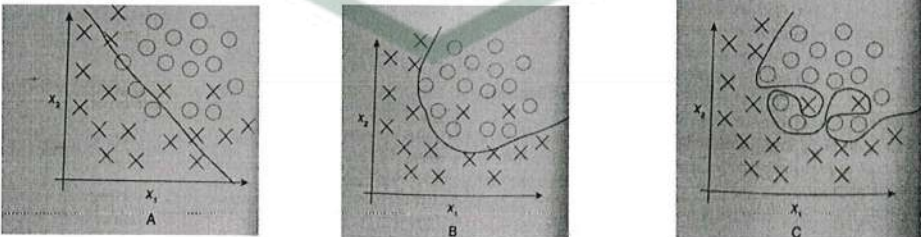## 2023

## SUBJECT NAME

*Full Marks : 100*

Time : Three hours

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

*Answer Q1 and any four questions from the rest.*

| 1. | A | Select the correct alternatives | |
|---|---|---|---|
| | a) | When we have two or more input variables and an output variable then the cost function is represented by a<br><br>i) Convex curve    ii) Concave curve    iii) Contour plot    d) All of the above | |
| | b) | If the output of a supervised model is a categorical output then it is a<br><br>i) Regression    b) Classifier    iii) Prediction iv) None of the above | |
| | c) | Which of the following is a measure of the spread of the data?<br><br>i) Mean        ii) Variance     iii) Covariance       iv) All of the above. | |
| | d) | How many coefficients do you need to estimate a simple linear regression model (two independent variable)?<br><br>i) 1      ii) 2     iii) 3     iv) 4 | |
| | e) | Below are the three scatterplots (A,B, and C)<br><br><br><br>i) A   ii) B   iii) C   iv) None of the above | |
| | f) | Which of the following is an advantage of a decision trees?<br><br>a) Possible scenarios can be added<br><br>b) The use of a white box model, if the given result is provided by a model. | |

| | | | |
|---|---|---|---|
| | | c) Worst, best, and expected values can be determined for different scenarios<br><br>d) All of the above. | |
| | g) | What do you mean by hard margin<br><br>I) The SVM allows low errors in classification<br><br>ii) The SVM allows high amount of error in classification<br><br>iii) Both of the above<br><br>iv) None of the above | |
| | h) | Which of the following method is not a spatial feature extraction method<br><br>i) SIFT    ii) SURF    iii) Harris corners    iv) Histogram | |
| | i) | Radial basis function network<br><br>i) adopts a supervised learning method.<br><br>ii) Shifts the feature point into a new domain<br><br>iii) Resolves X-OR problem in classification<br><br>iv) All of the above | |
| | j) | Which of the following network performs image segmentation<br><br>i) ANN ii) RNN iii) CNN iv) An auto-encoder. | |
| 1. | B | Write short answer questions | 2x5 |
| | a) | An ANN has 50 input neurons, two hidden layers having 10 and 60 neurons. The network classifies 10 types of patterns. Each hidden neuron and output neuron contains a bias which can also be considered as a weight. Find total number of weight parameters including bias. | |
| | b) | Deduce the covariance matrix of the following feature vector.<br><br>$x = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{bmatrix}$ | |
| | c) | A feature point x (3,4) undergoes two radial basis kernal having centroid at $x_c = (2,2)$ and $x_c = (8,10)$. The standard deviation $\sigma$ of the radial basis function is 1.<br><br>$\phi(x) = e^{-\|x - x_c\|^2} / 2 * \sigma^2$<br><br>What is the transformed point. | |
| | d) | The decision boundary of a 2 class classifier is 2x+3y=10. Two points (2,3) and (1,2) are classified by the boundary. State whether both these points in the same cluster or not. | |

| e) | Match the following | | | |
|---|---|---|---|---|

| A | $\phi=\dfrac{1}{1+e^{-kx}}$ | 1 | Signum |
|---|---|---|---|
| B | $\phi(z_i)=\dfrac{e^{z_i}}{\sum\limits_{j=1}^{N}e^{z_j}}$ | 2 | Sigmoid |
| C | $\phi(x)=max(0,x)$ | 3 | RELU |
| D | $\phi(x)=1$ for x>0 <br> $\phi(x)=-1$ for x<0 | 4 | Softmax |

| 2. | a) | Define the model of an artificial neuron and explain how you can implement a logic gate using that. | |
|---|---|---|---|
| | b) | State the role of the activation function in convergence of the error function. Give example of any four activation function. | |
| 3. | a) | State the difference between the supervised and unsupervised learning. | 4 |
| | b) | State different steps of the KNN algorithm | 6 |
| | c) | c) There are following points with N=2. Initial random centroids of the clusters are taken as (0,0) and (4,4). Derive 2 iteration for the given data and find the final position of the centroids.                    (5) | 10 |

| (1,1) | (8,8) | (-2,4) | (6,6) |
|---|---|---|---|

| 4. | a) | Describe the steps of a linear regression. Suppose the data $(X_i \to Y_i)$ is the given for a linear regression problem $Y_i=b_0+b_1 X_i$ . Apply method of least square error and deduce the parameters of a linear regression problem. Show that $$b_1 = \frac{\sum (X_i - X)(Y_i - Y)}{\sum (X_i - \bar{X})^2}$$ $$b_0 = \bar{Y} - b_1 \bar{X}$$ | 10 |
|---|---|---|---|
| | b) | The following dataset is provided. Find the value of $b_0, b_1$ as per given | 10 |

equations above from Table-1

| Sl No | $X$ | $Y$ | $(X_i - \bar{X})$ | $(Y_i - \bar{Y})$ | $(X_i - \bar{X})(Y_i - \bar{Y})$ | $(X_-X)^2$ |
|---|---|---|---|---|---|---|
| 1 | 151 | 63 | | | | |
| 2 | 174 | 81 | | | | |
| 3 | 138 | 56 | | | | |
| 4 | 186 | 91 | | | | |
| 5 | 128 | 47 | | | | |
| 6 | 136 | 57 | | | | |
| 7 | 179 | 76 | | | | |
| 8 | 163 | 72 | | | | |
| 9 | 152 | 62 | | | | |
| 10 | 131 | 48 | | | | |
| 11 | $\bar{X} =$ | $\bar{Y} =$ | | | | |

Table-1

| 5. | a) | What are names of the attributes in the following table. Write the key steps to form a decision tree. Estimate Information gain and Gain ratios for various attributes in the decision tree. | 2+4+14 |
|---|---|---|---|

| Sl No | Age | Income | Student | Credit | Buy |
|---|---|---|---|---|---|
| 1 | <30 | High | No | Fair | No |
| 2 | <30 | High | No | Excellent | No |
| 3 | 31-40 | High | No | Fair | Yes |
| 4 | >40 | Medium | No | Fair | Yes |
| 5 | >40 | Low | Yes | Fair | Yes |
| 6 | >40 | Low | Yes | Excellent | No |
| 7 | 31-40 | Low | Yes | Excellent | Yes |
| 8 | <30 | Medium | No | Fair | No |

| 9 | <30 | Low | Yes | Fair | **Yes** | |
| 10 | >40 | Medium | Yes | Fair | **Yes** | |
| 11 | <30 | Medium | Yes | Excellent | **Yes** | |
| 12 | 31-40 | Medium | No | Excellent | **Yes** | |
| 13 | 31-40 | High | Yes | Fair | **Yes** | |
| 14 | >40 | Medium | No | Excellent | **No** | |

Table-2

| 6. | a) | What do you mean by support in support vector machine. Derive expression of support in the Support vector machine. | 2+6 |
| --- | --- | --- | --- |
| | b) | What do you mean by XOR problem in classification. State how Radial basis function network overcome this issue. | 6+2 |
| | c) | State the following terminologies in a convolution neural network<br><br>i) Stride<br><br>ii) Convolution layer<br><br>iii) Maxpooling | 6 |
| | | | |
| 7 | | Write Short Notes (Any two) | 10x2 |
| | a) | Weight correction of output neurons in Back-propagation algorithm. | |
| | b) | Adam optimization algorithm | |
| | c) | Auto encoder | |
| | d) | Principle component analysis | |
| | | | |