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School of Computer Science and Engineering

B.Tech. (Hons). Degree Examination-May 2025

Semester : IV

Course Code : CS2213

Course Title : Introduction to Machine Learning

Duration : 2 hours **Max. Marks: 30**

Instructions to students: i) Answer all Questions

ii) Scientific calculators are allowed.

Sl. No.	PART A – Questions	Marks	L1-L6	CO
1.	What is the purpose of encoding categorical variables? Describe two methods used for encoding with an example in each case.	5	L2	CO1
2.	Build a simple classifier to predict whether a fruit is an Apple or an Orange based on its weight (in grams) and colour intensity (scale 1–10). The following labelled data is available: **Fruit** | **Weight (g)** | **Colour Intensity** | **Label** F1 | 150 | 6 | Apple F2 | 170 | 7 | Apple F3 | 140 | 5 | Apple F4 | 130 | 3 | Orange F5 | 120 | 2 | Orange F6 | 110 | 1 | Orange Now, you have a new fruit with: Weight = 135g, Colour Intensity = 4. Using KNN with k=3 and Euclidean distance, classify the new fruit.	5	L3	CO2

Sl. No.	PART B – Max Marks(20)	Marks	L1-L6	CO
3.	**a)** Given the following standardized dataset with two variables X_1 and X_2, compute the first principal component (PC1). Show all steps including calculating the covariance matrix, eigenvalues, eigenvectors, and finally projecting the data onto the direction of PC1. X1 | 4 | 8 | 13 | 7 X2 | 11 | 4 | 5 | 14			

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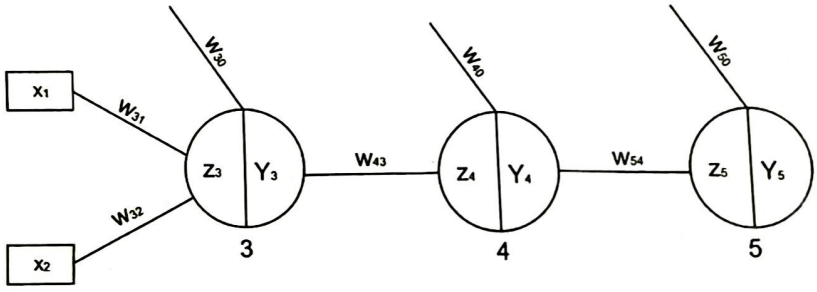
	b) Given a neural network with two inputs x_1=0.50 and x_2=0.80, a hidden layer-1 with one neuron (3), a hidden layer-2 with one neuron (4), and an output layer with one neuron (5), where the activation function is the sigmoid $Y_i=\sigma(Z_i)$ and the cost function $J=(Y_5-t)^2$ where target output t=1 and the weights are initialized as w_{30}=0.3, w_{31}=0.2, w_{32}=0.7 for neuron 3 . w_{40}=0.2, w_{43}=0.4 for neuron 4. w_{50}=0.8, w_{54}=0.9 for neuron 5. Consider Z_i indicates the weighted summation at a neuron i, before applying activation function. Compute the outputs Y_3, Y_4, and Y_5 and updated value of w_{31}. Sigmoid function $\sigma(z) = \frac{1}{1+e^{-z}}$ Consider learning rate = 1. [5 M]  	5+5	L3	CO3, CO4
4.	**a.** Consider a Convolutional Neural Network which has i) a Conv2D layer with 32 filters, followed by MaxPooling2D. ii. another Conv2D layer with 64 filters, followed by MaxPooling2D. iii a Flatten layer, and two Dense layers (128 and 10 units). **i.** Consider the input image dimension is 50x50x3 and the output feature map obtained by first Conv2D is 46x46x32. Find the spatial dimension of the convolution filter. You can assume stride=1, no padding applied. [2 M] **ii.** Consider the output feature map obtained from the first Conv2D is 46x46x32 which is given as input to the first MaxPooling2D layer. Assume this pooling layer uses a 2x2 filter with stride=4. Find the output feature map dimension and the number of parameters in this layer. [2 M] **iii.** Find the number of parameters in the first Conv2D layer. [1 M]	5+5	L3	CO5
	b. i. For a single sample, the true label is class 3 (one-hot encoded as [0,0,1,0,0]), and the predicted probabilities from the softmax layer are [0.1,0.1,0.6,0.1,0.1]. Calculate the categorical cross-entropy loss for this sample. [3 M] **ii.** Derive the gradient of the ReLU function f(x) with respect to x. Provide the expression for the gradient, considering all possible cases of x. [2 M] f(x) = max(x,0)			