

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Engineering



0043

Study Programme	: Bachelor of Science Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	: DMX5315 – Artificial Intelligence
Academic Year	: 2024/2025
Date	: 06 th of February 2026
Time	: 1400 – 1700 hrs
Duration	: 3 hours

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Five (5) compulsory** questions in **Six (6)** pages.
3. All questions carry equal marks.
4. Answer to each question should commence from a new page.
5. This is a Closed Book Test (**CBT**).
6. The symbols used in this paper have their usual meanings.
7. Clearly state any assumptions that you may make.
8. Answers should be in clear handwriting. Do not use a red pen.
10. You are not allowed to use a programmable calculator.

Question 01

- a. Name two (2) features of intelligent systems. [2 marks]
- b. Briefly describe two (2) characteristics or components of intelligence. [4 marks]
- c. How does an intelligent agent interact with its environment? [2 marks]
- d. Discuss the cognitive modelling approach using a suitable diagram. [3 marks]
- e. “Supervised learning is not possible if a labeled dataset is not provided”. Comment on this statement with clear justifications. [3 marks]
- f. Consider a medical expert system built using the expert knowledge of medical doctors in the field of cancer diagnosis. Using a suitable diagram, briefly explain the components of this medical expert system. How can this system differ when compared with a system based on ANNs? [6 marks]

Question 02

- a. Consider the following fuzzy rule base with three (3) fuzzy rules.

R1: if X is small and Y is small, then $z = -x + y + 1$

R2: if X is small and Y is large, then $z = -y + 3$

R3: if X is large and Y is small, then $z = -x + 3$

What is the most suitable fuzzy inference mechanism to use for this fuzzy system?

Justify your answer.

[3 marks]

- b. With the use of a **suitable example**, briefly explain the main components of a Fuzzy Inferencing System. [4 marks]
- c. Let $U = \{a, b, c, d\}$ be the domain, X and Y be fuzzy sets on U as given in Table Q2. Prove the following property of fuzzy sets X and Y , which is known as De Morgan's law $(X \cup Y)' = X' \cap Y'$, using the values given Table Q2. [6 marks]

	a	b	c	d
X	0.5	0.2	0.4	0.9
Y	0.3	1.0	0.8	0.2

Table Q2

- d. Consider the binary fuzzy relation R , on $U \times V$, where $U = \{a, b, c\}$ and $V = \{x, y\}$. Find the projections R_1 and R_2 . Show all the workings clearly.

NOTE:

Marks will not be given for answers without the definitions and clear solving using appropriate steps. [7 marks]

$$R = \begin{bmatrix} 0.6 & 1.0 \\ 0.3 & 0.5 \\ 0.4 & 0.2 \end{bmatrix}$$

Question 03

Consider the Artificial Neural Network diagram given in Figure Q3. Assume that the neurons have a **Bipolar continuous activation function** and that $\lambda = 1$ and $\eta = 1$. With the use of the backpropagation algorithm, find the following.

- a. Error after one pass of the trained network (Output node). [7 marks]
- b. Errors of the hidden layer nodes. [7 marks]
- c. New weight values for each connection. [6 marks]

NOTE:

Use the given error finding method to find the error and consider the Target value as 1.

[Error = Output(1-Output) (Target-Output)]

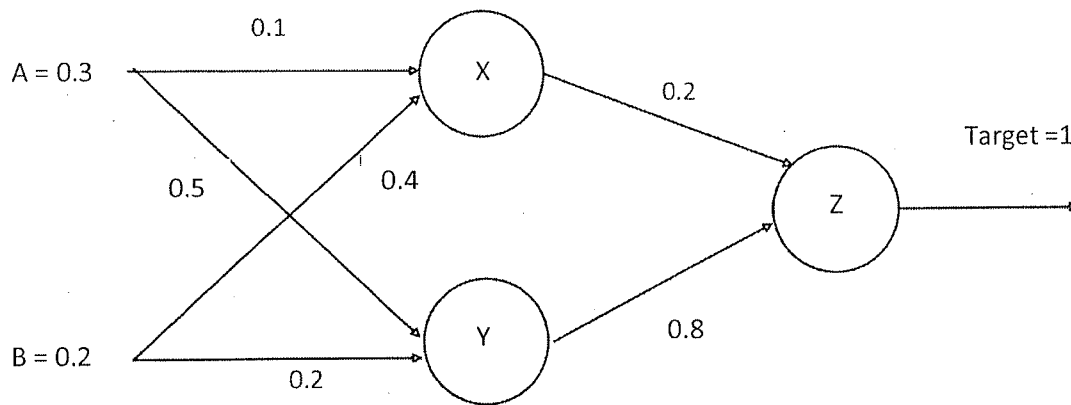


Figure Q3

Question 04

- Discuss “Informed” and “Uninformed” search algorithms, giving two (2) examples for each algorithm type. [4 marks]
- Consider Figure Q4 given below. Using separate graph diagrams indicate the sequence of traversal when the following algorithms are used.
 - Depth-First Search algorithm
 - Breadth-First Search algorithm

(Note: Stating only the sequence will not gain full marks. You need to draw each step using clear diagrams). [6 marks]

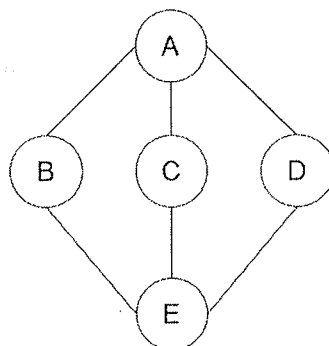


Figure Q4

- A dataset is available at a popular data repository which can be used to diagnostically predict whether or not a patient has diabetes. The prediction is based on certain diagnostic measurements included in the dataset. It consists of 768 samples and 8 attributes. The attributes are *No of Pregnancies*, *Plasma glucose concentration*, *Diastolic blood pressure*, *SkinThickness*, *Insulin*, *BMI*, *DiabetesPedigreeFunction* and *Age*. The output classes are Diabetics Positive and Diabetics Negative.

Answer the following questions based on the description above.

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- i. If you use Python to develop this ANN, write down the code necessary to build the architecture of the ANN (Creating the model).

You may assume values for any unknown variable/s. [3 marks]

- ii. If you use 5-fold cross validation for the training of the above ANN, how many samples will be considered for testing at one training cycle? What is the reason to use a cross-validation technique? [2 marks]

- iii. With the use of loss curves, briefly explain what you understand by the term 'overfitting'. [3 marks]

- iv. Consider an evaluation matrix that can be used to evaluate other than the matrix *accuracy*. Name the chosen evaluation matrix and write down any formulas or tables or graphs to explain how it works. If needed, you may indicate how to read this chosen matrix. [2 marks]

Question 05

Imagine that you are hired as a trainee engineer by an electronic goods manufacturing company in the country. The company is seeking your assistance in building an intelligent system using fuzzy logic for rice cookers. You have identified that the fuzzy inputs of the system to be as Rice Type (R) and Quantity (Q) while the Time to Cook (T) is considered as the output of this fuzzy controller.

The corresponding fuzzy values of the system are identified as:

R: Rice Type (VL: Very Low Quality, M: Medium Quality, VH: Very High Quality)

Q: Quantity (PS: Positive Small, PM: Positive Medium, PL: Positive Large)

T: Time to Cook (PS: Positive Small, PM: Positive Medium, PL: Positive Large)

The fuzzy rule base for the systems is given below:

R1: IF R is VL and Q is PS then T is PS

R2: IF R is M and Q is PL then T is PM

R3: IF R is VH and Q is PM then T is PL

Figure Q5.1, Figure Q5.2 and Figure Q5.3 depict the membership functions of *Rice Type*, *Quantity* and *Time to Cook*, respectively, along with their membership grades.

At a given instant, the following set of sensor data is available:

- *Rice Type* – 4.5
- *Quantity* – 3.2 cups

Determine the corresponding *inference membership function* of *Time to Cook* when the above sensor data is applied to the fuzzy system. [20 marks]

(Hint: Use Max-Min inference method as applicable)

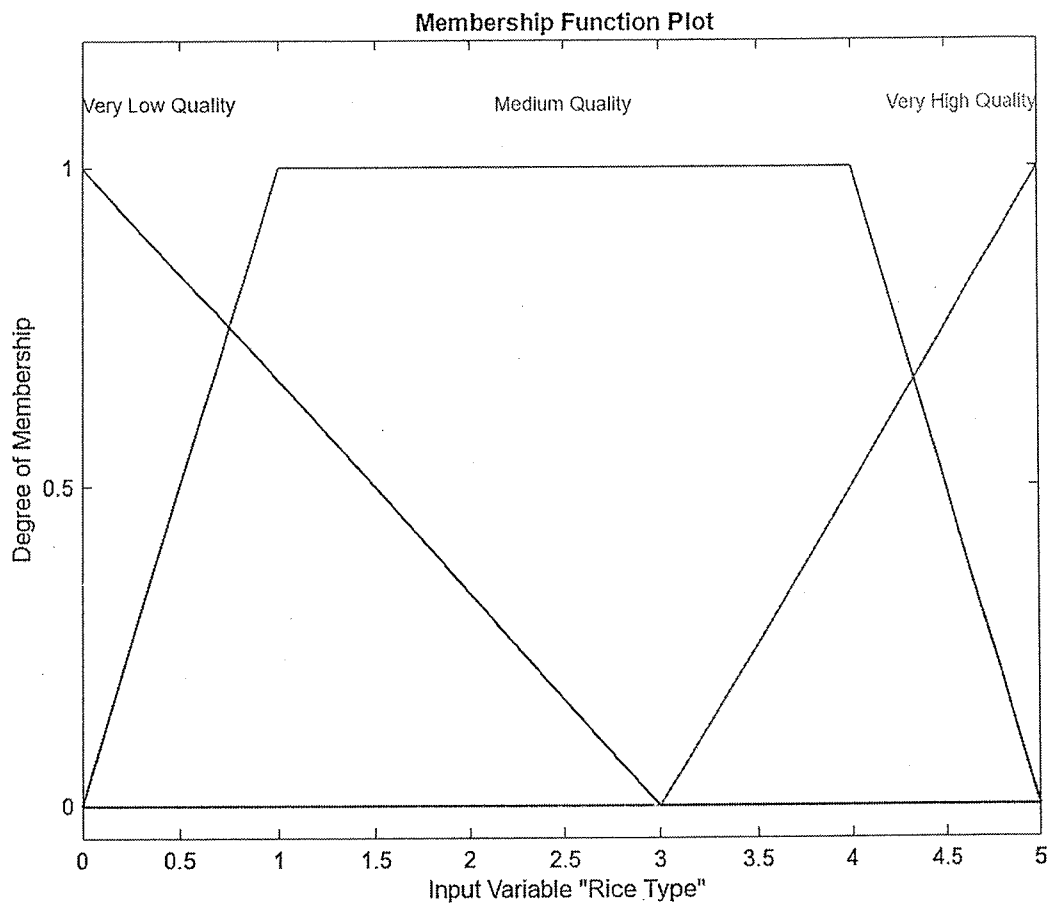


Figure Q5.1

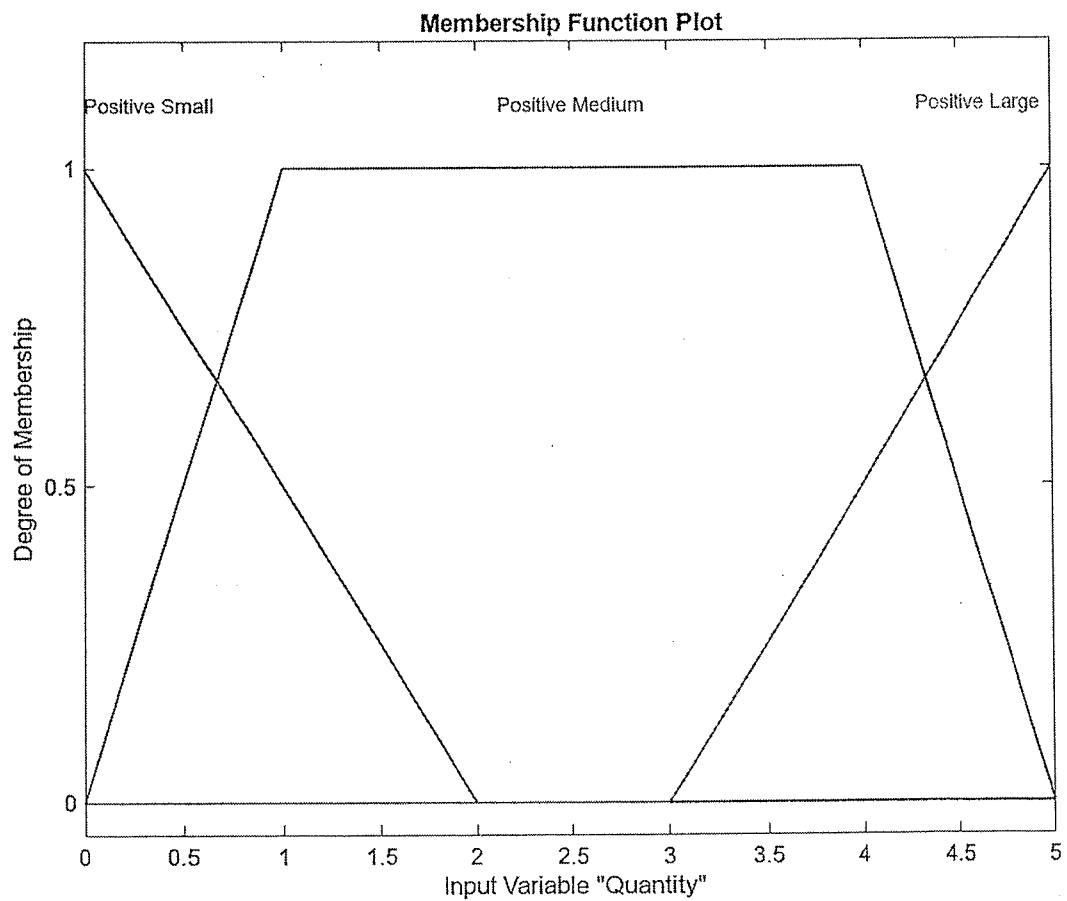


Figure Q5.2

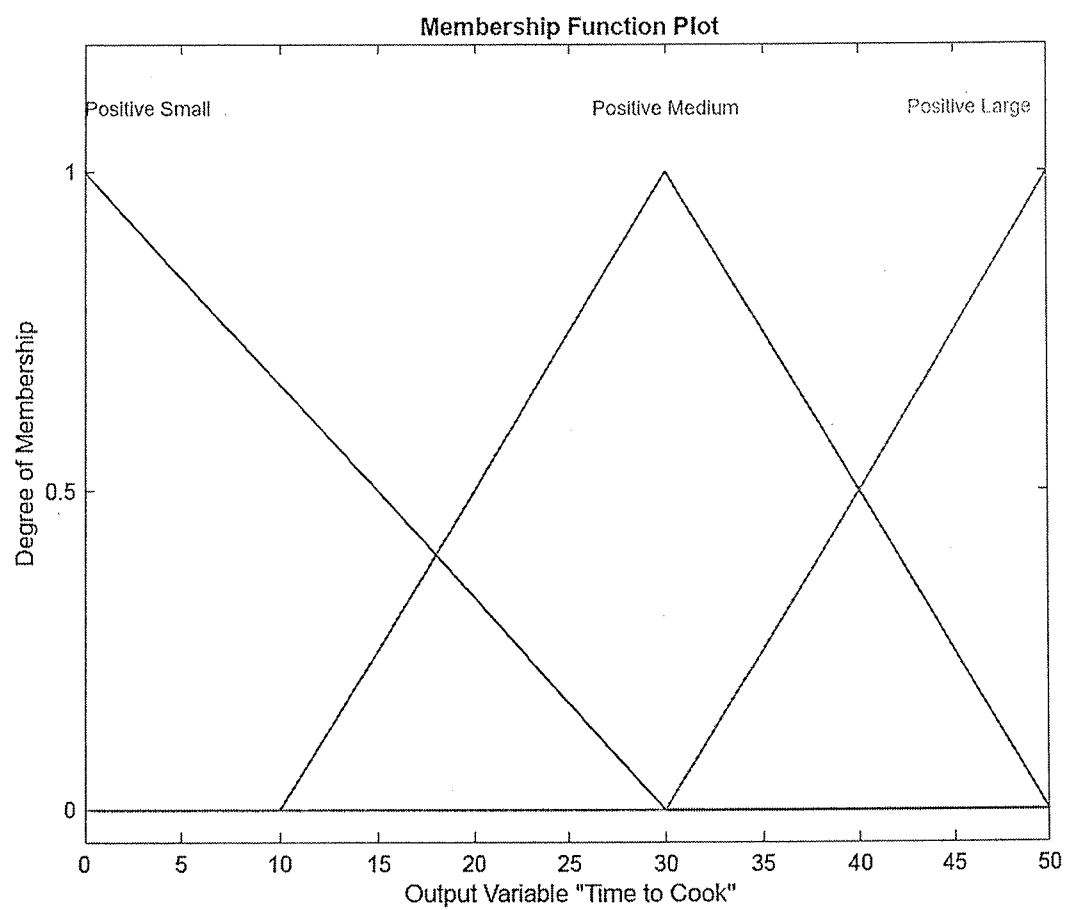


Figure Q5.3

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