(152)

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATIONS- 2026

B.Tech-IV Semester (CSE/IT/BT/ Mathematics and Computing)

COURSE CODE (CREDITS): L-25B11CI413 (3) MAX MARKS: 35

COURSE NAME: Artificial Intelligence and Machine Learning

COURSE INSTRUCTOR: Dr. Ravindara, Dr. Aman, Dr. Monika, Ms. Vani MAX. TIME: 2 Hours

Note: *(a) All questions are compulsory. (b) The candidate is allowed to make Suitable numeric assumptions wherever required for solving problems. (c) Use of calculator is allowed.*

Q.No	Question	CO	Marks
Q1	**Answer all of the following (Assessment-Based Questions): [5 x 1 = 5 Marks]** (i) What is the role of an activation function in an artificial neuron? Name any two types of activation functions. (ii) State the working principle of the McCulloch-Pitts neuron model. (iii) Define linear separability. Why is it important for a single-layer perceptron? (iv) What is a kernel function in SVM? Name any two kernel functions. (v) Differentiate between Max Pooling and Average Pooling.	CO1	5
Q2	**Answer all of the following (Theory Questions): [3 × 2 = 6 Marks]** (i) Define a support vector. What role do support vectors play in SVM classification? (ii) State the Perceptron Convergence Theorem and identify one condition under which it holds. (iii) What is the vanishing gradient problem? Name one technique used to address it.	CO3	6
Q3	**(i) Perceptron Learning — Multi-Step Weight Update (Numerical Question): [2 × 3 = 6 Marks]** A perceptron with two inputs is initialised with weights $w_1 = 0.3$, $w_2 = 0.2$ and bias $b = -0.4$. The learning rate $\eta = 0.3$ and activation function is a binary step function (output = 1 if net ≥ 0, else 0). The following three training samples are presented to the perceptron in order: Sample 1: $x_1 = 1$, $x_2 = 1$, desired output $d = 0$ Sample 2: $x_1 = 1$, $x_2 = 0$, desired output $d = 1$ Sample 3: $x_1 = 0$, $x_2 = 1$, desired output $d = 1$ For each sample, perform the following steps in order: (a) Compute net input: $net = w_1x_1 + w_2x_2 + b$ (b) Determine perceptron output $\hat{y}$ using the binary step activation. (c) Calculate error: $e = d - \hat{y}$ (d) Update weights using: $\Delta w_i = \eta \cdot e \cdot x_i$ and $\Delta b = \eta \cdot e$	CO2	6

	Carry updated weights into the next sample. State the final values of w_1, w_2, and b after processing all three samples. **(ii) SVM Margin Calculation:** Two support vectors are given: class +1 at (3, 3) and class −1 at (1, 1). The decision boundary is $w \cdot x + b = 0$ with $w = [1, 1]^T$ and $b = -2$. (1) Verify that both points satisfy their respective margin hyperplane equations. (2) Calculate the geometric margin of this classifier.		
Q4	**(i) Kernel Trick Analysis (Critical Thinking Questions):** **[2 × 3 = 6 Marks]** A dataset with 1000 features is processed by an SVM using an RBF kernel. A colleague suggests switching to a polynomial kernel of degree 3. Analyze the trade-offs in terms of computational cost, overfitting risk, and margin quality. Justify which kernel you would choose and why. **(ii) Skip Connections in ResNet:** ResNet introduced skip (residual) connections. Explain how skip connections address the vanishing gradient problem during backpropagation. If a 50-layer network is trained without skip connections on CIFAR-10, what training behavior would you expect compared to ResNet-50? Support your answer with concepts from the course.	CO4	6
Q5	**(i) CNN for Medical Image Classification (Project Based Questions):** **[2 × 3 = 6 Marks]** You are building a CNN to classify chest X-ray images as Normal or Pneumonia (binary classification). The dataset has 5,000 images per class. Design the CNN architecture by specifying: (1) Number of convolutional layers with filter sizes and strides. (2) Pooling strategy (type and position in the network). (3) Final fully-connected layers and output activation function. Justify each design decision. **(ii) Debugging an Overfitting Deep Neural Network:** Your 8-layer DNN trained on a large image dataset shows: training accuracy = 98%, validation accuracy = 62%. Diagnose the problem and propose a remediation plan. Your plan must include at least three specific techniques drawn from the course content, with a brief justification for each.	CO3	6
Q6	**(i) LeNet vs. AlexNet (Scenario Question):** **[2 × 3 = 6 Marks]** Compare LeNet-5 and AlexNet on the following dimensions: (1) depth and number of parameters, (2) activation functions used, (3) regularization techniques employed, and (4) the dataset or task each was designed for. What specific innovations made AlexNet a breakthrough over LeNet? **(ii) Inception Module (GoogLeNet):** Describe the Inception module used in GoogLeNet. Why does it use parallel filters of different sizes? How does the 1×1 convolution within the Inception module help reduce computational complexity? Draw a labeled diagram of the Inception module.	CO5	6