

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



Study Programme	: Bachelor of Science Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	: DMX5315 – Artificial Intelligence
Academic Year	: 2023/2024
Date	: 14th of February 2025
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 five (5) 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.
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Question 01

- a. Briefly discuss linguistic intelligence [2 marks]
- b. Give an example of deductive reasoning [3 marks]
- c. Briefly discuss 3 attributes of intelligent agents [6 Marks]
- d. Discuss one difference between linear regression and polynomial regression [4 marks]
- e. Explain briefly the working principle of k-means clustering using a suitable diagram [5 marks]

Question 02

- a. With the use of a suitable example, briefly discuss the difference between the fuzzy sets and crisp sets. [5 marks]
- b. Let $U = \{a, b, c, d\}$ be the domain, X and Y be fuzzy sets on U as given on Table Q2. Proof the following property of fuzzy sets X and Y , which is known as De Morgan's law $(X \cup Y)^t = X^t \cap Y^t$, using the values given Table Q2. [5 marks]

	a	b	c	d
X	0.6	0.9	0.1	0.2
Y	0.4	1.0	0.9	0.5

Table Q2

- c. Consider the ternary Fuzzy relation T , on $U \times V \times W$, where $U = \{a, b\}$, $V = \{x, y\}$ and $W = \{\&, *\}$. [6 marks]

$$T = \frac{0.2}{(a,x,\&)} + \frac{0.7}{(b,x,\&)} + \frac{0.3}{(a,y,\&)} + \frac{1}{(a,y,*)} + \frac{0.1}{(b,y,*)}$$

Find the following

- T_1
 - T_3
 - T_{23}
- d. Draw a suitable diagram to show the Core, Support and Boundaries of a fuzzy set. Make sure to label the diagram. [4 marks]

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 $\eta = 1$. Use Backpropagation method to find the old and new errors of the trained network. Use the given error finding method to find the error and consider the Target value as 1.

[Error = Output(1-Output) (Target-Output)] [20 marks]

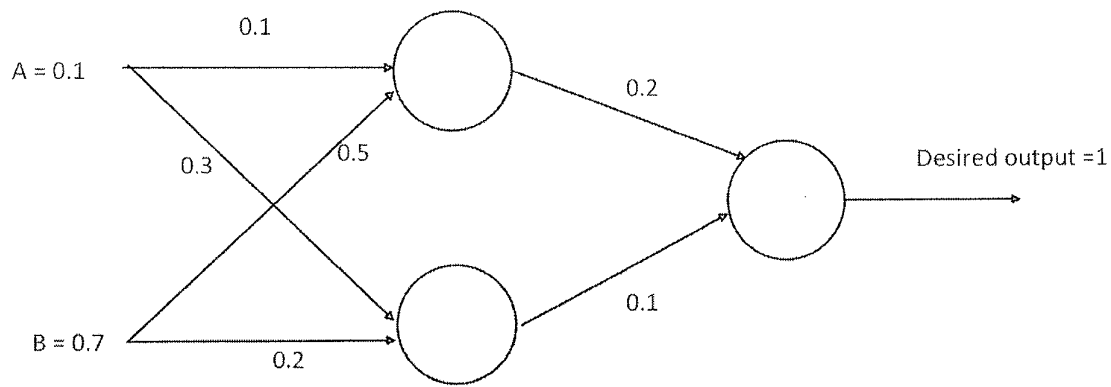


Figure Q3

Question 04

- List one blind search algorithm and one heuristic search algorithm. [2 marks]
- Describe “Search Space” with respect to Search algorithms. [3 marks]
- Consider the below given two graphs. In Figure Q4.1, indicate the sequence of traversal starting from node when Depth-First Search algorithm is used. In Figure Q4.2, indicate the sequence of traversal starting from node1, when Breadth-First Search algorithm is used. (Note: Redraw the graphs and indicate the sequence of traverse in numbers inside the nodes). [6 marks]

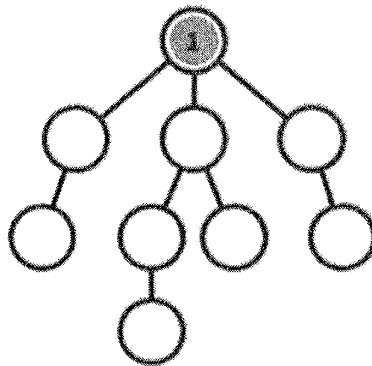


Figure Q4.1

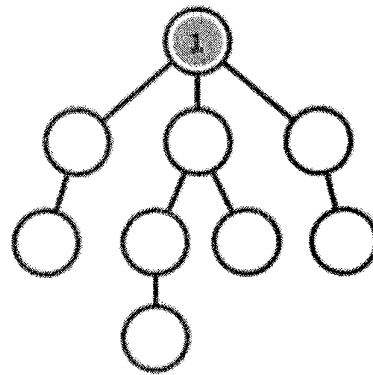


Figure Q4.2

- Consider the following description about the “glass dataset” available on a popular data repository on the web.

“glass dataset consists of 214 samples. There are 9 attributes and two classes, window glass or non-window glass. The 9 attributes are *Reflective index*, *Sodium*, *Magnesium*, *Aluminum*, *Silicon*, *Potassium*, *Calcium*, *Barium*, *Iron*”.

Answer the following questions based on the description above.

- i. How many input nodes are necessary if an Artificial Neural Network (ANN) is to be built for the classification of glass? [1 mark]
- ii. If you use Python to develop this ANN, write down the code necessary to build the architecture of the ANN.
You may assume values for any unknown variable/s. [3 marks]
- iii. If you use 10-fold cross validation for the training of the above ANN, how many samples will be considered for testing at one training cycle? [2 marks]
- iv. Consider the following confusion matrix that was received after the testing process. Identify the *True negative* value and calculate the *accuracy* of the classifier. [3 marks]

	Predicted: Non-window	Predicted: Window
Actual: Non-window	45	9
Actual: Window	10	150

Figure Q4.3

Question 05

A fuzzy controller is built to automate the braking system of a motor car. The two fuzzy inputs considered are Vehicle Speed (V) and Distance between the motor car and the vehicle in front (D). The output of this fuzzy controller is Braking Force(B) which controls the brakes.

The fuzzy variables and their corresponding fuzzy values are as follows:

- V: Vehicle Speed (PS: Positive Small, PM: Positive Medium, PL: Positive Large)
- D: Distance between the motor car and the vehicle in front (PS: Positive Small, PM: Positive Medium, PL: Positive Large)
- B: Braking Force (PS: Positive Small, PM: Positive Medium, PL: Positive Large)

Figure Q5 depicts the membership functions of the above fuzzy variables along with the membership grades.

A Simple rule base that is used in the fuzzy controller for the automatic braking system for motor car is given below.

- R1: IF *D* is *PM* and *V* is *PM* then *B* is *PM*
- R2: IF *D* is *PM* and *V* is *PL* then *B* is *PM*
- R3: IF *D* is *PL* and *V* is *PM* then *B* is *PM*

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

- Vehicle Speed – 55km/hr
- Distance between the motor car and the vehicle in front – 40m

Determine the corresponding inference membership function for the Braking Force (B) to be applied [20 marks]

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

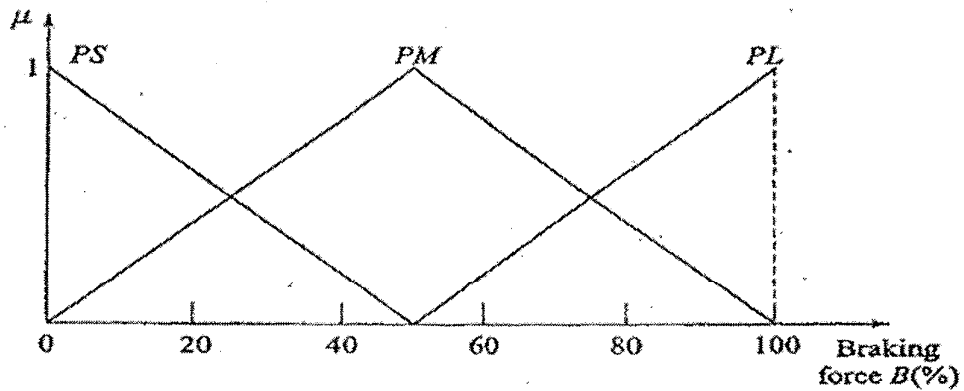
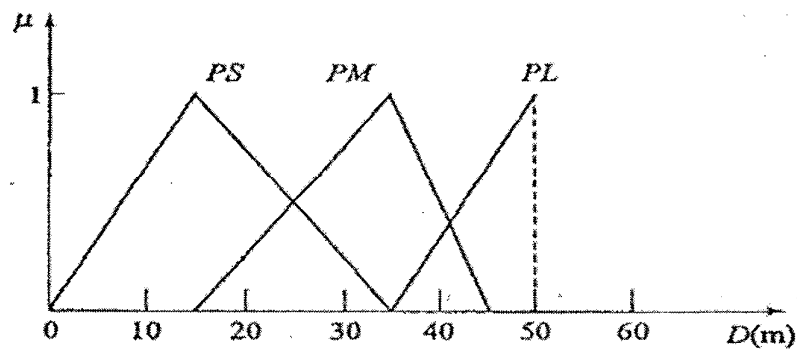
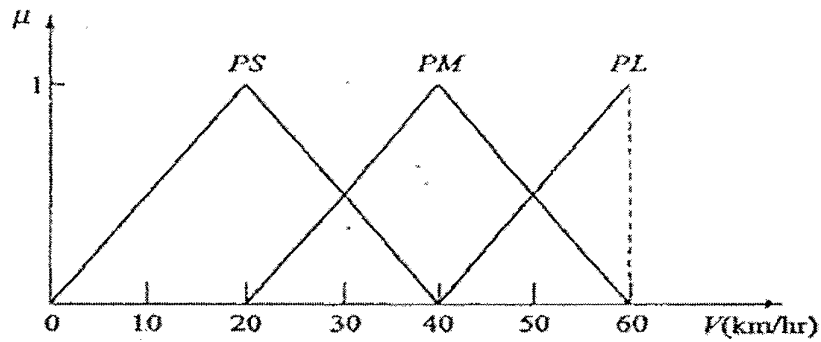


Figure Q5

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