National Institute of Technology, Delhi

Name of the Examination: End Semester Examination (Spring Semester 2022)

Branch : B. Tech. (CSE)   **Semester** : VI

Title of the Course : Machine Learning and Pattern Recognition   **Course Code** : ECL 708

Date of Examination: 20-05-2022   **Time: 3:00 Hours**   **Maximum Marks: 50**

Note: Attempt *all* sections. Be precise in your answer.

Assume any missing data. Marks are mentioned on the right side.

Section A

1. Attempt *all* questions.   [1 × 5]

(a). Define subspace of a vector space.
(b). Explain dimension of a vector space.
(c). When do you use the Singular Value Decomposition?
(d). What is a prior probability?
(e). Write the function of Chi-square distribution.

[1 × 5]

2. Attempt *all* questions:

(a). Explain deep learning.
(b). What are the characteristics of the Pattern Recognition system?
(c). What do you mean by cluster analysis?
(d). Write the difference between clustering and classification.
(e). Explain Kernel function.

Section B

[5 × 4]

3. Attempt any *four* of the following:

(a). Explain the difference between Statistical approach and Structural approach.
(b). What are the features of a Utility-based agent?
(c). Define the splitting technique for feature extraction.
(d). Explain loss function? How can it be factored into Bayes Decision theory?
(e). Consider a two-class problem having three independent binary features with known feature probabilities. Construct the Bayesian decision boundary if $P(\omega_1) = P(\omega_2) = 0.5$ and the individual components obey $p_i = 0.9$ and $q_i = 0.5$ for $i = 1,2,3$.

Section C

4. Attempt any **two** of the following: [10 × 2]

(a). Assume a two-class problem with equal a-priori class probabilities and Gaussian class-conditional densities as follows:

$$p(x/\omega_1) = N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} a & c \\ c & b \end{bmatrix}\right) \text{ and } p(x/\omega_2) = N\left(\begin{bmatrix} d \\ e \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}\right)$$

Where $a \times b - c \times c = 1$

Find the equation of the decision boundary between these two classes in terms of the given parameters, after choosing a logarithmic discriminant function.

(b). Formulate SVM as an optimization problem. How support vector machines can be used for classification of data which are not linearly separable?

(c). Suppose $X_1, X_2 \ldots \ldots \ldots \ldots X_n$ are i.i.d. random variables with normal density function having two unknown parameters μ and σ^2.

$$f(x|\mu, \sigma^2) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left\{-\frac{(x-\mu)^2}{2\sigma^2}\right\},$$

Find the maximum likelihood estimate of these unknown parameters.