U/D/TZ

Reg. No: 23BME0317

VIT
Vellore Institute of Technology

Final Assessment Test – April 2026

Course: BMEE407L - Artificial Intelligence

Class NBR(s): 2967 / 2970

Slot: A1+TA1

Time: Three Hours

Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

COs	CO Statements
CO1	Translate the characteristics of artificial intelligence and its sub-sets.
CO2	Implement appropriate algorithm for problem solving by searching.
CO3	Construct the logical agents and familiar in the application of fuzzy in AI.
CO4	Design the decision making algorithm with the reasoning of uncertainties.
CO5	Develop machine learning programs based on supervised, unsupervised and reinforcement learning.
CO6	Experiment the benefit of neural network in deep learning.
CO7	Apply machine learning approach to solve problems related to mechanical engineering.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions

(10 X 10 = 100 Marks)

1. Prove the logical equivalence in the De Morgan's Law and in the Distributive Rule using truth tables. **CO3 BL2**

2. Evaluate the health of a person with height of 185cm and weight of 49 kg using fuzzy inference system. The membership diagrams are as under **CO3 BL3**

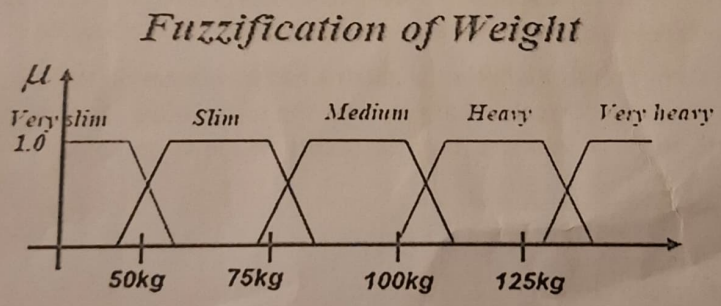

Fig.1(a)

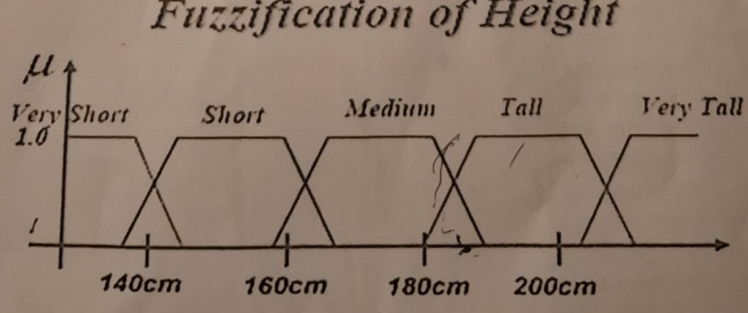

Fig.1(b)

The rule table is given below where H – Healthy, SH – Somewhat healthy, LH – Less Healthy, U – Unhealthy.

Height \ Weight	Very Slim	Slim	Medium	Heavy	Very Heavy
Very Short	H	SH	LH	U	U
Short	SH	H	SH	LH	U
Medium	LH	H	H	LH	U
Tall	U	SH	H	SH	U
Very Tall	U	LH	H	SH	LH

3. An industrial gas turbine is monitored by an AI-based predictive maintenance system using two sensors namely, Temperature Sensor (T) and Vibration Sensor (V) which operate independently. Historical data from the plant shows the probability that a turbine develops a mechanical fault is $P(F) = 0.03$ and it being normal is $P(\neg F) = 0.97$. If during monitoring, both sensors indicate a fault. Evaluate the probability that the turbine actually has a mechanical fault given that both sensors detect a fault. **CO4 BL4**

Sensor characteristics are as follows:

Temperature Sensor

Detects fault correctly, $P(T^+ \mid F) = 0.90$
False alarm rate, $P(T^+ \mid \neg F) = 0.07$

Vibration Sensor

Detects fault correctly, $P(V^+ \mid F) = 0.85$
False alarm rate, $P(V^+ \mid \neg F) = 0.05$

4. Discuss the applications of AI in material characterizations. **CO7 BL2**

5. A hospital AI system predicts whether a patient has a Disease or No Disease. The prediction results for 10 patients are given in the table below. Construct the Confusion Matrix and evaluate the metrics: Accuracy, Precision, Recall and F1 Score. **CO5 BL4**

Sample	Actual	Predicted
1	Disease	Disease
2	No Disease	Disease
3	Disease	Disease
4	Disease	No Disease
5	No Disease	No Disease
6	Disease	Disease
7	No Disease	No Disease
8	Disease	No Disease
9	No Disease	Disease
10	No Disease	No Disease

6. A predictive maintenance system groups machines based on two parameters i.e., Temperature (°C) and Pressure (bar). The following dataset contains five machines. CO5 BL3

Machine	Temperature	Pressure
M1	1	2
M2	2	1
M3	4	5
M4	5	4
M5	6	5

Apply the K-Means clustering algorithm for number of clusters K = 2. Take the Initial centroids as: C1 = (1, 2) and C2 = (5, 4). The distance between points is calculated using L2 norm.

7. A Deep Neural Network (DNN) is used in a mechanical condition monitoring system to predict the failure probability of a rotating machine based on sensor measurements. CO6 BL4

The architecture of the network is:

Input Layer: 2 neurons, x_1= Temperature (normalized), x_2= Vibration level (normalized)

Hidden Layer 1: 2 neurons (ReLU activation)

Hidden Layer 2: 2 neurons (ReLU activation)

Hidden Layer 3: 1 neuron (ReLU activation)

Output Layer: 1 neuron (Sigmoid activation)

Evaluate the final output of the network for an input value of $x_1 = 0.6, x_2 = 0.5$ and predict if the machine will fail or operate normally assuming the decision threshold of 0.5.

Weights and Biases

Input Layer → Hidden Layer 1

Connection	Weight
$x_1 \rightarrow h_1$	0.5
$x_2 \rightarrow h_1$	0.4
$x_1 \rightarrow h_2$	0.6
$x_2 \rightarrow h_2$	0.3

Bias: $b_{h1} = 0.2, b_{h2} = 0.1$

Hidden Layer 1 → Hidden Layer 2

Connection	Weight
$h_1 \rightarrow h_3$	0.7
$h_2 \rightarrow h_3$	0.5
$h_1 \rightarrow h_4$	0.6
$h_2 \rightarrow h_4$	0.4

Bias: $b_{h3} = 0.2, b_{h4} = 0.3$

Hidden Layer 2 → Hidden Layer 3

Connection	Weight
$h_3 \rightarrow h_5$	0.8
$h_4 \rightarrow h_5$	0.6

Bias: $b_{h5} = 0.2$

Hidden Layer 3 → Output Layer

Connection	Weight
$h_5 \rightarrow y$	0.9

Output Bias: $b_o = 0.3$

8. Discuss the different layers of Convolutional Neural Network. **CO6 BL2**

9.a) Apply $\alpha - \beta$ pruning algorithm to the game tree given below and determine the final optimal value at the root node. Show the (α, β) values during traversal. (Note: Read the leaf nodes as binary branches with 32 leaves.) **CO2 BL3**

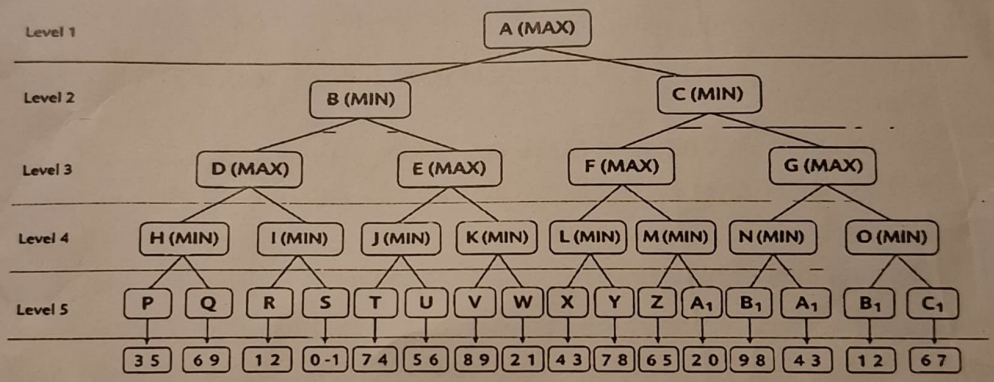

Fig.2

OR

9.b) Apply the DFS traversal algorithm starting from node A. and Draw the DFS traversal tree. Write the order in which nodes are visited and also show the stack operations during the traversal. **CO2 BL3**

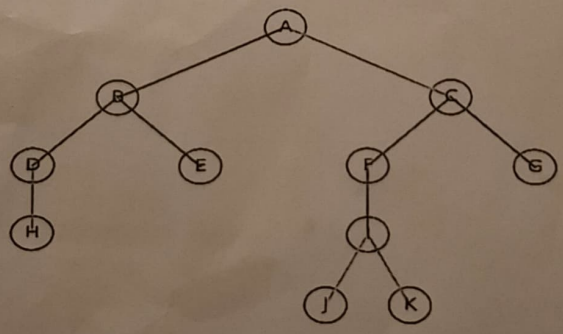

Fig.3

10.a) Discuss the architecture and operations of Knowledge-based agent and explain rules of inference system. **CO1 BL2**

OR

10.b) Explain the components of Learning Agent with neat schematic diagram. **CO1 BL2**

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