

**Subject Name: Statistical Foundation of Machine Learning, Date: 15/6/25**  
**Class Test/Quiz Exam, 20 Points, Time : 2 hrs exam. (All questions are compulsory)**

Q1 : (10 Points)

Q1: In a Gaussian Naïve Bayes classifier, we typically assume that the standard deviation  $\sigma_i$  of  $P(X_i|Y = k)$  is the same for all class values  $k$ . Now, suppose we relax this assumption and allow  $\sigma_{ik}$  to vary depending on both the feature index  $i$  and the class  $k$ . Given that  $P(X_i|Y = k)$  follows a Gaussian distribution  $N(\mu_{ik}, \sigma_{ik})$ , derive the new form of  $P(Y|X)$ . Does this modified Naïve Bayes classifier still result in a logistic regression-like form for  $P(Y|X)$ ? Justify your answer with a derivation.

Q2 : (10 Points)

- a) [5 Points] : Write the Pseudo-code for NaveBayes theorem for classification of IRIS dataset where you have 3 categories of flower (setosa, virginia, versicolor). Please use the features petal width as an input.
- b) [5 Points] Suppose you have been asked to develop a perceptron And Gate with threshold (final activation function) of 0.5 (i.e when predicted output is above 0.5, perceptron output is 1 otherwise 0). Use initial weights to be  $w_1=0.9$  and  $w_2=0.9$ . Update the final weights (using the steepest descent process) during the misclassification (i.e error=actual-predicted). Run this process when no further change is possible in the predicted output compared to actual output.

X1	X2	Y (actual)
0	0	0
0	1	0
1	0	0
1	1	1