Total number of printed pages: **3** **Programme(UG)/Eighth Semester/UIE818**

2025

MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

Full Marks: 100

Time: Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1.	a)	Determine if the vectors V_1=(3,4,-2), V_2=(4,-2,2) are orthogonal and orthonormal. Also determine the cross product and angle between them.	(1.5 × 4 =6)
	b)	What do you mean by linearly independent vectors? Give an example for each of the following matrix: lower triangular matrix, identity matrix and symmetric matrix.	(2+3=5)
	c)	What will be the rank of the following matrix: $\begin{bmatrix} 1 & 3 & -5 \\ 6 & 12 & 18 \\ 2 & 6 & -10 \end{bmatrix}$	(2)
	d)	What does eigen vectors signify in a data matrix? If the eigen values of a matrix A is -2 and 3, what will be the eigen values of the matrix for A^3?	(1+2=3)
	b)	When a space can be termed as a vector space?	(4)
2	a)	Decompose the following matrix using eigen value decomposition method: $\begin{bmatrix} 4 & -2 \\ 5 & 3 \end{bmatrix}$	(10)
	d)	Decompose the following matrix using singular value decomposition method: $\begin{bmatrix} 4 & 3 \\ -2 & 6 \end{bmatrix}$	(10)
3	a)	What do you mean by bias and variance? Explain with the help of example. How can you overcome the issue of variance in machine learning?	(2+2+2=6)
	b)	What do you mean by overfitting and underfitting?	(2+2=4)

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<tr><td></td><td>c)</td><td>Choose the correct answer or provide your opinion as applicable:
i) If a dataset contains numerous features and few samples (observations), there would be an issue of underfitting/ overfitting.
ii) A very simple model mostly leads to underfitting/ overfitting problem.
iii) What condition in data matrix is desired for better decisions in machine learning?</td><td>(1+1+1=3)</td></tr>
<tr><td></td><td>d)</td><td>What is the difference between regression and classification? Briefly explain with example.
Discuss about the method of linear regression.</td><td>(2+5=7)</td></tr>
<tr><td>4</td><td>a)</td><td>Using Naïve Bayes algorithm determine if play is possible on rainy day?
<table><tr><th>Observation</th><th>Outlook</th><th>Temperature</th><th>Humidity</th><th>Play Golf</th></tr><tr><td>0</td><td>Rainy</td><td>Hot</td><td>High</td><td>No</td></tr><tr><td>1</td><td>Rainy</td><td>Hot</td><td>High</td><td>No</td></tr><tr><td>2</td><td>Overcast</td><td>Hot</td><td>High</td><td>Yes</td></tr><tr><td>3</td><td>Sunny</td><td>Mild</td><td>High</td><td>Yes</td></tr><tr><td>4</td><td>Sunny</td><td>Cool</td><td>Normal</td><td>Yes</td></tr><tr><td>5</td><td>Sunny</td><td>Cool</td><td>Normal</td><td>No</td></tr><tr><td>6</td><td>Overcast</td><td>Cool</td><td>Normal</td><td>Yes</td></tr><tr><td>7</td><td>Rainy</td><td>Mild</td><td>High</td><td>No</td></tr><tr><td>8</td><td>Rainy</td><td>Cool</td><td>Normal</td><td>Yes</td></tr><tr><td>9</td><td>Sunny</td><td>Mild</td><td>Normal</td><td>Yes</td></tr></table></td><td>(7)</td></tr>
<tr><td></td><td>b)</td><td>Explain how K-nearest neighbor (KNN) algorithm works?</td><td>(6)</td></tr>
<tr><td></td><td>c)</td><td>Discuss the working principle of support vector machine algorithm.</td><td>(7)</td></tr>
<tr><td>5</td><td>a)</td><td>What is the basic difference between supervised and unsupervised learning? Illustrate the steps for implementing K-Means algorithm for clustering the different categories of data?</td><td>(1+7=8)</td></tr>
<tr><td></td><td>b)</td><td>Discuss the density-based clustering algorithm.</td><td>(6)</td></tr>
<tr><td></td><td>c)</td><td>Explain how the independent component analysis (ICA) algorithm can be used to extract the source components from a signal of mixed sources.</td><td>(6)</td></tr>
<tr><td>6</td><td>a)</td><td>What do you mean by reinforcement learning? Give an example.
How does the Q learning arrive at the solution-explain the steps?</td><td>(2+2+6=10)</td></tr>
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6	b)	What is the difference between Q learning and SARSA algorithm? Discuss how genetic algorithm (GA) works to determine the optimal solution of a problem?	(2+8=10)
7	a)	What do you mean by neural network? With the help of a schematic diagram illustrate a perceptron model.	(1+3=4)
	b)	What are activation and objective functions? Briefly define.	(2)
	c)	What problem of recurrent neural network (RNN) algorithm can be resolved by Long short-term memory (LSTM) algorithm? How it does so?	(2)
	d)	Write short notes on any two: i) Back propagation algorithm in neural network ii) Convolutional neural network (CNN) algorithm iii) Decision tree algorithm	(2 × 6= 12)