

**Department of Electrical and Computer Engineering  
AIML (ECE304) - Spring 2025**

**Instructor: Prof. Vinod Sharma**

**ASSIGNMENT-1**

1. Consider the given data set (*Dataset1\_Assignment1.csv*). The Data set contains 10000 samples with two features  $x_1$  and  $x_2$  and four classes  $y \in \{0, 1, 2, 3\}$ . The features are independent and identically distributed (iid). The distributions are Gaussian with means  $(-1, -1)$  for class 0,  $(-1, 1)$  for class 1,  $(1, -1)$  for class 2, and  $(1, 1)$  for class 3, respectively and the variances are  $(\sigma_1^2 = 0.1, \sigma_2^2 = 0.1)$  (i.e.,  $P(x|i) = \frac{1}{\sqrt{2\pi\sigma_1^2}} \exp(-\frac{(x_1-\mu_1)^2}{2\sigma_1^2}) \frac{1}{\sqrt{2\pi\sigma_2^2}} \exp(-\frac{(x_2-\mu_2)^2}{2\sigma_2^2})$ ). The prior probabilities of the classes are  $\pi(0) = 0.1$ ,  $\pi(1) = 0.3$ ,  $\pi(2) = 0.25$ , and  $\pi(3) = 0.35$ .
  - (a) Using the given information, design a Bayesian Classifier and get the probability of error.
  - (b) By using the first 5000 samples of the given data set, estimate the prior probabilities  $\hat{\pi}(i), i \in \{0, 1, 2, 3\}$  and the variances  $\hat{\sigma}_j^2, j \in \{1, 2\}$ . For the second 5000 samples,
    - obtain the probability of classification error using the Bayesian classifier of part(a)
    - obtain the Bayesian classifier using the obtained  $\hat{\pi}(i)$ ,  $\hat{P}(x|i)$  and  $\hat{\sigma}_j^2$ , and obtain the probability of classification error using this classifier.