QP Code: SN23BTECH210 Reg. No | | | | | | | | | | AY 23

Gandhi Institute of Engineering and Technology University, Odisha, Gunupur (GIET University)

B. Tech (Fifth Semester - Regular) Examinations, November 2025

23BCMPC35002—Advanced Machine Learning

CSE(AIML)

Time: 3 hrs Maximum: 70 Marks

Answer ALL questions
(The figures in the right hand margin indicate marks)

PART – A **(2 x 5 = 10 Marks)**

Q.1. Answer ***ALL*** questions

	Question	CO #	Blooms Level
a.	Discuss the importance of cost/loss functions and hypothesis space in the learning framework.	CO1	K1
b.	What is the difference between convex and non-convex optimization problem	CO1	K2
c.	Given true labels [1,0,1,1] and predicted probabilities [0.9,0.2,0.6,0.4], compute the binary cross-entropy (log loss) averaged over samples	CO3	K3
d.	Given feature X = [1, 2, 3] and target Y = [2, 4, 6], find the Pearson correlation coefficient	CO3	K3
e.	Compute one step of batch gradient descent for y = w·x, given (x, y) = (2, 4), learning rate 0.1, current w = 1.	CO1	K3

PART – B **(10 x 5 = 50 Marks)**

Answer ***ALL*** the questions

Marks | CO # | Blooms Level

2. a. Differentiate between the convex and non-convex optimization techniques and Explain briefly about regularization techniques with a suitable example — 5 | CO1 | K1

b. Consider the dataset below: Apply the Gradient Descent approach to estimate the parameters of the Linear Regression model :Y = wX + b.after two iterations, using a suitable learning rate. α=0.1. Consider the initial values are b0=0,b1=0. Compute the updated values of b0 and b1 after three iterations. — 5 | CO1 | K1

i	(X_i)	(Y_i)
1	1	2
2	2	3
3	3	4

(OR)

c. Consider **a** binary classification dataset where the training samples are given as: X=[1,2,3],Y=[0,0,1] and perform the following task. — 5 | CO1 | K3

i. Derive the log-likelihood function for logistic regression.
ii. Write the gradient descent update rules for b0 and b1.
iii. Using one iteration of gradient descent, estimate updated values of b0 and b1 assuming initial parameters b0=0,b1=0, learning rate η=0.1
iv. Compute the predicted probability for X=2.5 using the updated parameters.

d. Write a short notes on the followings: — 5 | CO1 | K2

i. Batch Gradient Descent,
ii. Stochastic Gradient Descent (SGD)
iii. Mini-Batch Gradient Descent

3.a. A dataset consists of three features F1, F2,F3 and a target variable T. The data is as follows:

OID	F1	F2	F3	T
1	2	5	8	10
2	3	6	5	12
3	4	7	6	14
4	5	8	7	16

Using Significant Feature Selection (SIGF), test which features (F1,F2,F3) are statistically significant predictors of the target variable T at a 5% significance level. Use $\alpha = 0.05$ (two-tailed) and compare the computed t-value with the critical value $t_{0.05}$, df=2 is 4.30 — 7 CO2 K4

b. Differentiate between Random Forest and XGBoost classifier with a suitable example — 3 CO2 K2

(OR)

c. A survey was conducted among 40 students to check the relationship between Gender and Preference for Online Classes. The observed data is given below: Using the Chi-Square Test of Independence, determine whether there is a significant relationship between Gender and Preference for Online Classes. Use $\alpha = 0.05$. — 5 CO2 K3

Gender	Prefer Online	Do Not Prefer Online	Total
Male	10	10	20
Female	14	6	20
Total	24	16	40

d. Explain briefly Elastic net regression and solve the numerical of the following :
A dataset contains the following observations for one independent variable X and a dependent variable Y:

X	Y
1	2
2	4
3	5

1. Fit a linear regression model of the form Y=b0+b1X.
2. Apply Ridge Regression (L2) and Lasso Regression (L1) with λ=1.
3. Compare the coefficient values b1 obtained from each regularization technique.

5 CO2 K3

4.a. A binary classification model was applied to predict whether a crop is Healthy (1) or Diseased (0).

i. Construct the Confusion Matrix.

ii. Estimate the followings :

a. Accuracy
b. Precision
c. Recall
d. F1-Score
e. Interpret the performance of the classifier.

Sample	Actual (Y)	Predicted ($\hat{Y}$)
1	1	1
2	0	0
3	1	0
4	0	1
5	1	1

5 CO3 K3

b. Take a suitable example to demonstrate the visualization tools such as **:=** Confusion Matrix, Learning Curves, Feature Importance Plots, Residual plots for regression — 5 CO3 K2

(OR)

c. A classifier assigns probability scores for the positive class (Healthy = 1) to 6 test samples. Estimate the AUC (Area Under Curve) approximately using the trapezoidal rule. The true labels and predicted probability scores are: — 7 CO3 K4

Sample	1	2	3	4	5	6
True label (Y)	1	0	1	0	1	0
Score (s)	0.95	0.85	0.6	0.4	0.3	0.1

d. Compute F-statistic for groups [2,3], [5,6], [7,8]. compute the F-statistic and full ANOVA table for these groups and give the decision at α=0.05 . The critical value from the F-table is $F_{0.05}$=9.552 | 3 | CO3 | K3

5.a. The following table shows the scores of three different teaching methods (A, B, and C) on student performance.

Group A	Group B	Group C
4	6	8
5	7	9
6	8	10

At a significance level of α = 0.05, apply the Kruskal–Wallis H **test** to determine whether there is a significant difference in the median performance among the three groups .Compute the H statistic**,** and make a decision based on the tabulated χ^2 value **is :**[$\chi^2_{0.05,2}$ = 5.991] | 5 | CO4 | K4

b. A researcher wants to determine whether a new learning technique improves students' test scores. The scores before and after using the new technique are given below:

Student	Before	After
1	55	60
2	48	50
3	52	53
4	47	45
5	50	49

At a significance level of α = 0.05, perform the Wilcoxon Signed-Rank Test to check if there is a significant difference between the two sets of scores. The critical value is T = 0. | 5 | CO4 | K4

(OR)

c. A researcher conducted an experiment to compare the effectiveness of three fertilizers **(A, B, and C)** on crop yield (in kg). The results obtained are as follows:

Fertilizer	Yield (kg)
A	20, 22, 23
B	25, 27, 26
C	30, 31, 29

Apply Post-hoc Tests (Post-hoc Tests) where Significance level α=0.05. Perform a One-Way ANOVA to test whether there is a significant difference in mean yields among the fertilizers at a 5% significance level. If ANOVA is significant, apply Post-hoc tests — Tukey's HSD and Bonferroni correction — to determine which fertilizer pairs differ significantly. F 0.05= 5.14.For Tukey's HSD (pairwise comparisons), Critical studentized range q 0.05= ≈4.34 .For Bonferroni critical t is 3.33 | 8 | CO4 | K4

d. Provide the flowchart for Hypothetical test | 2 | CO4 | K2

6.a. Define Explainable Artificial Intelligence (XAI). Why is it important in modern AI systems? | 5 | CO5 | K2

b. Explain the Gen AI with suitable example and architecture | 5 | CO5 | K2

(OR)

c. "Explainable AI is essential for ethical AI." — Justify this statement with reference to regulatory and user-trust aspects. | 5 | CO5 | K2

d. Write a short notes on Edge AI | 5 | CO5 | K2

--- End of Paper ---