
Dewiswch o'r canlynol os gwelwch yn dda / Please select from the following:

Cyfrifiannell / Calculator ☒

Llyfr Agored / Open Book ☐

Llyfr Fformiwla / Formula Book ☐

Arall nodwch os gwelwch yn dda / Other please specify

DO NOT change Margins/Headers/Footers/Layout of Cover page

Font: Arial

Office Use Only:			
Author:		Semester:	
Internal Verifier:		R Y/N?	Yes / No (Please delete as applicable)
Contribution to Overall Module Assessment (%):			

1. Question One [25 Marks]

A smart irrigation system is deployed in a vineyard to optimise water usage. The system uses fuzzy logic to determine irrigation levels based on soil moisture, temperature, and sunlight intensity. The fuzzy sets are defined as follows:

- Soil Moisture: Dry (0–30%), Optimal (30–70%), Wet (70–100%)
- Temperature: Cold (0–15°C), Moderate (15–30°C), Hot (30–45°C)
- Sunlight: Low, Medium, High (based on lux readings)

- a. In this context of irrigation system, explain how the concept of fuzzy sets differs from crisp sets. **[4]**
- b. Provide an example using the 'Soil Moisture' input to illustrate how membership values are assigned differently in fuzzy and crisp logic, and discuss the implications for irrigation decision-making. **[6]**
- c. Explain the concept of a triangular membership function in the context of fuzzy logic. Include a diagram to illustrate it and discuss its key characteristics. **[7]**
- d. Define the membership function for the fuzzy set “Moderate”, assuming it has a peak at 22.5°C and spans from 15°C to 30°C. Provide the piecewise linear equations for the increasing and decreasing segments. **[6]**
- e. Calculate the membership value for a temperature of 20°C in the “Moderate” fuzzy set. **[2]**

2. Question Two [25 Marks]

A smart logistic company is developing an AI system to optimise delivery routes and predict delivery delays. The system uses AI models to predict delivery times based on historical data such as traffic patterns, weather, and driver behaviour. To find the most efficient delivery routes, Hill climbing search strategy is proposed.

- a. Explain how supervised learning can be applied to forecast delivery delays. In your answer specify the type of learning involved, the relevant input features and clearly define the target variable. **[8]**
- b. Describe the Hill Climbing algorithm and explain how it could be applied to optimise delivery routes. What does a “state” and a “neighbour” represent in this context? **[5]**
- c. Discuss two limitations of Hill Climbing in route optimisation and suggest one variant or improvement that could help overcome these limitations. **[3]**
- d. Suppose the machine learning model performs well on training data but poorly on unseen data. What does this indicate, and how would you address it? **[5]**

- e. Briefly explain how combining machine learning with search algorithms can lead to more intelligent decision-making in logistics. **[4]**

3. Question Three [25 Marks]

A city council is implementing smart city technologies to improve urban services. They are collecting data from traffic sensors, public transport systems, social media, and citizen feedback platforms. The goal is to use machine learning to support decision-making in areas like traffic management, public safety, and citizen engagement.

- a. Describe the main characteristics of supervised, unsupervised and semi supervised machine learning method. **[6]**
- b. For each of the following smart city problems, identify the most suitable machine learning method (supervised, unsupervised, or semi-supervised) and justify your choice. **[9]**

Table 1: Learning problems

No	Smart City problem	Suitable ML method (1 Mark)	Provide Justification (2 Mark)
i	Classifying emergency service calls as fire, medical, or police based on call transcripts.		
ii	Grouping areas of the city based on traffic patterns to optimise signal timings.		
iii	Detecting unusual patterns in electricity usage where only some data is labelled as "normal" or "abnormal."		

- c. A model is being developed to predict whether a citizen complaint will be resolved within 48 hours. Explain how you would split the dataset into training, validation, and test sets, and describe the purpose of each. **[6]**
- d. During training, the model performs well on the training set but poorly on the validation set. What does this indicate, and how might you address it? **[4]**

4. Question Four [25 Marks]

A large online retailer wants to segment its customers using K-Means Clustering based on features such as purchase frequency, average order value, and time since last purchase. The goal is to tailor marketing strategies to different customer groups. However, the company is also aware of the ethical implications of using customer data for automated decision-making.

- a. Explain the working process of the K-Means clustering algorithm. In your answer, describe the function of centroids and how the algorithm iteratively updates cluster assignments. **[10]**

- b. Explain how you would determine the optimal number of clusters (K) for this dataset. **[4]**

- c. In K-Means clustering, why is the choice of distance measure (like Euclidean distance) important, and how can it affect the results? **[3]**

- d. After clustering, the company notices that one group consists mostly of low-income customers. Discuss one ethical concern that may arise from targeting this group with specific marketing strategies. **[4]**

- e. Suggest two ways the company can ensure its use of clustering respects customer privacy and avoids discriminatory practices. **[4]**

Diwedd / End